British Journal of Educational Technology (2007)
doi:10.1111/j.1467-8535.2007.00697.x

The quest for deeper learning: an investigation into the impact of a knowledge-pooling WebQuest in primary initial teacher training

Jo Allan and Mark Street

Mark Street is Deputy Head Teacher at Meriden CE Primary School in Solihull. He was previously a senior lecturer in Primary Initial Teacher Training at the University of Wolverhampton, UK, where he was a member of the Learning and Teaching Research Network Technology Supported Learning Cluster. Jo Allan is Associate Dean responsible for research and postgraduate study at the University of Wolverhampton, UK. Her work focuses on research into improving the quality of learning and teaching in higher education. Address for correspondence: Mark Street, Meriden CE Primary School, Fillongley Road, Meriden, UK. Tel: +44 01676 522488; email: m.e.street@btinternet.com. Jo Allan, School of Education, Walsall Campus, University of Wolverhampton, UK. Tel: +44 01902 322849; email: j.l.allan@wlv.ac.uk

Abstract
This paper explores the impact on learning in higher education of the integration of a knowledge-pooling stage into a WebQuest. We explain the concept of WebQuests, consider recent literature regarding the effects and difficulties of this approach to learning, and examine students' perceptions of the impact of this tool on high-order learning. The level of learning achieved by respondents is analysed using Biggs' Structure of the Observed Learning Outcomes (SOLO) taxonomy. With judicious use of a 'pooling knowledge stage', and provided that students are fully aware of the desired learning outcomes, the findings suggest that WebQuests do have the potential to promote high-order learning. The paper concludes by suggesting the need for further research into the potential of WebQuests to promote high-order learning within different disciplines in higher education.

Research issue

One important aspect of developing the use of information and communication technology (ICT) to promote learning is the growing use of the Internet as an educational resource. However, studies suggest (Gibson & Oberg, 2004; Office for Standards in Education, 2004) that despite an increasingly ICT-literate workforce, many teachers are not yet using the Internet to its maximum potential, particularly with regard to enhancing student learning through collaboration, creation and dissemination activities. Also, time on task can be put in jeopardy through use of the Internet.

Murison-Bowie (1999, in Laurillard, 2002, p. 120) points out that it is very easy for a learner to end up 'lost among the virtual stacks, easily distracted by trivia and irrelevancies on the way'. A possible way forward with these issues is the WebQuest (Dodge, 1997). This study critically investigates the impact on learning of the use of a WebQuest within two primary mathematics initial teacher training (ITT) modules. Learning is considered both in relation to subject-specific outcomes and in relation to the level of learning achieved by participants.

The nature of WebQuests

A WebQuest can be defined as 'an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the Internet' (Dodge, 1997). WebQuests are usually collaborative ventures, requiring students to work in groups, often with particular assigned roles. They tend to follow a fairly specific model, although this is very often adapted. Crucially, a pooling-of-knowledge stage advocated by Young and Wilson (2002) was added with the third and fourth iterations of the Postgraduate Certificate in Education (PGCE) groups.

Thus, the WebQuest used in this piece of research[1] contains the following stages:

1. *Introduction*—sets the stage, provide background information about the scenario.
2. *Pooling knowledge*—an opportunity for students to discuss the issue, drawing on, and combining, prior knowledge, and to stimulate critical reflection.
3. *The team*—allocation of specific roles for group members.
4. *The task*—explanation of the expected outcome from the group.
5. *Where to look*—students working in role, individually or in pairs, research links to appropriate Web resources.
6. *Getting together*—time to share and synthesise findings within groups, and put together a presentation.
7. *Share and Review*—group presentations and questions.

There is general agreement that one of the main aims of WebQuests is to encourage higher-order learning (Aoki, 2004; Richards, 2005; Young & Wilson, 2002). Biggs (2003, p. 48) claims that higher-order learning can be seen through an ability to do such things as 'compare, explain, contrast, analyse, relate, apply, theorize, generalize, hypothesize and reflect'. In other words, it involves an 'holistic' approach to learning, in which the learner seeks to understand and build a network of relationships between different aspects of learning in order to construct a picture of the whole.

Aoki (2004, p. 1614) suggests that WebQuests are 'rooted in constructivism', promoting 'knowledge construction and not knowledge reproduction'. Young and Wilson (2002, p. 2117) appear to agree, linking WebQuest strategies to schema theory in

[1]The WebQuest *Homing in on Learning* used for this research can be accessed at http://pace.wlv.ac.uk/webfolio.aspx?webfolioid=25437.

which 'students undergo a conceptual shift that leads to new schemas and ways of seeing the world', thereby developing knowledge from information. Richards (2005, p. 65) notes that while WebQuests are intended to 'encourage independent and collaborative learner-centred inquiry as well as higher-order thinking', in practice they 'mainly promote active engagement with information resources on the Internet' and are often used to 'inadvertently reinforce the very inherent assumptions of the traditional lesson which their originators seem to be challenging'. Richards has a point. There is clearly a danger that WebQuests could be used in such a way as to encourage lower-order or surface learning: students could use the links provided to visit many websites, briefly scan the contents and pull quotes from each without ever really engaging with the text or developing a sense of what a paper as a whole is saying.

It seems vital then that WebQuest activity should involve elements of reflection upon learning and opportunity to compare, contrast and synthesise knowledge in order to build new understandings. It is therefore important to consider how students can be effectively encouraged to engage in higher-order learning, rather than taking a surface approach. One suggestion put forward by Young and Wilson (2002, p. 2120) is the addition of a 'What Do You Know?' stage near the beginning of the WebQuest process. This involves group discussion around the issues involved in the task before beginning the search activity. Young and Wilson (2002) suggest a number of potential benefits from the addition of this stage:

> both students and teacher can identify students' prior knowledge and experience; the stage provides a benchmark against which students can compare their conceptual growth through using a WebQuest; the stage allows them to understand the thinking of the other members of their team.

Essentially, this stage is an opportunity for the pooling of existing knowledge on the topic, and, in itself, is likely to begin the process of reflecting and reconstructing understanding as students share, reflect on and adapt each other's ideas. In this study, this is effected through the 'Pooling Knowledge' stage that included a number of prompt questions designed to focus students on a range of key issues. It was also intended that this early focus on key issues would allow students to gain a better understanding of what they were looking for during the search activity. This is a slight deviation from the notion of an open-ended 'brainstorm' put forward by Young and Wilson (2002), and could be seen in some senses to be restrictive, in that the inclusion of particular questions guides students towards particular issues (chosen by the tutor) relating to the topic.

However, we consider that the presentation of a wide range of issues to a group of students with (relatively) narrow experience of the topic could actually be more *liberating* than restrictive. By including issues that may not have been directly relevant to students in the past (and so otherwise may not have been raised at this stage), students are actually *enabled* to develop a wider perspective through this directed discussion. Discussion then gives students a basis for further inquiry.

Young and Wilson (2002) suggest a further adaptation of the traditional WebQuest structure through the inclusion of a 'Share and Compare' stage once the task outcome has been produced. This is conducted at whole-class level and is intended to allow all students to experience solutions, thus giving opportunities for large-group analysis, comparison between groups and reflection upon learning, possibly leading to further reconstruction of students' concepts. A similar stage was included for the WebQuest used in this study, in which students shared presentations with the class, allowing time for questions and discussion. This concept was taken a stage further through the posting of PowerPoint presentations on the university's virtual learning environment, which allowed further reflection on all the groups' presentations. Discussions with students during focus group interviews revealed that they served to further develop a sense of collaboration among students, as they benefited not only from their own groups' presentations, but from presentations produced by other groups, who had perhaps taken different routes during the WebQuest session.

The positive effect of developing a sense of collaboration within a group of students on learning is well documented (Biggs, 2003; Meier, 2000; Smith, 1996). Aoki (2004) found that 'cooperative learning was enhanced as each student was responsible for a part of the project' (p. 1619), that it 'encouraged autonomy', that students perceived that working collaboratively helped information become 'easier to grasp (while trying to explain it to each other)', and that the WebQuest stimulated 'interest and motivation to learn', a key factor in developing deep approaches to learning (Biggs, 2003). The WebQuest is thus posited as a critical thinking tool that, when 'used for activities that encourage, stimulate and focus meaningful reflection, can be viewed as a knowledge-modelling device that facilitates learning in a social context' (Coombs & Smith, 1998, p. 27).

Research questions

This paper reports on an investigation into the use of a WebQuest based upon the subject of mathematics homework—the pedagogic aspect of Level 3 final-year undergraduate and Level 3 PGCE primary mathematics modules at the University of Wolverhampton. The session was undertaken with four groups of teacher training students, each in classes of between 21 and 28 students. The first two groups were Bachelor of Education (BEd) final-year students; the remaining groups were PGCE students.

The investigation was based on the following research questions.

1. What are student perceptions of the impact of WebQuests on the level of their subject-specific learning?
2. What is the impact of WebQuests on the level of synthesis achieved in written assignments?
3. What aspects of WebQuests are perceived by students to be effective in encouraging higher-level learning?

Methodology and data collection instruments

Three sets of data were collected for this study: (1) from a student questionnaire focusing on students' perceptions of the impact of the WebQuest session; (2) from focus groups; and (3) an analysis of 48 feedback sheets for PGCE assignments.

Questionnaire

The questionnaire was used in order to gain as broad a picture as possible of student perceptions of learning via the WebQuest. Questionnaires were completed anonymously by 87 of the 95 students participating in the sessions; 37 of these respondents were on the BEd course and 50 were on the PGCE.

The questionnaire items derive from Biggs' (Biggs & Collis, 1982) SOLO taxonomy. This taxonomy is based on an extensive study of students' learning outcomes in a range of academic disciplines and on research (Marton, Dall'Alba & Beaty, 1992; Marton & Säljö, 1976) that suggests that learning involves 'two main changes: quantitative, as the amount of detail in the student's response increases, and qualitative, as that detail becomes integrated into a structural pattern' (Biggs, 2003, p. 38). The SOLO taxonomy comprises four levels of learning: unistructural, multistructural, relational and extended abstract. The levels are organised hierarchically, representing an increasingly deep outcome. Biggs and Collis (1982) provide examples of statements made by learners about their learning that characterise each level, together with an analysis of why each statement corresponds to the level to which it has been assigned. Key verbs (eg, 'identify', 'apply') exemplifying structures of learning were taken from Biggs' (2003) descriptions of the four levels of learning and were adapted to form statements linked to outcomes of the WebQuest session. Students were asked to select the overall statements that best summed up their learning experience in the session. Figure 1 shows the four statements and their corresponding levels of learning.

In order to assure the validity of the statements in Figure 1 in relation to the SOLO taxonomy, the statements were written by one researcher and classified independently by a second researcher with experience in working with the SOLO taxonomy. The categorisation of the statements was fully supported by this second analysis. Validity was addressed further by piloting the questionnaire with colleagues and with a group of six students who had completed the WebQuest session in order to minimise the risk of students not understanding the nature of the task and to assure the validity of the statements in terms of the potential learning outcomes of the WebQuest work.

Focus groups

In order to compare and contrast views, two focus groups were formed: one consisting of eight BEd final-year students, and one consisting of six PGCE students. Twelve questions were used to guide the focus group sessions. For the purpose of validity, the questions were designed to corroborate or refute the findings of the questionnaire and to allow further exploration (see Figure 2).

Unistructural
I am now able to identify some issues regarding homework. I now know more about one or two aspects of homework.

Multistructural
I could now describe a selection of separate, but useful ideas and opinions about homework. I could use some of these ideas in school.

Relational
I have been able to compare, contrast and analyse a range of views regarding homework. I have begun to establish a cohesive set of general principles regarding homework. I hope to apply these principles in school.

Extended abstract
I have built upon and adapted my original ideas about homework, taking into account a range of views. I have combined personal experience and a range of new perspectives to construct my own general principles regarding homework. These principles should be applicable in a variety of school settings.

Figure 1: Groups of questionnaire statements about subject-specific learning based on Biggs' Structure of the Observed Learning Outcomes taxonomy

It was felt that focus groups would facilitate in-depth discussion and interaction, and encourage greater development of ideas, as well as possibly allowing unanticipated matters to be raised. A sample of students was chosen for each focus group, with a mix of male, female, older and younger students included in each.

Analysis of assignment feedback
The analysis of assignment feedback allowed insight into actual outcomes and a means of corroborating the views expressed by students via the questionnaire and focus group interviews. This effected a form of data triangulation as both student perceptions and written outcomes were investigated and compared. For practical reasons, the assignment feedback sheets for the PGCE students were chosen for analysis. This presented a sample of 48 feedback sheets.

Results and analysis

What are student perceptions of the impact of WebQuests on the level of their subject-specific learning?
Responses to this central question (see Table 1) suggest there is good reason for the conflict of opinions discussed earlier. When asked to indicate the statement that best summed up their learning from the session, responses were mixed. Forty per cent of students felt that their learning was at a lower-order level (uni- or multistructural), while 60% felt they learned at a higher-order level (relational or extended abstract).

This is perhaps not a surprising outcome, as with any learning experience, one would expect a range of achievement. The picture becomes more revealing when the different teaching groups are separated (see Figure 3).

Opening:
Tell us your name, and what sort of experience you had had of using the Internet prior to the WebQuest session. *(Ask all participants one at a time for this question.)*

Introductory:
What are the first things that come to mind when you think of the WebQuest session on homework? (*Briefly review WebQuest with participants, recapping stages.*)

Transition:
Think back to the beginning of the WebQuest session. How did you feel about the way the task was introduced? What were your first impressions?

Key Questions:
What, if anything, did you find particularly helpful about the WebQuest session?

What, if anything, did you find frustrating about the session?

How does your learning in this session compare with other sessions on the course?

In what ways (if any) are your views about homework different as a result of the WebQuest session?

PGCE: The WebQuest was divided into six distinct stages. As a group, sort the stages into order of importance in the development of higher-order learning. *(Give criteria for relational and extended abstract learning as defined in questionnaire. Give cards to sort.)*
BEd Year 3: The WebQuest was divided into five distinct stages. As a group, sort the stages into order of importance in the development of higher-order learning. *(Give criteria for relational and extended abstract learning as defined in questionnaire. Give cards to sort.)*

PGCE: What do you feel were the benefits of including the 'Pooling Knowledge' stage?
BEd Year 3: What impact do you think the addition of a 'Pooling Knowledge' stage near the beginning of the process might have on the learning achieved in the session? *(Show 'Pooling Knowledge' stage as example.)*

Ending Questions:
I wanted you to help me evaluate the WebQuest session. I want to know how to improve the quality of learning in sessions. Is there anything that we missed? Is there anything that we should have talked about, but didn't?

Figure 2: Focus groups questioning route
PGCE, Postgraduate Certificate in Education; BEd, Bachelor of Education.

Table 1: Responses to 'Choose the group of statements that you feel best sums up your learning experience in the WebQuest session'

	Unistructural	*Multistructural*	*Relational*	*Extended abstract*
Number of students ($n = 85$)	16 (19%)	18 (21%)	23 (27%)	28 (33%)

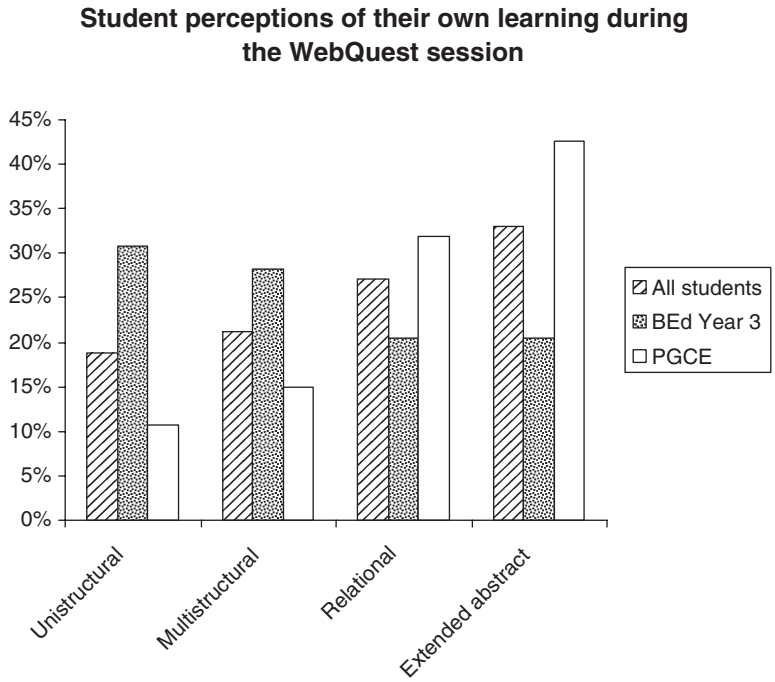

Figure 3: Student perceptions of their learning during the WebQuest session—comparison by PGCE, Postgraduate Certificate in Education; BEd, Bachelor of Education.

A significant difference was found in the responses of BEd and PGCE students to the item 'Choose the statement that you feel best sums up your learning experience in the WebQuest session' (chi-square = 10.390, $df = 3$, $p = 0.016$, $phi = 0.348$). Interestingly, PGCE students' perceptions skewed towards higher-order learning, while BEd final-year students' perceptions were skewed towards lower-level learning. Possible reasons for this pattern are discussed later, but it seems that this evidence supports the views of both Richards (2005), who felt that WebQuest activities often ended up as low-level learning experiences (well over half of the BEd students), and Aoki (2004) and Young and Wilson (2002), who felt that WebQuests could encourage higher-order learning (over 70% of PGCE students). This difference between groups was also evident from the

responses during focus group interviews, which (for BEd students) illustrated a lack of full engagement with the vital 'Getting Together' stage in the way we would have wanted them to be in order to encourage deep learning—ie, comparing, contrasting, prioritising, synthesising ideas and forming them into one cohesive presentation rather than almost separate presentations within presentations.

What is the impact of WebQuests on the level of synthesis achieved in written assignments?
For the purposes of this study, the following criteria were either highlighted or left blank depending on whether the marker felt they had been achieved:

There is considerable evidence of synthesis of ideas and some original thought. The different strands of thought and of evidence are pulled together very effectively to reach justified conclusions.

Some 65% of assignments (31 out of 48) were judged to have met the criteria, which was the top grading for the assessment. Of the five trainees who were absent from the session, none achieved the criteria. These results corroborate the findings from student questionnaires and the PGCE focus group, as well as the findings of Aoki (2004) and Young and Wilson (2002), who indicated that WebQuests have the potential for developing higher-order learning.

What aspects of WebQuests are perceived by students to be effective in encouraging higher-level learning?
It has already been noted that there was a significant difference between the two cohorts of students in their perceptions of the depth of learning they engaged in during the WebQuest session. This may have been a result of the following: the two BEd final-year sessions were held 6 weeks before the PGCE sessions. In this time, two changes were made to the way in which the sessions were conducted as a result of reflecting on the successes and failures of the first two sessions and in a bid to increase the level of synthesis evident in the student presentations. The first change was the introduction of the 'Pooling Knowledge' stage. Evidence from the focus groups suggests that this was a key stage in encouraging higher-order learning. From this evidence, Young and Wilson's (2002) suggestion of adding an early 'What do you know?' stage seems to have been beneficial.

The second change to the session involved a much more detailed introduction regarding the anticipated outcomes of the session. The intended higher-level outcomes were fully shared with students and put into the context of the task set for the PGCE students. The BEd final-year students did not receive this introduction, and comments from focus group respondents suggest that they did not understand the purpose of the session. The data emphasise the importance of communicating 'high expectations' to students (Biggs, 2003; Chickering & Gamson, 1987). Interestingly, this interchange also demonstrates the importance of students' concept of learning and how this can actually determine the approach they take and, subsequently, the type and level of learning achieved.

Conclusion

It appears evident from the findings that WebQuests *can* be an effective means of encouraging students to engage in higher-order learning as part of an initial teacher training module. As with any tool for learning, it is important that it is used only where appropriate and helpful to a particular aspect of a particular module with a particular group of students.

Importantly, it seems that there is a fine balance between WebQuest activities that *do* encourage higher-order learning, and WebQuest activities that prompt surface learning for many students. While it is not possible to be certain of the reasons for the perceived increase in the level of learning in the PGCE group (as opposed to the BEd group), findings suggest that the addition of two stages to the WebQuest led to a quite major shift in learning levels. Thus, it is vital that any educator hoping to use a WebQuest to promote higher-order learning does not simply assume that the WebQuest formula will work. Very careful thought needs to be put into the best educational practices that need to be combined with the WebQuest process.

Clearly, the two additions to the WebQuest are neither new ideas nor anything other than recognised good practice. The value (Biggs, 2003; Meier, 2000; Ramsden, 2003; Smith, 1996) of sharing desired learning outcomes and high expectations is well known.

A key factor in the success of the 'Pooling Knowledge' stage seems to be that students are able to do exactly that: *pool knowledge*. That way, they do not start only from what *they* know, but from what all the others in their group know as well. Furthermore, the addition of prompt questions took the process a stage further by introducing new lines of thinking and promoting critical reflection from the outset. This aspect also proved useful in giving focus and direction to student research.

In this study, WebQuests have been shown to provide possibilities for encouraging higher-order learning in certain circumstances and with carefully thought out approaches. Further investigation is recommended into their impact in different settings and with different subject matter, both within and away from ITT.

References

Aoki, J. (2004). The impact of a WebQuest on pre-service elementary school teachers in an undergraduate life science studies course: a snapshot. *World conference on elearning in corporate, government, healthcare, and higher education*, *1*, 1614–1621.

Biggs, J. (2003). *Teaching for quality learning at university* (2nd ed.). Buckingham, UK: The Society for Research into Higher Education and Open University Press.

Biggs, J. & Collis, K. (1982). *Evaluating the Quality of Learning: The SOLO Taxonomy*. New York: Academic Press.

Chickering, A. & Gamson, Z. (1987). Seven principles for good practice in undergraduate education. *American Association for Higher Education Bulletin*, *39*, 7, 3–7.

Coombs, S. & Smith, I. (1998). Designing a self-organized conversational learning environment. *Educational Technology*, *38*, 3, 17–28.

Dodge, B. (1997). *Some thoughts about WebQuests*. Retrieved 12 November 05, from http://edweb.sdsu.edu/courses/edtec596/about_webquests.html

Gibson, S. & Oberg, D. (2004). Visions and realities of Internet use in schools: Canadian perspectives. *British Journal of Educational Technology*, *35*, 5, 569–585.

Laurillard, D. (2002). *Rethinking university teaching: a conversational framework for the effective use of learning technologies* (2nd ed.). London: Routledge Falmer.

Marton, F., Dall'Alba, G. & Beaty, E. (1992). Conceptions of learning. *International Journal of Educational Research*, *19*, 277–300.

Marton, F. & Säljö, R. (1976). On qualitative differences in learning II: outcome and process. *British Journal of Educational Psychology*, *46*, 4–11.

Meier, D. (2000). *The accelerated learning handbook*. New York: McGraw-Hill.

Office for Standards in Education (2004). *ICT in schools: the impact of government initiatives five years on*. HMI 2050. London: Ofsted.

Ramsden, P. (2003) *Learning to teach in higher education* (2nd ed.). London: Routledge Falmer.

Richards, C. (2005). The design of effective ICT-supported learning activities: exemplary models, changing requirements, and new possibilities. *Language, Learning and Technology*, *9*, 1, 60–79.

Smith, A. (1996). *Accelerated learning in the classroom*. Stafford, UK: Network Educational Press Ltd.

Young, D. & Wilson, B. (2002). WebQuests for reflection and conceptual change: variations on a popular model for guided inquiry. *World Conference on Educational Multimedia, Hypermedia and Telecommunications, 2002*, *1*, 2116–2121.