

Issues, challenges and needs of student science teachers in using the Internet as a tool for teaching

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In recent years there has been a strong emphasis on the value of various applications of information and communication technology as tools to support teaching and learning. One tool that has been given prominence is the Internet and in order to attain Qualified Teacher Status in England, student teachers are required to demonstrate an ability to use remote databases, such as those provided through the Internet, to support their teaching. However, the experience of the collaborating researchers, working with student teachers in five different higher education institutions, suggests that use of the Internet remains limited. This research project sought to examine current attitudes and practice amongst student secondary science teachers. In particular, factors promoting or hindering the use of the Internet in the classroom were investigated, alongside views concerning what might constitute good pedagogy. The results indicate that most student teachers are making at least some use of the Internet and see its value in promoting learning. However, many issues arose in addition to those which were simply related to lack of resources or technical difficulties. Thus the disparate nature of the material on the Internet and a perception of limited information about effective pedagogy, coupled with a shortage of role models to demonstrate successful use, were also identified as important barriers to their development of effective use of the Internet. The implications of this for initial teacher education programmes are discussed and suggestions for development and further research outlined.

Introduction

Although the benefits of the use of computers in education are not universally accepted (for example, see: Cordes & Miller, 2000; Brabazon, 2002), a commonly

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held view is that pupils attending schools with better information and communication technology (ICT) resources perform at a higher level than other similar schools (British Educational Communications and Technology Agency, 2001). Although, without careful use, learning from the Internet is not something that can always be guaranteed (Pritchard & Cartwright, 2004), an earlier review, again commissioned by the British Educational Communications and Technology Agency (Becta) (Harris, 2000), certainly catalogues a persuasive array of positive outcomes from the use of this tool and Osborne and Hennessy (2003) note examples of activities that would be impossible without access to the Internet. Supported by additional research (British Educational Communications and Technology Agency, 2000; Flecknoe, 2001; Department for Education and Skills, 2003), the United Kingdom (UK) Department for Education and Skills (2002), in its vision for the future of ICT in schools, would appear to be convinced that information and communication technology in general, and Internet access in particular, has the potential to improve learning in our schools. The importance that the UK Teacher Training Agency places on the use of ICT is supported, amongst other resources, by a 57-page explanatory document (Teacher Training Agency, 2002a) on the use of ICT to support science teaching. In addition, the UK government finances a web site (National Grid for Learning, 2002) to provide a facility where practising teachers are encouraged to share ideas and resources.

Not surprisingly, the UK (Teacher Training Agency, 2002b) Standards for the Award of Qualified Teacher Status include a requirement (2.5) for student teachers to:

know how to use ICT effectively, both to teach their subject and to support their wider professional role.

In the non-statutory guidance (Teacher Training Agency, 2004, p. 23) on Qualified Teacher Status and initial teacher training requirements, one of the illustrations is:

their ability to access resources and information from, for example, the National Grid for Learning (NGfL), and their ability to select, customise and use these materials with pupils.

In addition, assessors are urged to consider how well students use, for example, electronic mail and the Internet. These requirements are not restricted to the UK and parallels may be found, for example, in Queensland, where the 'minimum standards' for teachers state that teachers are expected to:

create learning experiences in which students actively use information and communication technologies to organise, research, interpret, analyse, communicate and represent knowledge. (Education Queensland, 1997)

Similarly, in Western Australia, a teacher in Phase 2 of the competency framework:

provides opportunities for students to use technology for a variety of purposes: for example, to support enquiry, advance communication, extend access to resources [and] encourage expression of ideas. (Martin, 2001, p. 26)

Selinger and Austin (2003) have reported the concerns expressed by a number of entrants to teacher training who lacked even rudimentary ICT skills. There would

certainly, therefore, appear to be a need for trainers of teachers to ensure that their students are given every opportunity to enhance their ICT skills in order to attain the standards required to enter and function in the teaching profession of the twenty-first century. However, their efficiency in performing this duty has been questioned. For example, in the Netherlands, Kirschner and Selinger (2003, p. 7) report that:

the majority of teacher training students are graduating in an information age without proper guidance in how to use technology in the classroom.

In addition, findings from the ImpaCT2 enquiry (Department for Education and Skills, 2001), supporting those of previous studies (for example Cox & Johnson, 1993; Stevenson, 1998), reveal that many existing UK teachers have yet to develop confidence and competence in ICT and that relatively few are integrating the technology into their subject teaching in a way that enriches learning or stimulates higher-level thinking and reasoning. Such findings have been mirrored in the USA (Beck *et al.*, 1999). This apparent lack of use may not be entirely due to an unwillingness on the part of teachers; a lack of suitable training or resources may be a significant hurdle to practising teachers' use of this medium and adopting the use of new technologies requires 'the individual teacher ... to make changes in teaching strategies, scheduling, and allocation of time' (Norum *et al.*, 1999, p. 202). As Norum *et al.* (1999, p. 202) go on to argue, this is challenging for all teachers and requires individual teachers to 'face their own fears and struggles with technology and change' as well as work with student teachers in context in their role as subject mentors in teacher training when they themselves may be struggling with the technological and other demands that using the Internet involves. However, the UK non-statutory guidance (Teacher Training Agency, 2004) assumes that students should be able to demonstrate that they have met the standard required during the school-based elements of their training. Not only does this depend upon the placement school's hardware, software and access to the Internet but it also raises issues of how well existing teachers may be placed to act as role models and offer advice. Indeed, Stuhlmann and Taylor (1999), in their case studies of student teachers' use of technology, found in one of their cases that, although the (cooperating) teacher was very supportive of the student teachers' use of technology, she was also 'excited about what they could teach her and took full opportunity to learn from them' (Stuhlmann & Taylor, 1999, p. 345). A situation of the 'master' learning from the pupils! Therefore the evidence noted above would seem to indicate that not all existing teachers may be as well placed to offer advice as one would wish. Kirschner and Selinger (2003, p. 5) rather humorously describe the situation for some existing teachers when they write that:

If the Internet is an information superhighway, then teachers just might be the road-kill on the asphalt of the information superhighway.

The mismatch between the demands placed upon new entrants to the profession and opportunities offered within placement schools was highlighted by Selinger and Austin (2003), who reported that students could not see the point of emphasising the use of ICT in the higher education institution when schools could not give them the experiences in order to meet the required standards. If, as it seems, many existing

teachers and schools are not yet in a position to act as role models, what can be done to support students in such circumstances?

The investigation

Student teachers, nearing completion of their course, from five English higher education institutions were involved in the study. The institutions themselves represented a broad range of those involved in the education of teachers, including long-established universities, newer universities and a university college. All five institutions were rated by the *Sunday Times* newspaper (2003) as being excellent for teacher training. The respondents accounted for a small, although significant, proportion (7.9%) of all biology, chemistry and physics students recorded by the Graduate Teacher Training Registry for the same year and had a similar composition. The research sought to establish the attitudes towards and experience, competence and confidence in the use of the Internet by student teachers.¹ In addition, perceived constraints and barriers to usage were also explored.

Focus groups of university-based tutors and students were consulted and information gained from these discussions raised the following questions:

- What was the current use of the Internet by students?
- What levels of confidence did students have in their use of the Internet?
- What constraints existed that prevented students from using the Internet?
- What perceptions did students have of the potential for the Internet as a tool to support their teaching?
- What perceptions did students have of their success in using the Internet and how did they analyse such success?
- Were there any identifiable groups of students with needs that could be collectively addressed?

Given the limited amount of time available for training, the latter question was considered to have particular importance.

Methodology

In order to address these questions, the following tools were employed:

- A pilot questionnaire was considered by samples of students ($n = 15$).
- Focused discussions took place with students ($n = 12$) to check on the interpretation of the questions and, where appropriate, the questionnaire was modified accordingly.
- The resultant questionnaire was completed by the student teachers ($n = 128$).
- Structured interviews and observations of lessons were conducted with a sample of students from the partnerships ($n = 11$).

The questionnaire was used to give a broad perspective across the institutions. Two types of closed questions were employed. Firstly, descriptive questions which allowed

students to be categorised according to age, gender, subject specialism and home access to the Internet. Secondly, questions using a four-point Likert scale. These were designed to explore their confidence in using the Internet; its use at home and school for lesson preparation; its use by themselves and class teachers during lessons; and their rating of the potential of the Internet as an effective tool for teaching. A Likert scale was used because these tend to perform well with samples of 100 plus respondents and have added advantages in that they are easy to construct and provide more precise information about the respondents' experiences or attitudes than a straightforward yes/no response (Oppenheim, 1992). A four-point scale was chosen to prevent respondents from opting for a mid-scale response 'because raters are a little afraid of using the extreme categories' (Oppenheim, 1992, p. 233). In addition further, more open questions were used to explore factors that had prevented them from using the Internet in school and areas for development that would increase their use of the Internet to support their teaching. The details of the questions used are presented through the findings.

The structured interviews and observations were used to explore the emerging issues from the questionnaire in more depth. The 11 students who were selected for the sample were those who, with one exception, had made use of the Internet in a number of lessons and viewed at least some of their use as successful (for details of sample see Table 1). This allowed for a more detailed examination of what good practice might look like, the barriers that existed and the issues arising.

In this part of the investigation, data from interviews and observations were gathered to be able to look in more depth at:

- the students' age, gender, subject specialism, prior use, initial confidence;
- the type of school of main practice, including computer facilities;
- student teachers' perceptions of practice in the placement science department;
- students' use of the Internet in teaching, including types of use, groups, successes/failures, challenges, barriers to use;
- students' confidence at the end of the course, their future plans and needs.

Observation followed by interview allowed the interviewer and student teacher to have a set of shared experiences to talk about. Brown and McIntyre (1995, p. 36) used this technique when looking at the craft knowledge of experienced teachers because it, amongst other issues, 'constrained the teachers to concentrate on real and shared events rather than imagined reconstructions'. Therefore, whereas in the questionnaire the student teachers reported success in their use of the Internet and we had no means to understand what criteria they were using to judge success, in the interviews the shared observation experience allowed us to probe much more deeply and in a concrete sense about the criteria the student teachers were using for successful teaching and all the other teaching issues that arose.

Thus the structured interviews explored the same areas as those in the questionnaires, but related these to the particular lesson observed. The lesson observations were conducted using an observation proforma developed in the light of issues identified from the initial focus group and the group of tutors' experience across the

Table 1. Personal details (%)

Subject	Biology 64	Chemistry 26	Physics 10	
Age	21–30 77	31–40 16	41–50 6	50+ 2
Gender	Male 40	Female 60		
Home access to the Internet	Access 83	No access 17		

partnerships, together with consideration of previous observations carried out by tutors of student teachers using the Internet. These identified the following areas of focus: procedural issues (including booking of computers, rooms, discussions with technicians, etc); instructions and support; organisation of groups; layout of room; nature of task; interactions taking place (teacher–pupil, pupil–pupil); end of lesson. In order to support the observations the tutors also discussed the lesson with some of the pupils during the lesson. Within this overall framework there was room for other issues to emerge. Thus no attempt was made to quantify the data. However, these observations were carried out by experienced teacher educators used to making judgements on the effectiveness of the teaching and learning seen in science lessons.

Descriptive results from the questionnaire were analysed using simple statistics to determine any significant differences between identifiable sub-groups of students. Responses to open-ended questions in the questionnaire were coded and grouped to form categories. Again, simple statistical analysis was carried out to examine any significant differences between identifiable sub-groups. The structured interviews were analysed using content analysis procedure. This involved individual researchers reading through the interview transcripts and identifying categories. These were then compared across the researchers and categories revised accordingly.

The responses from the questionnaires were compared to responses to the same areas in the interviews as part of the triangulation process.

Summary of results and discussion

Outcomes from the questionnaire

Overall the return rate for the questionnaires was high (82%) (see Table 1).

Looking at access to the Internet, the figure of 83% having home access compares favourably with the figure of 64% (Department for Education and Skills, 2001) of their pupils. For successful completion of the course, requirements are that the remaining 17% would have to rely upon access at their university or teaching practice school, which explains the higher number claiming later on to have used the Internet for background research, for lesson preparation and personal interest.

Table 2. Use of the Internet outside the classroom (%)

		Never	Rarely	Sometimes	Frequently
Preparing self-study packages ¹ for pupils	Home n = 116	23	29	35	13
	School n = 128	42	34	21	2
Preparing interactive study packages ² for pupils	Home n = 117	39	31	23	8
	School n = 128	55	27	16	2
Personal interest	Home n = 117	8	6	29	57
	School n = 128	34	17	32	17
For lesson preparation	Home n = 118	7	17	35	42
	School n = 128	23	21	39	16

1. Includes web quests and worksheets that take pupils to one or more sites.

2. Packages that require pupils to respond to or input data and receive a response, e.g. a quiz.

The questions on Internet usage outside the classroom produced the following replies (see Table 2):

This shows that the students were far more likely to access the Internet at home rather than school, with some 76% reporting that they have sometimes or frequently accessed the Internet at home for lesson preparation, compared with 56% doing this at school. Whilst the proportion using the Internet to prepare self-study packages for their pupils is lower, it is interesting to note that nearly half have made use of the Internet in this respect. In comparison, the figures are much lower than reported for lesson preparation, reflecting perhaps, less confidence, expertise or opportunity to prepare interactive packages for their pupils.

Although using the Internet for background research and lesson preparation is an extremely valuable use of the resource, one of the targets of the research was to investigate its use with the pupils, rather than its use on their behalf. Student responses concerning use of the Internet within lessons, coupled with their views on the success and potential of such an approach, are listed below (see Tables 3, 4 and 5). These figures certainly reflect a degree of confidence on the part of students in their ability to use the Internet in an interactive way, rather than merely using it as a medium for themselves to find information to help support their teaching and lesson preparation, with more than four out of five students having used the Internet in lessons.

These replies indicate a high level of success, with approximately half of the Internet-supported lessons being, by the students' judgement, frequently successful. If one interprets the 'sometimes' category as having had success on at least one occasion

Table 3. Use of the Internet inside the classroom (%) (n = 125)

Used the Internet during a lesson	Never used the Internet during a lesson
82	18

then we have a situation where 92% of students considered they had delivered a lesson in which the Internet was used with success. It might have been expected that the figures for students' rating of the potential of the Internet as an effective tool for teaching would have indicated even more positive views. However, whilst the views are positive, it is still the case that some 71% of the students rated the Internet's potential as an effective tool for teaching at best only sometimes effective. From the questionnaire, it was not clear why this figure is so high. However, the structured interview data indicate that the respondents were considering practical issues which might influence effectiveness, such as room booking and system reliability. Although the numbers rating their Internet lessons as successful are high, the questionnaire did not seek evidence of their criteria for judging success but subsequent interviews did provide some illustrations.

Table 4. Student rating of their Internet lessons (%)

	No success	Rarely successful	Sometimes successful	Frequently successful
Student rating of their Internet lesson(s) (n = 125)	1	7	43	50

If, then, a large proportion of students are already using the Internet to support their teaching, what have they used it for (see Table 6)? Is it being used as a demonstration tool or, although specifying sites to be used, are the pupils being given freedom to work more independently or are they using it as a research tool and, if the latter, how much freedom are the pupils given?

Table 6 shows that the majority of these student teachers are allowing their pupils freedom to work independently and, when asked to identify the activities they had found particularly successful, the most common examples cited were pupil research (29%) and revision (14%).

Table 5. Student rating of the potential of the Internet as a tool for teaching (%)

	Not effective	Rarely effective	Sometimes effective	Usually effective
Student rating of the potential of the Internet as an effective tool for teaching (n = 103)	1	5	66	29

Table 6. Class uses of the Internet (%)

	Yes	No
Used as a demonstration tool (n = 126)	20	80
Used for extracting information from specified sites (n = 123)	61	39
Used for individual pupil research (n = 122)	66	34

These responses indicate that the majority of students feel sufficiently competent in their use of the Internet to use it in support of their teaching. Taking this into consideration, the approach of delivering a series of whole-course sessions would be unproductive. However, what of those who had not yet had success in their use of the Internet within their lessons or those nervous of placing the first toe in the water? Is there, as proposed earlier, an identifiable sub-group of beginning science teachers who could be given the option of attending support sessions or is there a group of common stumbling blocks for which all would benefit from some form of training?

In order to find a possible answer to the first part of the last question, any connections between the groups categorised earlier and use of the Internet in the classroom were investigated. An analysis revealed no significant level of connection between the variables of home access, subject specialism, age or gender groups and use of the Internet. It would seem therefore, from this sample, to be a topic to be treated universally and not specific to any particular grouping.

What, then, of the students who are not as confident as we would hope or are not yet persuaded as to the benefits of using the Internet? What has prevented its use or dissuaded students from experimenting? Asking the students for answers to these questions produced some insights into issues which may be affecting their use (see Table 7).

From these responses, it is clear that school provision and arrangements constitute a considerable barrier to students' use of the Internet. It may well be that these factors are the same ones preventing existing teachers from using the Internet, are compounding the problem and, unfortunately, are outside the influence of the training institutions. However, when asked to make suggestions for developments that would increase the use of the Internet for teaching, a different pattern emerged (see Table 8).

Table 7. Factors that have prevented students from using the Internet in school

Factor	Number of responses
Lack of computer room/resources	25 (24%)
Booking difficulties	23 (22%)
Technical problems/unreliability	16 (15%)
Slow server	13 (12%)
No Internet access	7 (7%)
Site blocks	7 (7%)
Administration/lack of pupil passwords	5 (5%)

Table 8. Areas for development that would increase the use of the Internet for teaching

Development areas	Number of responses
More/better resources/computers	24 (27%)
Improved knowledge of suitable sites	24 (27%)
Better/faster access	18 (20%)
More guidance/instruction on Internet use	13 (15%)

Although still citing issues that are outside the influence of the training institutions, there are two other factors that could be addressed, namely increased knowledge of suitable sites (27%) and guidance on Internet use (15%). However, the figure of 15% of those who need further support and guidance in using the Internet is quite low and other findings here on students' own use of the Internet in planning and teaching are also quite encouraging and tend to challenge Selinger and Austin's (2003) view that entrants to teacher training lack even rudimentary skills. However, the issue still remains that this study deals with the perceptions of students in this area and not their actual practice or, indeed, what might constitute effective practice in using the Internet in teaching and learning.

Outcomes from the structured interviews and observations

The 11 students, as may be seen in Table 9, included a balance of gender, age and subject specialisms but no attempt has been made to generalise from this sample but simply just to report, in more detail, some the of the issues raised by the observations and interviews.

All had made considerable use of the Internet prior to their training, many for research purposes. They were, therefore, mostly familiar with the use of search engines. Unsurprisingly, they were generally confident about their skills.

Table 9. Details of sample involved in structured interviews

Name	Gender	Age	Subject	Prior experience
Leslie	F	22	Chemistry	Research and personal use
Paul	M	24	Physics	Research and personal use
David	M	24	Chemistry	Research, web page design and personal use
Richard	M	25	Biology	Personal use
Maggie	F	23	Biology	Research and email
James	M	52	Physics	Research, industry and personal use
Neil	M	36	Biology	Research and personal use
Ron	M	36	Biology	Research, industry and personal use
Laura	F	28	Biology	Research
Kath	F	23	Biology	Research and personal use
Carol	F	25	Chemistry	Research and personal use

A number of crucial pedagogical factors for successful lessons were identified. These included:

- check computers/sites working just prior to lesson;
- identify sites of right level for groups in advance;
- structure activities carefully in relation to sites;
- select attractive sites;
- have a back-up;
- have clear routines in the lab/computer room;
- share objectives with pupils—avoid it becoming an ICT lesson;
- check pupils' prior knowledge;
- differentiate—at least by having an extension task available.

Technical issues and access were also major issues in the schools. Nearly all these students commented about the problems with technical support and that it was they who had to check that computers were working and sites operating.

This resonates strongly with the questionnaire findings. The computer facilities and access to the Internet varied widely between placement schools. However, even in schools with more facilities, students still reported problems in access to computer rooms and dedicated technical support was lacking. Thus at times they (and other teachers) were unable to run the lessons they had planned. As some students said:

a big problem was booking the computer room. It was booked out weeks in advance, some slots for the whole year.

I had to check things myself, the school didn't have anyone to do this for you.

one lesson I'd planned couldn't go ahead because the network was down, this seemed to happen a lot.

Data projectors and interactive whiteboards were also in short supply and this had limited some of the students who wished to demonstrate particular applications or run simulations in an interactive manner involving the whole class. As one student teacher said:

I wanted to use the [interactive] whiteboard but there was only one and it was difficult to do a swap. I didn't like to keep asking.

the whiteboard projector had been removed so I couldn't use it.

The possible gains cited from the use of the Internet were similar to those found through the questionnaire research. Interest, motivation and enjoyment were mentioned by all the students. Some spoke of better learning, especially where lessons were structured well, and all felt that use of the Internet could enhance learning provided technical issues were overcome:

they really liked using the Internet ... there were some really good sites that had great clips on them ... the pupils were much more motivated in these lessons.

they liked working on the net and I think they learned more ... they said it was better than working from books, made it more interesting.

In terms of challenge, many commented on the time taken to identify good sites at the right level. There were also a number of students who commented on specific technical difficulties and issues of school systems with regard to access, saving and printing. For example:

the key is to find the right sites at the right level. Even then there can be problems with the school blocking particular sites.

there didn't seem to be any system at the school ... I was never sure what I was allowed to do and how they [the pupils] should save things.

logging on, passwords, saving stuff, it was a nightmare at times ... I sometimes thought the effort wasn't worth it.

It was interesting to note that most of the group had had worries about behaviour and inappropriate use of the Internet prior to their practice but such worries had usually dissipated following experience. Several noted that the partnership schools had very strict expectations of pupils using the Internet and this seemed to have been effective. As one student teacher said:

I was really worried about accessing 'iffy' sites. I thought it'd be difficult to control but the school seemed to have sorted this. The pupils knew they'd be in big trouble if they weren't doing what they were supposed to and there didn't seem to be any problems.

they were actually better behaved than in normal lessons.

As far as encouragement for further use was concerned, the need for more hardware, better access and technical support was again highlighted. Particular emphasis on the need for data projectors to support a broad range of use was made by some students. In addition many comments were made in relation to the need for more role models, examples of practice, lists of sites to use for particular topics and general advice. For example:

the school needed more of everything ... I had the time to play around and sort things out, you know, order the projector, set it up etc. Many of the teachers were just too busy to do this ... I think I used the net more often than all the others put together.

there was no one to ask about it and no list of good sites. I felt I had to do everything myself. I wanted more support and someone to tell me whether what I was doing was any good ... I seemed to know more about it than most of the staff.

In order to help with problems of the time involved in preparing lessons, the need for collaborative practice and sharing the workload was also mentioned. It was clear from the case studies of the lessons that a lot of work had been required for their preparation and even the most enthusiastic students were concerned about how sustainable this would be as a full-time teacher. As one student teacher indicated:

they needed to build up a list of resources and share them.

working together is crucial. It takes ages to prepare an Internet lesson so you need to share ideas ... I'm not sure how much I'll use the net next year, I want to but there'll need to be support for this.

In conclusion, all but one were more confident about using the Internet at the end of their practice. The one exception reported no change. At the same time, all felt there were gains to be had, though time was an issue.

overall I think the Internet is a brilliant resource but [teachers] need more support ...

Overall summary

The evidence presented indicates that:

- there is a need for some training in terms of operational skills for some students but there are no specific identifiable sub-groups that could be targeted;
- the potential for the Internet to motivate pupils and promote learning has been seen by most students;
- use of the Internet in many partnership schools is fairly limited;
- students need more support in terms of the pedagogy of Internet use and felt relatively ill-prepared in this regard.

Implications

A need has been established for further support in terms of resources and advice for student teachers' development. As far as Internet sites are concerned, the problem is not one of a lack of good sites but of the sheer breadth, range in quality and disparity of those available. Student teachers taking part in this research often talk of 'wasted time' and 'giving up'. There is therefore a need for high-quality portals or access guides to support teachers in their practice.

In terms of advice to support student teachers, this is more limited as there has been relatively little research into what constitutes effective pedagogy for the use of the Internet in science teaching. The work that has been done, for example, in England, through Schools On-Line Science at Sheffield Hallam University, the Association for Science Education and agencies supported by the government, such as Becta, is not perceived as immediately accessible or directly relevant to the specific needs of the student teachers. Thus many issues arose in examining the case studies including: the degree of openness and structure which should be included in tasks, especially those involving web searches linked to particular learning outcomes; how far students should work on their own in completing particular tasks; the role of the teacher; the balance of individual, group and whole-class activities and the links between Internet-based activities and other activities, ICT or otherwise. This suggests both a need for further research into practice and better dissemination of our current understandings.

Although this investigation did not look in depth at the picture in schools, the evidence collected indicates that, whilst some mentors are well equipped and imaginative in their use of the Internet, others are not as well placed to provide the students with the help and advice in this area that one would wish. Clearly, it will be important for all involved in teacher training, especially tutors and mentors, to share good practice and disseminate research outcomes across partnerships. In order to support

development at all levels and overcome problems of resourcing and time, collaboration is vital. It is interesting that the more successful ICT training for practising teachers in England, such as that provided by the Science Consortium (Rogers & Finlayson, 2003), built in collaborative approaches to their methodology. This suggests that structures be developed within partnerships which support collaborative use of the Internet between student teachers, mentors and tutors.

In this study the focus was upon students' use of the Internet in an attempt to identify good practice, restrictions and pedagogical issues arising. Participating students were an opportunity sample, selected on a volunteer basis, and all who presented themselves had made at least some use of this tool in their teaching. It is acknowledged that a more in-depth study of non-users would provide valuable information and the intention is for the focus of a future study to be upon the identification and tracking of reluctant users of the Internet.

It is interesting to note the mention of the need for more role models. This study has been focused upon use of the Internet from the student teachers' perspective with no input from school-based mentors. This, to a certain extent, limits the scope of the findings and would be a valuable addition to further study.

Note

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References

- Beck, R., Evans, D. & Riel, M. (1999) *The Irvine Experiment in restructuring credential program preparation and support through technology: a capacity building grant proposal to the US Department of Education*. Available online at: www.gse.uci.edu/ccre/knowledge_building/tieprop.html#abstract (accessed 6 January 2005).
- Brabazon, T. (2002) *Digital hemlock* (Sydney, University of New South Wales Press).
- British Educational Communications and Technology Agency (2000) *A preliminary report for the DfEE on the relationship between ICT and primary school standards*. Available online at: www.becta.org.uk/research/research.cfm?section=1&id=184 (accessed 6 January 2005).
- British Educational Communications and Technology Agency (2001) *The secondary school of the future: a preliminary report to the DfEE by Becta*. Available online at: www.becta.org.uk/research/research.cfm?section=1&id=341 (accessed 6 January 2005).
- Brown, S. & McIntyre, D. (1995) *Making sense of teaching* (Buckingham, Open University Press).
- Cordes, C. & Miller, E. (2000) *Fool's gold: a critical look at computers in childhood*. Available online at: www.allianceforchildhood.net/projects/computers/computers_reports.htm (accessed 6 January 2005).
- Cox, M. & Johnson, D. (1993) *The Impact report: an evaluation of the impact of information technology on children's achievements in primary and secondary schools* (London, Department for Education and Employment/King's College London).
- Department for Education and Skills (2001) *ImpaCT2: emerging findings from the evaluation of the impact of information and communications technologies on pupil attainment* (Norwich, Her Majesty's Stationery Office).

- Department for Education and Skills (2002) *Transforming the way we learn: a vision for the future of ICT in schools* (Norwich, Her Majesty's Stationery Office).
- Department for Education and Skills (2003) *ICT and attainment: a review of the research literature*. Available online at: [www.becta.org.uk/page_documents/research/ict_attainment_summary .pdf](http://www.becta.org.uk/page_documents/research/ict_attainment_summary.pdf) (accessed 6 January 2005).
- Education Queensland (1997) *Minimum standards for teachers—learning technology*. Available online at: <http://education.qld.gov.au/itt/learning/docs/min-standards.pdf> (accessed 6 January 2005).
- Flecknoe, M. (2001) The use of virtual classrooms for school improvement, paper presented at *BELMAS annual conference*, Newport Pagnell, October. Available online at: www.leeds.ac.uk/educol/documents/00001900.htm (accessed 6 January 2005).
- Harris, S. (2000) How have new technologies, particularly networked technologies, affected student attainment? Unpublished report commissioned by British Educational Communications and Technology Agency.
- Kirschner, P. & Selinger, M. (2003) The state of affairs of teacher education with respect to information and communications technology, *Technology, Pedagogy and Education*, 12(1), 5–17.
- Martin, G. (2001) *Competency framework for teachers* (Perth, Education Department of Western Australia).
- National Grid for Learning (2002) *Virtual Teachers Centre*. Available online at: <http://vtc.ngfl.gov.uk/> (accessed 6 January 2005).
- Norum, K. E., Grabinger, R. S. & Duffield, J. A. (1999) Healing the universe is an inside job: teachers' views on integrating technology, *Journal of Technology and Teacher Education*, 7(3), 187–203.
- Oppenheim, A. N. (1992) *Questionnaire design, interviewing and attitude measurement* (London, Pinter Publishers).
- Osborne, J. & Hennessy, S. (2003) *Literature review in science education and the role of ICT: promise, problems and future directions*. Available online at: www.nestafuturelab.org/research/reviews/se01.htm (accessed 6 January 2005).
- Pritchard, A. & Cartwright, V. (2004) Transforming what they read: helping eleven year olds engage with internet information, *Literacy*, 38(1), 26–31.
- Rogers, L. & Finlayson, H. (2003) Does ICT in science really work in the classroom? Part 1, The individual teacher experience, *School Science Review*, 84(309), 105–111.
- Selinger, M. & Austin, R. (2003) A comparison of the influence of government policy on information and communications technology for teacher training in England and Northern Ireland, *Technology, Pedagogy and Education*, 12(1), 19–38.
- Stevenson, D. (1998) *Information and communications technology in UK schools: an independent inquiry* (London, The Independent ICT in Schools Commission).
- Stuhlmann, J. M. & Taylor, H. G. (1999) Preparing technically competent student teachers: a three year study of interventions and experiences, *Journal of Technology and Teacher Education*, 7(4), 333–350.
- The Sunday Times* (2003) Degree courses rated excellent, 14 September, p. 32.
- Teacher Training Agency (2002a) *Using information and communications technology to meet teaching objectives in secondary science* (London, TTA).
- Teacher Training Agency (2002b) *Qualifying to teach. Professional Standards for Qualified Teacher Status and requirements for initial teacher training* (London, TTA).
- Teacher Training Agency (2004) *Qualifying to teach: handbook of guidance Spring 2004* (London, TTA).