Interactive Teaching and ICT

STEVE KENNEWELL
Swansea Metropolitan University (SMU)

HOWARD TANNER
Swansea Metropolitan University (SMU)

GARY BEAUCHAMP
University of Wales Institute Cardiff (UWIC)

JOHN PARKINSON
Swansea Metropolitan University (SMU)

SONIA JONES
Swansea Metropolitan University (SMU)

LYNNE MEIRING
Swansea Metropolitan University (SMU)

NIGEL NORMAN
Swansea Metropolitan University (SMU)

ALEX MORGAN
Swansea University (SU)

GERRAN THOMAS
Aberystwyth University (AU)

ABSTRACT

The *Interactive Teaching and ICT* project was designed to explore the effect of ICT on teaching and learning when used specifically to support 'interactive teaching'. A range of good teachers agreed to participate in interviews and lesson observations over two 6-month phases. They worked in pairs with one using ICT and one not using ICT for a particular class and subject in the first phase, and both used ICT in the second phase.

Whilst many teachers did not identify any changes in their pedagogical approach, some decreased the amount of direct teaching, broadened the range of activities for pupils and increased the independence of pupils.

Teachers who are very effective without ICT may not immediately enhance their teaching when they adopt ICT, and their performance can dip as they gain ICT skills and experiment with how ICT can best be integrated into their practice. Teachers already using ICT, however, tended to improve their effectiveness and to gain from reflecting on their practice, discussing ideas and sharing resources from colleagues.

The project was found to have made an important contribution to the confidence and skills in research for those involved, and to have contributed to the development of research capacity in Wales concerning ICT Education.

Framing the study

Following the massive investment in ICT in UK schools in the late 1990s which was largely an act of faith (Kennewell et al., 2000), policy-makers have sought evidence that it has been effective in aiding their attempts to raise standards of attainment by students. Whilst there is much case study evidence to illustrate effective learning in particular classrooms where the teachers' use of ICT is well established (Comber et al., 2002; Hennessy et al., 2006; Somekh et al., 2007), it seems hard to find clear evidence that ICT is, in itself, a significant factor in raising attainment in general. Post-hoc statistical analysis on a large scale shows only very small effects when other variables are factored out (Harrison et al., 2002). As means of confirming the expectations of ICT's success in raising attainment, experimental and quasi-experimental designs are fraught with the difficulties of isolating ICT from the myriad other variables which impact on learning, individually and in combination – not least, the quality of the teacher's pedagogical practices generally (Cox and Abbott, 2004).

Furthermore, the 'what works' approach to evaluation has been criticised for several reasons. Generally, it "… restricts the scope of decision making to questions about effectivity and effectiveness, but … also restricts the opportunities for participation in educational decision making" (Biesta, 2007: 2). Specifically for ICT, it is suggested that traditional tests of attainment involving manual skills and recall of factual knowledge are unlikely to reflect the changes in learning which may be associated with ICT (Cox and Abbott, 2004)

Against this background, it seemed that if ICT was going to make a difference when adopted by teachers, it would be seen most clearly in situations where technology most effectively supported the teacher's strategies. A key idea in linking ICT with pedagogical approaches is that of 'interactivity'. One of the features of ICT is that it is interactive, and teachers in the UK are expected to know how to take advantage of this feature (TTA, 1998). At the same time, the government in England has promoted the idea of 'interactive teaching' in its National Strategies for Literacy and Numeracy:

> High-quality direct teaching is oral, interactive and lively. It is not achieved by adopting a simplistic formula of 'drill and practice' and lecturing the class, or by expecting pupils to teach themselves from books. It is a two-way process in which pupils are expected to play an active part by answering questions, contributing points to discussions, and explaining and demonstrating their methods to the class (DfEE, 2001: 1.26).

Whilst the use of the term 'interactive' in relation to ICT concerns interaction between learner and technology, its use in relation to pedagogy primarily concerns interaction between teacher and learners, particularly in a whole-class setting (see, for instance, Hargreaves et al., 2003; Pratt, 2006). The literature on pedagogy and learning, particularly that concerning mathematics, suggests that there is a continuum of pedagogical interactivity from the 'lecture' style with no interaction between teacher and learners, through 'funnelling', probing questioning, uptake/focussing questioning through to collective reflection (Kennewell et al., 2008). At the higher (or deeper) end of this scale, teaching which is collective, reciprocal, supportive, cumulative and purposeful has been characterised as dialogic (Alexander, 2004). The approach recommended by the National Strategies was clearly intended to be at the higher end of the scale, although this was not often observed in practice (see, for instance, Burns and Myhill, 2004).

Furthermore, at the time when the National Strategies were introduced in England, it was not immediately clear how the use of technology could contribute to their recommended forms of pedagogical practice, and there was little reference to ICT in the National Strategy documentation. However, at the same time, the ideas were having a considerable influence in Wales, too, and a new technological tool was being promoted – the interactive whiteboard (IWB). Here was a technology which could have been designed precisely to meet this need to enhance whole-class teaching through the use of ICT.

However, the nature of ICT is such that it may not be best employed merely as a means of making existing pedagogical practices more effective;

rather, pedagogical practices – and the knowledge behind the decisions made by teachers in planning lessons and managing learning in the classroom – may need to change when ICT is introduced in order to best exploit its potential (Mishra and Koehler, 2006).

It was against this background that a project was developed by a team now based at Swansea Metropolitan University and including colleagues from Swansea University and Aberystwyth University. The full title was 'The use of ICT to improve learning and attainment through interactive teaching' and it had the following objectives:

1. To compare the learning outcomes of effective teaching in mathematics, science and languages using digital and non-digital tools.
2. To analyse and theorise the links between interactive teaching practices and improved learning outcomes when ICT is used in classroom settings.
3. To analyse changes in teachers' pedagogical practice as a result of designing interactive teaching strategies and engaging in reflective dialogue in relation to ICT tools for teaching and learning.
4. To develop research capacity in Wales concerning learning, teaching and professional development.

Methods

The project involved a total of forty one teachers from twenty one primary and secondary schools, working in pairs to plan a six month period of teaching in one subject (mathematics, science or language) with a particular class. In phase one, one teacher worked with ICT and one worked without in this limited context. In phase two, all teachers were expected to use ICT when they judged it to be appropriate. When using ICT, all teachers had an IWB available as a resource, and many had access to at least one other computer.

Data was collected from semi-structured initial teacher and pupil interviews, assessment tasks, classroom observation, video-stimulated reflective dialogue (VSRD) with teachers and with groups of pupils, and final interviews with teachers and pupils. The initial assessment tasks took the form of tests similar to those used in National Curriculum assessments for the KS2 and KS3 pupils. For KS1 pupils, questions were presented orally and visually with symbolic responses in order to avoid the limitations of reading and writing for many of this age group.

A mixed-sex group of four pupils from each class were asked initially about their classroom and activities, focussing particularly on what they did in lessons, how they participated in joint/communal activity, and how they learned from this. They were also asked about their perceptions concerning differences when ICT is used.

After a classroom observation which was recorded by two cameras, one focussed on the front of the classroom and one capturing pupil activity, the teacher selected a particular section of the lesson which represented interactive teaching to discuss with a member of the research team. These interviews were unstructured, with the researcher prompting the teacher to reflect on their pedagogical decisions and reasoning. The group of pupils were also asked about their perceptions of this episode, using the video as a prompt for recalling the activity. A second assessment, using the same task as the initial one, was carried at the end of the phase of teaching.

Interview data was analysed using a grounded approach, with comparisons of emergent themes being made between ICT and non-ICT users, between subjects, and between key stages. Observation data was analysed using a framework for analysing teaching and learning in activity settings (see Figure 1), with defined categories of factors and relationships against which classroom activities have been classified and compared. Assessment data was used to compare gains in attainment between ICT and non-ICT groups using analysis of covariance (ANCOVA) techniques with initial scores as covariate, and responses to conceptual questions are being analysed in depth to seek patterns of response within ICT and non-ICT groups. Teachers in each pair were also compared, using the pedagogical interactivity scale referred to above, concerning the proportion of deeper interactions observed. More detail of the analysis of observations can be found in Kennewell et al. (2008).

In most of the nine subject/KS cells in the research design (see Table 1) there were two pairs of classes, although data was incomplete for some pairs because of changes in staffing or anomalies in the teaching or assessment process. This limited the degree of analysis which was possible.

Although this was not an intervention study, professional development was a key theme of the project and it was expected that teachers would change their beliefs and practices to some extent through the reflective data collection, and through the project conferences – an initial one to induct teachers into the research and one between phases to allow them to share ideas with colleagues in other schools and Key Stages. Specific training was also provided for two teachers who were to use ICT in phase Two but did

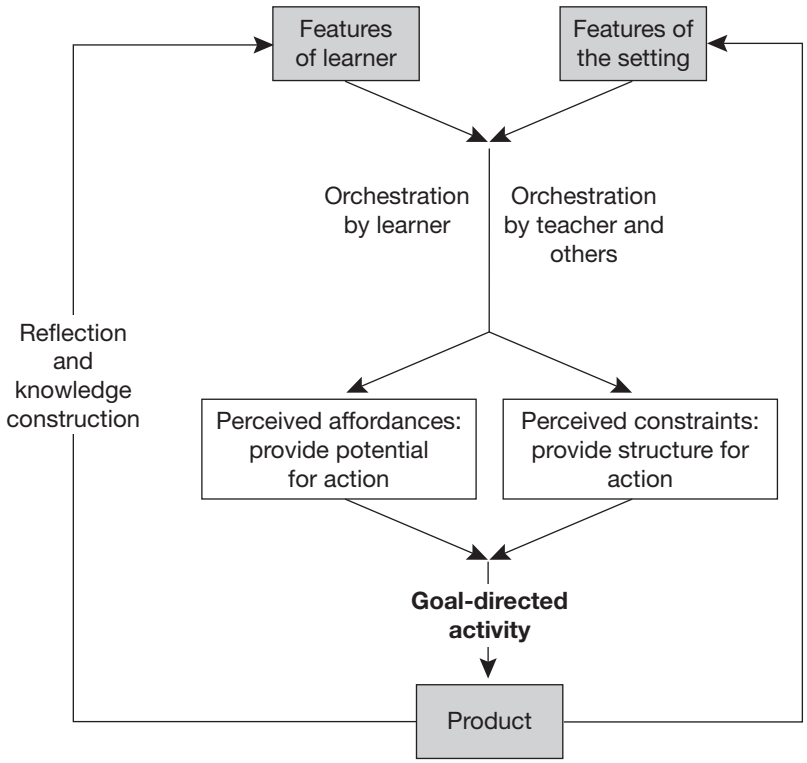

Figure 1 analysing teaching and learning in activity settings (ATLAS)

Table 1 The subjects in each phase

	Science	*Maths*	*Languages*
KS1	1 pair	2 pairs	2 pairs (Welsh second language
KS2	2 pairs	2 pairs	2 pairs (Welsh second language
KS3	2 pairs*	2 pairs	2 pairs (Welsh 2L)

* Teaching through the medium of Welsh

not have IWB experience. The effects of this process were studied by means of final interviews and a post-project evaluation conference.

Results

In this paper, the main focus is on the teachers' developing ideas about interactive teaching with ICT and its effects on pupils' attainment. A full report is available in Kennewell et al. (2007), and details concerning the results of classroom observation and subsequent reflective dialogue, particularly in relation to the use of ICT, can be found in Kennewell et al. (2008); and Beauchamp and Kennewell (2008).

Themes in the teachers' views of interactive teaching

The questions asked in the initial interviews were designed to elicit general responses. Where teachers' responses lacked a precise or standard language for describing pedagogical practice, clarification was sought when meanings were unclear. Teachers referred to the organisation of pupil activities in general, including whole-class, group and individual forms of activity. Most spoke clearly about the relationship between their role in generating interactivity and greater pupil responsibility for managing activities, generating ideas, reflecting on learning and assessing what they had achieved. This suggests that their thinking, at least, was focussed on the dialogic end of the pedagogic interactivity scale.

Teachers' views were characterised against three themes: 1. the purpose of the interactions, 2. the participants, and 3. the modes of communication.

1. *The purposes of interactions* were broadly characterised as:
   - instructional: those interactions initiated with the intention of developing specific aspects of another participant's knowledge;
   - organisational: those interactions initiated with the intention of developing/maintaining social relationships and an effective learning environment generally.

Instructional interactions may be planned by the teacher, using their knowledge of the learners' characteristics; initiated by the teacher when they realise an intervention is needed to generate learning; initiated by a pupil

who realises they can help one of their peers; or initiated by pupil who feels that they do not have the knowledge required for the task. Many of the teachers highlighted the value of making mistakes explicit and discussing what changes should be made. ICT was seen by some as a means of encouraging learners to attempt an answer. Organisational interactions concerned task organisation and social management, with a common emphasis on group/pair work. Several teachers indicated that participation in activities by all learners was a pedagogic goal in itself, and perhaps a prerequisite for effective learning. There was no indication of any difference in purpose when ICT was involved.

2. *The participants* in interactions could be:
   - teacher and pupil(s)
   - pupil and pupil(s)
   - pupil and resource.

The key element of deeper interactivity was the contingency of feedback to the pupils' response and the sustaining of interaction for as long as is necessary for learning. There was some expectation that pupils should initiate interactions with teachers, but teachers did not wait for pupils to ask them questions. They referred to observing pupil activity and listening to group discussion, intervening when an opportunity arose to advance learning. Teachers felt that group work encouraged pupils to initiate interactions, and tasks were often structured to ensure that these interactions took place. Several teachers gave pupils explicit peer-teaching roles.

Pupils were also expected to initiate interactions with resources, and there was some reference to ICT as a resource for pupils to control. ICT was also seen as the initiator of the interaction, by providing a question (often chosen randomly so that the teacher could not plan what it would be) or a problem to be solved (such as matching or classifying images or words). The lack of any facility for the teacher to select the right level of challenge for the class was seen as a limitation of pre-programmed resources. ICT also initiated interactions and was seen as valuable in stimulating mental interactivity for the learners.

3. *The modes of communication* were broadly classified as:
- talk
- text (handwritten, printed, electronic)
- image (diagrams, pictures, video, other items looked at rather than handled)

- movement (including handling materials other than writing/speaking aids, gesture and touch).

Speaking and listening were seen as important tools for interaction in all subjects. Text was also seen as a valuable mode of interaction, but mostly in a brief and ephemeral form. Mini-whiteboards were provided for all pupils to write responses which could be shown to the teacher or to another pupil without the whole class being able to see; again this fostered risk-taking and mistake-making which was seen as necessary for effective learning. More public texts were often produced in electronic form, particularly on the interactive whiteboard.

Images are seen as particularly valuable in initiating interactions, and the size, clarity and variety available using projected computer images were considered to have a positive effect on pupils' engagement with the subject matter during whole class teaching. Animation and video provide alternatives to direct experience in a way that static images cannot.

Communication through physical movement often has an organisational purpose, and is used to help maintain pupils' attention. The action called 'drag and drop', whereby a pupil touches the board and traces out a path to move an item on the board to a new position is usually used for matching and classifying tasks and is seen as a valuable alternative to speech or writing as a way of indicating relationships between items. The kinaesthetic experience at the board rarely represents the idea to be grasped, however.

Factors affecting interactive teaching

Teachers varied in the extent to which they implemented interactive teaching, and their responses revealed a number of factors which influenced their decisions on interactivity. Most of these factors were common to all the subjects involved in the project:

- beliefs about the teacher's role
- beliefs about the learner's role
- perceptions of learners' knowledge and ability to learn
- awareness of learning styles
- perceptions of learners' motivation and confidence
- assessment principles and procedures
- reflection and metacognition

- perceptions of the statutory and local curriculum
- learners' gender
- preferences for class and group organisation
- type of task set for learners
- knowledge of resources available

It was clear that adopting a more dialogic approach involved changes in the role of teacher and learners. Teachers saw themselves more as managers or facilitators of interactions designed to bring about learning, and learners taking a pro-active role and engaging in actions traditionally associated with the teacher such as questioning, evaluating and explaining. Problem-solving was encouraged in all subjects, and making mistakes was generally viewed positively as an opportunity for reflection and pedagogical interaction. One secondary mathematics teacher took this even further:

> … putting something up deliberately incorrect to see if they can spot what you've done and don't even tell them that it's there because you're always going to get 'Miss it's not right!' 'Is it? Is it wrong? What's wrong? Come and change it for me, what should it be?
>
> (Secondary mathematics teacher)

The extent to which these features of interactive teaching were observed in practice varied, however.

Non-ICT tools and resources were also seen as valuable in supporting interactivity of all types. The use of mini-whiteboards for each learner – on which they could write brief ideas and quickly rub them off – was frequently described in all subjects. Books, however, were rarely considered to be part of interactive teaching, and then only to compare unfavourably with ICT resources which were dynamic, interactive and could be shown simultaneously to the whole class.

The influence of ICT was limited at the time of the initial interviews. The value of tool software such as graph plotting and slide presentation software was recognised by some, but teachers felt they needed more time to understand how to exploit it fully. Software with pre-programmed teaching content was used selectively, and again the time needed to identify the most worthwhile aspects was at a premium. Teachers working in the medium of Welsh felt that the lack of prepared resources in Welsh affected their use of ICT, particularly for the teaching of Science.

Changes in teachers' views and practices

The interviews carried out at the end of the project were analysed in terms of the changes in pedagogical beliefs and practice during the project, the influence of ICT on practice, and the ways that the project had stimulated professional learning.

Although several of the teachers did not acknowledge any change in their ideas or practice during the project, most identified a greater integration of ICT into their practice as a result of reflection on experience, discussion with other teachers, and internet searching. Those who did recognise a change often highlighted their emphasis on the value of mistakes – making mistakes explicit and developing a culture whereby pupils could make public mistakes with expectation of support and explanation rather than fear of ridicule. They had shifted more responsibility to pupils, listened to them more, made their actions more contingent on what pupils did, and encouraged pupils to teach each other. They questioned pupils more deeply, set more open, activity-based tasks in groups, allowed more movement and prepared more differentiated activities to cater for pupils with additional needs either grouped together or with more able pupils.

For some, starting to use ICT had made little difference to teaching approaches, providing no more than additional and replacement material such as images, video clips and quizzes to enhance existing practice. Some experienced users recognised that they were more selective with ICT, and some had changed their ways of working: for instance, allowing pupils to work on the IWB in small groups, or using the ICT room to enable pupils to find things out for themselves rather than presenting prepared material on the board. There was some feeling that ICT enables pupils to take more responsibility and work independently, and that rapid feedback boosts confidence. There was a feeling that pupils with learning difficulties were stimulated and encouraged, and for one teacher, seeing what they could do with ICT had changed her perception of pupils' ability. They felt that ICT could not do everything, however, and needed to be supplemented with practical work in science and oral work in language teaching.

In reflecting on the project process, many teachers referred to the frustrations of ICT malfunctions, but felt in a position to take greater initiative in solving problems and developing their own skills. They valued the collaboration with other teachers, but placed most value on being able to watch themselves teach and discussing episodes with the researchers. They had become more open to ideas and more confident in developing their own

with ICT. One teacher also commented on the value of pupils reflecting on a video of the learning.

Impact on learning and attainment

The main purpose of the quantitative pre- and post-assessment data is to help with analysis at a 'local' (case-study) level rather than 'global' level across the project. A large number of factors affect the learning and its measurement – including the nature of the school, the classes involved, the teachers, the schemes of work, and the resources available – and these need to be considered case by case. In each combination of subject and Key Stage, a more detailed analysis of the differences in classroom activity across the teachers involved is continuing and the assessment responses will be examined at a fine level of detail in order to help identify the learning achieved under the conditions pertaining during each phase of the project.

Whilst no generalisation from global analysis of quantitative data is possible in this research design, it has been possible to carry out a number of analyses of post-test attainment for particular sets of teachers, using pre-test as covariate, and it is reasonable to consider what patterns have emerged to date in looking across the analysis of particular comparisons, and what hypotheses for future investigation might be generated from these instances.

The overall pattern was of 'no significant difference' in Phase One between classes taught using ICT and those not taught using ICT. This confirmed the indications from the qualitative data that, despite the greater attention and interest that might be generated by ICT, this was not converted into significant improvements in learning. Indeed, there was a general trend for the non-ICT teacher to achieve better results, and when the qualitative data was examined for possible explanations for this, it emerged that, in most cases, the greater proportion of high-level interactivity was demonstrated by the non-ICT using teacher.

This produced a new hypothesis, for which there was already strong evidence from the qualitative data, that the level of interactivity of teaching is a more important factor for successful learning than whether ICT is used or not. Using a combination of data across classes, with 'pedagogical interactivity' as a fixed factor in the analysis of covariance, it was found that in all cases where there was a teacher rated as using a substantial amount of higher level interactivity, that teacher achieved a higher gain in attainment during Phase One than colleagues using less higher level interactivity – in some cases, significantly so.

However, this differential in attainment gains was not generally maintained in Phase Two. Using a combination of Phase One and Phase Two data for the same teacher and Phase as the fixed factor in the analysis of covariance, it was found that in some cases, the non-ICT using teacher who had achieved highly during Phase One appeared to be less effective when using ICT in Phase Two; unfortunately, the timescale of the project did not provide an opportunity to explore whether this was just a temporary dip in effectiveness whilst gaining expertise in using new technology or a more permanent negative effect. Additionally, there was evidence that some ICT-using teachers in Phase One had become more effective in using ICT to support interactive teaching during Phase Two. This could reflect the professional development in pedagogy with ICT gained during Phase One.

Overall conclusions and implications for developing policy and practice

The results from different aspects of the project converge on some important ideas concerning the combination of ICT and the quality of interactions in the classroom.

There is a clear balance of evidence in favour of a focus on increasing the depth of interactivity of teaching rather than on using ICT for its own sake. The findings suggest that teachers should focus on more dialogic activity, mixing whole-class, small group, pair and individual work supported by appropriate resources. They need to become attuned to the potential and structure of ICT's features so that they can orchestrate these effectively in support of learning goals; this takes time outside the classroom and experimentation in the classroom.

Consequently, future ICT resource provision in schools, including computers, IWBs, handheld devices and learning platforms, should be clearly linked to a professional development strategy concerning interactive pedagogy, so that teachers gain an understanding of how use of the ICT resources by teachers and pupils can support a deeper, more dialogic level of interaction for their pupils. The potential of VSRD as a tool for professional development was suggested by teachers participating in the project, and this needs further investigation and development.

There seems to be potential for more use of ICT to support more dialogic approaches to groupwork (see, for example, Wegerif and Dawes, 2004) and in individual work by pupils inside and outside the classroom (Kennewell and Beauchamp, 2008), but for deeper interactivity with these applications of ICT

to become embedded in teaching and learning, improvements to resources as well as programmes of professional development may be necessary. The value of ICT in supporting pupils in trying out tentative ideas, gaining feedback and easily making corrections seems a particularly fruitful aspect to develop further. However, the project identified some difficulties for pupils in achieving learning goals when the teacher was not available to carry out the key role of orchestrating the potential and structure for action. This suggests that more careful consideration should be given by ICT resource designers to the ways in which learners interact with their products during independent work. Furthermore, professional development for teachers should focus on skills of orchestrating resources to provide potential and structure for learners' actions and subsequent reflection.

Finally, there are conclusions concerning the building of research capacity.

The project provided an opportunity to evaluate some methodological innovations, particularly in the characterisation of the pedagogical interactivity observed in different episodes of a lesson in terms of orchestration of features of the setting, and in the analysis of learning during classroom activity and reflection. The use of digital video for recording lessons enabled episodes to be selected precisely and retrieved easily for stimulating reflective discussion.

For many of the researchers participating in the project, this was their first major funded research project and they were developing their skills and understanding of research practices through working alongside more experienced colleagues. For those who were more experienced in research, it represented a significant increase in the level of importance accorded to their work and an extremely valuable opportunity both to learn from the wider research community and to raise their profile through involvement in a major UK research programme. All members of the team consistently responded positively concerning their learning and are now working towards further publications from the project and new proposals for research. This suggests that a social practice model of developing research capacity has much to offer.

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