THE SCIENCE EDUCATION WEBSITE: MAKING JUDGEMENTS ABOUT SCIENCE UNDERSTANDINGS

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ABSTRACT
This project involved developing a lively, interactive, visually interesting website for university students enrolled in the subjects: Primary Science Education and Science Education for Young Children. This site allows students to view experiments through video, therefore expanding opportunities to develop their science concepts and to gain practice in identifying children's level of science understanding. Flexible delivery of all or part of subjects at tertiary level is proving to be increasingly attractive to students, often to allow for work or home commitments. This site supplemented lectures and provided intensive work for pre-service teachers in the key 'graduate quality' of assessment of children's science work. It provided students with access to video clips and stills of participants engaged in science investigations and key understandings about assessment of this work. These images provided the opportunity to: observe people talking about their science ideas, gauge the level of science understanding, design lesson plans, comment on safety procedures, and make judgements about pedagogy. It provided feedback systems so that students could self-select for revision of key ideas and reflect on their practice. This paper reports on feedback gathered through online forms, email feedback and structured interviews and documents the response to this innovative initiative currently located at http://www.maps.jcu.edu.au/develop/hickey. Research on the effectiveness of websites is critical considering that some sites can be problematic in that they are difficult to navigate, are overloaded with text and lack those very attributes which make the web attractive in the first place. This paper provides a critical analysis of which parts of this website students find appealing and interesting and how it supports productive learning.

KEYWORDS
Website, website evaluation, science assessment, tertiary teacher education

THE CONTEXT AND IDENTIFIED PROBLEM

Students enrolled in the Bachelor of Education program for elementary (primary) teaching at the School of Education, James Cook University (Cairns Campus) in Far North Queensland, Australia, attend 40 hours of lectures and workshops that are intended to prepare them for teaching science to children from 5 to 12 years old. Apart from the limitations this restricted time places on students' development as effective science teachers, during their practical, school-based experience students may not work with a teacher who is skilled in science teaching. Indeed, too many of our students report that they never see a science lesson during their time in classrooms. Practising teachers have been shown to have unsophisticated concepts and misconceptions with many science concepts, and limited skills in translating these into effective pedagogy (Hickey, 1997, 1998; 1999; Hickey & Schibeci, 1997, 1999). Consequently, their classroom exposure is typically without the critical guidance of educators specialising in science assessment and pedagogy. They do not have the opportunity to develop skills in identification of children's level of understanding by using cues which include the sophistication of language, the complexity of ideas, and the ability in managing variables in an investigation. Consequently, students are unable to maximise their development in terms of recognising indicators of children's level of science understanding.

Compounding this problem is students' typically low-level of science conceptual understanding (Kruger & Summers, 1989; Smith & Neale, 1989). Our predominantly female students have either not studied science, or their experience is limited to biology, and they report little exposure to the areas of natural and processed materials (chemistry), energy and change (physics) and working scientifically (science methodology). In addition, students at this early stage of their careers seem to focus on their presentation of the science activity (that is, the mechanics of preparing the equipment, sequencing the lesson, working out what to say) rather than on children's learning (making judgements about conceptual growth, facilitating children to develop more sophisticated understandings) that should result from the activity (Schibeci & Hickey, 1998).

These issues were the stimulus for the project "Science Education Web Site: Making Judgements About Science Understandings" (funded by a JCU Teaching and Learning Development Grant) to develop a website for students that would stimulate the depth to which they are able to reflect on the educational aspects of lessons, the intensity with which they critique pedagogy, and improve their awareness of the subtlety of cues they can use to evaluate children's understanding. The site would supplement their formal class time; augment their existing conceptual level of understanding about energy, materials and working scientifically; and help them focus on making judgements about children's learning rather than merely the activity itself. The website would also meet the needs of students for more flexible delivery (part of the university's strategic plan) due to part-time work, parenting responsibilities, and travel from outlying areas (JCU is a regional university). Web-based access was superior to the alternatives of provision of CDROM or VHS because of the need to reduce on-going costs such as handling and replacement. It was also made feasible by recent increases in Far North Queensland Internet transmission speeds, and easier-to-use software. Furthermore, current Australian education policy demands greater use of information communications technology (ICT), particularly within the context of online learning (Baskin and Anderson, 2002).

Designing the website

The project's focus was not to supplement the extensive selection of science and science education related websites already accessible to students (comprising lesson planners and reproducible sheets, links to curriculum plans provided by local government departments such as environment, etc) but to design a site which was distinctive and engaging to its audience of enrolled science-education pre-service teachers.

One design aspect was a focus on assessing children's learning, including suggestions on how to assess (e.g., questioning, observation, written work, interpreting graphic information). Reference was made to levels of conceptual development as described in the Queensland Schools Curriculum Council science syllabus and support documentation (2000, 2001), and a widely-used primary science kit was also included - documents that students are expected to use in Qld schools.

Another design consideration was to include video clips of enrolled students as presenters rather than professional actors. Site users would then have personal knowledge of co-students, who would become role models for tackling the challenges of video production, and using communication technology to contribute to a website. These are linked to the goals of JCU Graduate Qualities which specifies key skills in areas necessary to function as effective teachers and members of the educational community (including 1. design and plan engaging and effective learning experiences and programs; 2. incorporate information technology in learning and teaching activities; 3. promote learning by monitoring and assessing children's progress.)

A third aspect was to promote learning activities in areas identified as least well known by our typical student (i.e., natural and processed materials, energy and change and working scientifically). The final aspect was to attempt to overcome the "flat" feeling that staring at video clips seems to engender in the viewer. The design aspect here was to provide a more "natural feel" by mimicking face-to-face interaction during which people do not stare at the speakers' face continuously, but glance away to something else momentarily, then return to the face. To achieve this, the video clip would be nested within text, so that the viewer could iterate between the changing face and fixed, supporting text.

In the researchers' view, some websites are problematic in that they are hard to navigate, are over-loaded with text, and lack those very attributes that make the web so attractive in the first place. Many researchers have outlined problems with technical aspects of websites under headings such as navigation, logic and behaviour, operation, wording, layout and fonts, graphics and colour (Weinchenk 2003; Park & Noh 2002; Nielsen 2000; Elges, 2002) whereas others have concerned themselves with pedagogical issues such as content and usability (Barnd and Yu 2002; Thompson 2003; Oliver & Herrington 2003; Oliver 2000). Nielsen; Park and Noh and Elges emphasise the importance of simplicity as a key factor associated with successful websites. In response, to aid navigation, the site was simply constructed, with a home page showing nine presenters' faces and/or colourful views of intriguing equipment. Selecting one of the faces or a picture of an activity takes the user to the second level, which is a choice of three clips: introduction to the activity, the activity itself, and making judgements about learning. The site allows users to self-select for revision of key ideas, and a "print the text" option was included to encourage students to keep a hardcopy for use in their own planning and to reflect on practice. Recent studies support the view that online learning for teachers should contain explicit means whereby participants can reflect on practice (Anderson and Baskin, 2002).

The nine learning activities presented a range of concepts and ways of making judgements. Three are outlined in this paper. Phil talked about using a model truck to identify a relationship between the number of bolts (the truck's load) and how far a nail will move along a ruler (measuring device to infer force). He suggested the sorts of terms (force, speed) he would want students to use, and what type of graph they would produce. Nancy's site was also about working scientifically: setting up an investigation to classify substances that dissolve (e.g., sugar) from those than don't (e.g., plasticine) to develop concepts about solvents and solutes. Specific guidelines were given to assess children's skills in working scientifically (e.g., does the child know the reason we use a "control"?). Jane's site was about testing a range of materials (plastic, cotton handkerchief, curtain netting, aluminium foil) for their suitability in making a parachute. She described the type of terminology she would expect children to use at three levels of conceptual development (e.g., "at level for their suitability for making a parachute. She described the type of terminology she would expect children to use at three levels of conceptual development (e.g., "at level 4 I would expect a child to know …").

The website would support critical analysis to identify which aspects of web sites students found appealing, interesting, and which supported productive learning. This applied research will inform JCU-wide practice in using web-based learning.

Students were invited to participate by the lecturer. Each signed a form clearing use of their image and included an understanding that participation would not affect their grading for the subject. Students attended an individual coaching session to develop understanding of acting for a camera (e.g., "continue to look at the camera for 2 seconds after you finish rather than looking at the director"). Filming on VHS was conducted on one day, with a camera operator, and one of the authors as director. Students generally reported they found the experience difficult, but very rewarding in terms of their understanding of science teaching, and how to use video. Raw footage was selected by one of the authors. Website development (Dreamweaver) and digital conversion of video (Final Cut Pro) was completed by the JCU media production unit.

RESEARCH METHODOLOGY

The research design was in two parts: general and intensive. In the general mode, students were invited to provide feedback on the site's appeal (in terms of engagement) and productivity (in terms of its contribution to their development as teachers). In the intensive mode, 10 students were observed and interviewed while using the site, to provide feedback on technical aspects (e.g., ease of log on, navigation) and track usage patterns (the sequence of pages visited) to establish user profiles.

These qualitative and quantitative data were used to generate general recommendations for web sites (e.g., the value of supporting text to engage learners) and specific recommendations for educational aspects (e.g., effectiveness of use of video clips of undergraduate teachers describing their planning to promote evaluations of levels of children's concept development).

The sample consisted of 37 students (27 – general mode, 10 – intensive), drawn from School of Education students at JCU Cairns campus enrolled in either Science Education (in their 3rd year of study) or in Information Technology (in their 4th year of study). These students were directly informed about the site (which was described as relevant to their studies) or responded to posters in the School's reception area inviting them to participate. All participated voluntarily and signed Informed Consent forms. General Feedback was anonymous. The majority (90%) used hardcopy and (10%) preferred the on-line response form. Users rated the website using a 5 point Likert scale. To increase parity between respondents understanding of the scale and what is meant by "1=poor" and "5=very good" a comment bank was supplied.

Students provided ratings for a range of factors relevant to this project. They were asked to rate navigation (How easy was it to navigate around the site?) and the mechanics of selecting alternative download speeds (How easy was the screen download speed you selected?). Questions also focused on how well the site supported science pedagogical development (How much did you learn about the learning activities? How relevant was this website to your needs as a pre-service teacher?), making judgements (How much did you learn about assessment decisions?) and children’s development (How much did you learn about children’s conceptual development in science concepts?). Specific questions asked about features of the site which could be modified in later versions of the site (How helpful was the support text for the video clips? How helpful was option to print the support text?) and some of the design foci (How relevant was it having JCU students present their own ideas?).

Ten students were involved in the second part of the research design: the intensive mode. The trained observer/interviewer worked side-by-side with participants while they used the site. The interview protocol included items the same as those used in the general mode, relating to engagement with the site (Which features were the most successful in engaging your interest?), learning (To what extent did the web site help you learn about evaluating understandings? Which features were most successful in helping you learn?). They tested the site for functionality (technical aspects) such as problems logging on, links that failed, screen sizing problems, differences between hi-resolution and low-res options, between on-campus and off-campus computers, Macintosh and PC, and download speed.

The observer used a Likert 5-point rating scale (from 1 "unacceptable" through 2 "can live with it", 3 "OK", 4 "good" and 5 "very good"). To improve rater reliability, each value was given examples of what users may say. For example, the choice for students' views about the speed and quality of the site ranged from 1 "very annoying and frustrating", to 2 "got a bit annoyed because most parts were a bit awkward but some were OK", 3 "good enough although some parts were a bit awkward", 4 "most parts were good", and 5 "very easy to use, no awkward parts at all". Ratings were also given for the educational value (1 "didn't learn anything at all" to 5 "learned very good stuff about science") and navigation (1 "couldn't get it to work at all" to 5 "I was always clear on what to do next").

As well, the observer/interviewer watched how they navigated, tracked their progress, and tallied the sequence of pages visited. This was recorded and sequenced onto a one-page chart. For example, a track may show a student first visited Invisible Solutions and watched the Introduction Video, then went to a linked page of Invisible Solutions Learning Activity and read the supporting text closely, then jumped to the Moving Trucks Introduction and replayed it twice and printed the text, etc). This aspect of the research was intended to describe which pages proved most engaging to users, which ones were least visited, and which aspects of the site (video clip, supporting text, print options, replay) were most accessed. This type of information will inform subsequent versions of the site. This may also help establish if the site supports a variety of user profiles, for example, those who work thoroughly through all pages in a section, to those who prefer an ad-hoc, serendipitous (grasshopper-style) approach.

Students in both general and intensive mode were asked for a general estimate of number of hours (ranges of 5-20, 20-50, 50, 50-100, or 100+ hours) to determine if there was an effect due to the familiarity with websites.

RESULTS

Table 1. General mode - evaluation of the site

Question	1	2	3	4	5	N/A
1. How easy was it to navigate around the site?				13	12	2
2. How easy was the screen download speed you selected?	1		3	11	10	2
3. How much did you learn about learning activities?			5	14	6	2
4. How much did you learn about assessment decisions?		1	3	16	7	
5. How helpful was the support text for the video clips?		1	4	14	8	
6. How helpful was the option to print the support text?	1		2	10	11	3
7. How much did you learn about children's conceptual development in science concepts?	1	1	9	14	2	
8. How relevant was this website to your needs as a pre-service teacher?			4	12	10	1
9. How relevant was it having JCU students present their own ideas?			3	13	9	
10. How engaging did you find the website?		1	7	12	7	
11. How interesting did you find the web site?			5	15	7	

1 "unacceptable", 2 "can live with it", 3 "OK", 4 "good" and 5 "very good"

General Mode

Of the population who could be expected to provide feedback about the site (all 160 students enrolled in science education and information technology) 27 completed the feedback form. Not all students who visited the site completed feedback. Consequently, results are not generalisable to the population. Of those who did respond, some aspects are very informative and provide direction for further development of this particular site, and sites in general in an educational setting.

The majority of students (96%) found the site engaging with ratings ranging from the middle to very good. Only one student rated the site at below the midpoint range. All of the students found the site to be interesting with 100% of respondents falling within the midpoint to very good range. The 27 students rated all areas very positively, with 'ease of navigation' being the most outstanding result with 100% of respondents choosing the good to very good range as their response. Perhaps the most negative response was to the question 'How much did you learn about children's conceptual development in science concepts?' In this area 41% of students rated the site from the midpoint to unacceptable. In some ways this response could be anticipated considering the limitations of learning about children's development from a website compared to learning from direct observations of children engaging with science activities. The group rated the download speed favorably as most of the students used the university broadband system. Users on narrow bandwidth modem connections rated the site as unacceptable (1 student) to OK (2 students). Although the site offers different size video files and formats, even the smallest files can download at frustratingly slow speeds via modem connections. In Australia many home users in larger cities are connecting to cable, whereas in country areas many users are opting for ADSL or satellite connections. Nevertheless, slow modem connections will continue to be a problem for many Australian users for quite some time.

Intensive mode

Results from the 10 students observed and interviewed are presented in three sections: connection and speed, site quality and educational value.

Connection and speed

The majority of the 10 users involved in the intensive feedback mode (90%) were experienced web users who reported spending more than 100 hours prior experience in web browsing. All of the respondents rated the ease of connection and linking to the site at level 5 (very good). All of the users except one reported the download speeds to be excellent, even at high resolutions. Only one student reported that the download speeds were prohibitively slow and this is not surprising considering that this student was the only one that accessed the site via an external modem link.

Site quality

Reaction to the general layout of the site was mixed, although the majority (60%) rated this aspect at mid to high levels. Positive comments included: 'The text beside the video was a good idea as it can be read while the video is loading' and 'supporting text within the video was very helpful'. Negative comments were 'Links once visited fade into the background colour' and 'everything is too blue on the homepage – more contrast is needed'. Ease of navigation (as in the general mode) was rated highly with 70% placed in the mid to high range. Some students felt that the navigation bar would be better placed at the side of the page where it would be always visible rather than at the bottom of the page. All respondents reported that the necessity to select the resolution and player for each clip to be annoying and suggested that the choice be made once only, with the preference being applied automatically from then on. Common general comments about the quality of the site were very positive such as 'very professional', 'great' and 'really good'. Some negative comments included 'all typographical errors should be corrected' and 'some speakers sounded boring and lacking in confidence' and 'the variation in sound levels of the clips should be rectified'.

Educational value

Most respondents (90%) reported that the educational value of the site was high and that they would return to the site to use it in their teaching. Comments included 'good ideas on teaching and assessment, and shows a strong connection to syllabus documents' and 'would like to return to this when I'm teaching to check on methods'. Students felt that the print option was useful as they could limit the time that they spent on the web. The site was also shown to a cohort of 50 practicing teachers at a professional development workshop. Many of these teachers subsequently reported using the website to inform their teaching.

CONCLUSIONS

Students reported various reasons for using this website including a love of science, recognizing a weakness in their knowledge and preparation, or even wanting to see themselves or their friends on the web. The resulting levels of engagement varied in accordance with both the intensity of the reason for initial access to the site and the diversity of other educational needs that the site may satisfy. This initial examination of data demonstrates the value of user feedback to provide information that will substantially inform the modification and further development of a site that has been positively received by pre-service and practicing teachers. Although only 10 users were involved in the intensive feedback and observation sessions, the feedback gained was found to be very useful in planning for changes to the site. Thompson (2003) and Nielsen (2000) concluded that even 5 users undergoing intensive observation and interviews can identify 85% of problems with a website. Tertiary educators should be aware of the multitude of factors that can enhance or detract from the value of a website and although, in this study, most of the respondents were familiar with websites and various means of navigation, not all students had this level of experience, even in third and fourth year of their tertiary courses. Therefore, the assumption should not be made that all students will be able to successfully engage with websites, especially if concerted efforts are not made to closely examine features of websites as they appear to users and to use these research results to modify and improve such sites.

Furthermore, the intensive use of video in the website was seen as a disadvantage when using the site on a modem connection but an advantage when using broadband. All students had access to broadband connections via the university labs, but those without private broadband connections felt restricted by having quality access only during the times they attended university. Nielsen (2000) argues that high-end media such as video should only be used when it truly adds value by showing something that can't be otherwise presented. In this case video enabled the pre-service teachers to observe experiments and make judgments about levels of conceptual understanding that would normally only be possible during their time spent in schools. A major pedagogical advantage of the site is that the content i.e. students conducting experiments and assessing the learning outcomes, is clearly linked to activities in the world of professional practice outside of the university. Herrington and Oliver (2003, p.62) conclude that, "authentic activities have real world relevance and match as nearly as possible real world tasks of professionals in practice rather than decontextualised or classroom based tasks". Finally, involving the pre-service teachers in the construction of the site afforded problem-based learning and engendered 'ownership' of the site.

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