Learning science with ICT

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Background, Aims and Framework

Background
A new national curriculum for Icelandic schools was published in 1999. Both the science and the information and technology education curricula from 1999 made considerable demands on teachers. Science was to be taught through three themes – the nature and function of science, science content (physical, life and earth sciences), and methods and skills. Information and technology education was divided into three subject areas – information studies, creativity and the practical use of knowledge, and design and technology. In addition, guidelines were provided for the development of computer skills.

A recent study in Iceland drew some general conclusions about the kinds of support and structure teachers seem to need in order to make the use of ICT a real option in their teaching (Authors, 2005). Technical difficulties can hinder the use of ICT in subject-based classes and many teachers need support from teaching advisers, library specialists or computer specialists in order to use ICT in their classroom teaching. Other research indicates that teachers do not adopt ICT unless its use is aligned with their usual teaching practice and that this practice is largely teacher-centred (La Velle, McFarlane and Brawn, 2003). In a study of 25 technology-rich classrooms in five European countries, Smeets and Mooij (2001) drew essentially the same conclusion; that despite more pupil-centred environments, teachers tend to stay firmly in control of them. Osborne and Hennessy (2003) suggest that part of the difficulty with using ICT seems to lie with a national curriculum loaded with science content although new curricula are more likely to encourage the use of ICT with an emphasis on critical and analytical skills (Osborne & Hennessy, 2003, p. 41).

Aims
During 2005 research was carried out with five science teachers in the urban southwest area of Iceland with support from the KHI Research Fund. The study was designed:
1) to consider the conceptions of teaching and learning held by these teachers and
2) to assess the extent and manner in which ICT was used by them in their science teaching.

In the first part the authors found that all five teachers experienced the pressure for coverage as a constraint and they were well aware of their students' different needs and diverse learning styles (Þórólsson, Macdonald and Lárusson, 2007). The teachers talked about taking the differences of students into account and admitted that the learning context is a crucial factor for learning. They suggested that the system assumes that teaching science is still mostly about transmission of knowledge and the transfer of information from books and other sources of information into student’s minds.

The aim of this paper is to report on the second part of the study i.e. to assess the way in which the five teachers were using ICT in their science teaching.

Framework
Research suggests that ICT can be used to strengthen procedural knowledge and that the main forms of ICT which are relevant to school science activity include: tools for data capture, processing and interpretation, multimedia software, information systems, publishing and presentation tools and computer projection technology (La Velle, McFarlane & Brawn, 2003; Osborne and Hennessy, 2003). Using ICT for such purposes calls for a particular view of school science. ICT could reduce both the time and resources constraints in practical work. There is however a need for a learning context in which exploration and testing can occur, for example, simulation and digitally presented data sets, such that students can learn more about the underlying scientific processes.

Newton and Rogers (2003) suggest that ICT tools add value to science lessons in two ways; through the intrinsic properties of ICT, such as time saving or handling data, and through potential learning benefits from the manner in which ICT is used in the classroom. They make a distinction between properties and benefits. Operational skills are needed to exploit the properties of ICT but application skills are needed to exploit the benefits.
Newton and Rogers suggest that use of ICT can be related to pupil-learning modes suggested by Scrimshaw (in Newton and Rogers, 2003) which are in line with constructivist ideas of teaching and learning science. As receivers learners can obtain knowledge or collate and record information. As explorers they explore ideas and external knowledge. As creators they presenting, reporting and creating their own understandings. To Scrimshaw’s roles they add that of reviser where students engage in revision activities or practice activities.

Twining (2002) developed the Computer Practice Framework (CPF) with which it is possible to differentiate ways in which computers are used in teaching situations. The question “For what purpose?” concerns the extent to which the use of the technology is affecting the content and practices of learning. Twining has identified three categories:

- ICT used as support (same content, automated process but essentially unchanged; could be more efficient but does not change the content),
- ICT used for extension (different content and process but neither requires a computer) and
- ICT used for transformation (different content or process, both requiring a computer such that either the content or process changes).

In summary, the literature indicates that for effective use of ICT in science the following factors will be important:
- ICT is usually used in alignment with existing pedagogical practice,
- ICT can be used to support the development of procedural knowledge, and
- Teachers need technical and advisory support for using ICT in science teaching.

Furthermore, teachers could find it is useful:
- to differentiate between the properties and the benefits of ICT,
- to consider the different roles which learners must such as revisers, receivers, explorers or creators of knowledge, and
- to realize that ICT can be used to support, extend or transform learning

Methods and Samples

During 2005 the research team carried out a study on the use of ICT in science teaching, with funding from the KHI Research Fund. Five teachers, three male and two female, participated in the study and were all from the urban southwest. A snowball sample was used in identifying the first three teachers as being “good” science teachers. The other two were known to the researchers as innovative teachers of science. Four teachers were teaching at lower secondary level, and one at middle school level.

Semi-structured interviews lasting about 60 minutes were taken with five teachers in their classrooms, followed later by an observation of a lesson selected by the teacher as being a typical lesson. The interviews focused primarily on the ideas teachers had about learning and teaching in science and their typical practice. The interviews were then transcribed for further analysis. During the observations attention was paid to nature and content of the interactions between teacher and learners. The observation was followed by a short interview to clarify points arising from the earlier interview and the observation.

Results

It appears that the use of ICT by science teachers seemed to be consistent with their ideas about teaching and learning science.

Three of the teachers favoured a student-centred approach to science learning, one a mixed methods approach and one a teacher-centred approach. The way in which ICT was being used is aligned with these approaches. Those who favour a student-centred approach would like to encourage a range of skills; and would like to use ICT in all areas of learning. Simon uses digital film clips to tape presentations for later evaluation and interacts informally with students. Smart board and slide presentations are used by students during presentations. Jacob emphasises discussion periods and allows students good access to him, between lessons and through MSN after school. There is a relaxed atmosphere in the lesson and students encouraged to use the web to look for information. Olive likes to use a variety of teaching methods, to meet different interests and needs, and prefers to follow the national curriculum rather than books. She uses the computer and the Internet much of the time and students use the Internet, spreadsheets, slide presentations and word processers.

Saga, who adopts a mixed approach, values traditional investigations and is guided by the textbook. She seldom uses demonstrations and follows the curriculum closely. She feels she is not strong in ICT but would like to be stronger. She is reluctant to direct students towards web-based information because so much of it is in English. Students take notes from powerpoint presentations.
Peter who adopts a teacher-centred approach favours direct teaching, built on the text, notes and key concepts. He values a structured approach and uses demonstrations in place of students doing practical work.

Conclusions and Implications
The teacher who used ICT the most in science had a strong student-centred approach but also had a strong background in ICT itself. Few of the teachers seemed to use ICT in order to transform learning (cf. Twining, 2002) but some used ICT to support or extend learning.

There is little evidence of ICT being used to develop procedural knowledge in science as suggested by La Velle et al. (2003). Indeed the first results from these five teachers do not indicate the presence of a strong science culture – for example, Simon and Ádalsteinn appeared to be very different in their approach to the subject of school science.

Follow-up work is needed to look more closely at the conditions which seem to favour the use of ICT in science teaching and learning in Icelandic schools by studying teachers who are known to use ICT in learning and to understand critical points in their personal history of science teaching.

Bibliography


