Designing Internet-based Inquiry Lessons: An Analysis of Students’ Internet Search Practices

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Abstract

In recent years increasing emphasis has been placed on the appropriate use of the Internet in schools. However, pervasive use of Internet technology alone does not guarantee positive gains in pedagogical strategies, nor does it automatically translate into meaningful learning. Inefficient, haphazard, and disorganized searching for information results in students either becoming disorientated or retrieving information from unreliable sources. Often this problem has become further compounded due to most Internet-based student activities being poorly guided and students are left on their own to locate and sift relevant information. This paper discusses the findings of a major study conducted in Singapore to assess student Internet literacy skills and practices. The findings provided the basis for developing a framework of heuristics on which to design and teach Internet-based multidisciplinary, inquiry lessons. This framework enables teachers to build a rich repertoire of cognitive reasoning, research and problem solving skills amongst students.
Introduction

The Internet offers great promise as a powerful tool for curriculum and instruction. It provides access to a suite of tools and educational resources that could improve teaching effectiveness and stimulate students' thinking and knowledge building through collaborative learning. In Singapore, all schools are linked electronically to the global digital highways of the Internet with hardware and infrastructure facilities in place to be able to support Internet-based learning activities. Many schools have reported widespread access of their Internet facilities both during and after school hours but it is appropriate to simply assume this means that students are engaged in constructive online learning.

Existing literature has revealed that the pervasive usage of Internet technology alone doesn’t guarantee positive gains in instructional outcomes. Technologies such as the Internet can only play a peripheral role in scaffolding pedagogical processes. The heart of learning lies in effective learning strategies that efficiently tap the potential of technology to support students learning activities.

For effective Internet-based instructional activities to be designed an analysis of students’ current proficiency levels in using the Internet as an information repository needs to be assessed. This study aims to investigate Secondary One students’ digital information literacy skills in the context of using the Internet as a learning aid. It was conducted as an integrated element of a broader research agenda of the project titled Digital Information Literacies (DCL) DCL is one of the specific focus research projects of the Centre for Research in Practice and Pedagogy (CRPP) at the National Institute of Education and is funded under the auspices of the Singapore Ministry of Education. It was framed as a multi-disciplinary study and was designed to investigate students’ digital curricular competencies within the curriculum areas of Science and History. It explores the use of ICTs within the curriculum, as they support knowledge acquisition and the production or artefacts which employ effectively writing genres and represent ideas in multiple modalities.

Use of the Internet in Schools

The Internet is a technological tool with the potential to alter traditional classroom teaching and learning dynamics, due to the massive number of informational resources that it offers for both teachers and students. These resources can be accessed flexibly and thorough many different channels. Access to the Internet can facilitate more autonomy in learning and give learners control over their own learning progress. From the advent of the World Wide Web in 1989 educators have tapped into its affordances to inject innovation into teaching practices and to create more authentic learning experiences for students. Prior to 1989 information resources on the Internet had been disorganized and accessible only to researchers and keen individuals with advanced technical skills (Grabe & Grabe, 2000). The World Wide Web infused much needed flexibility and user-friendliness into the Internet, it provided a networked version of a hypermedia system based upon
a hypertext model of interaction, emphasising a search-and-browse method to access information (Chang, 2003).

Bruce and Levin (1997) suggest that the Internet provides the following three basic types of tools in the educational domain:

- Tools for inquiry
- Tools for communication
- Tools for construction

By providing tools for inquiry the Internet facilitates finding sources of information appropriate to a task, working to understand the information resources and how they relate to the task, and if possible applying this understanding in a productive way (Grabe & Grabe, 2000). By facilitating students’ access to resources from the outside world including experts in the field, as well as the potential collaboration directly with them, the Internet enhances students’ knowledge construction in a motivating way. Exposure to real world contexts supports the apparent relevance of learning activities and brings students into an understanding of the uncertainties of the ever-changing outside world (Labbo, Reinking & McKenna, 1998; Michaelson, 2003).

By providing tools for communication the Internet is an appropriate tool for rapid communication. Such communication can be either synchronous or asynchronous and could take on many forms such as e-mail, mailing lists, newsgroups, chat and videoconferencing (Grabe and Grabe, 2000). From a social perspective the Internet can also assist students in developing a broad, deep and creative understanding of community, culture and economics. Students acquire necessary social skills that enable them to interact across differences and distances. Such interaction involves communication between students in distant places and cultures as well as putting teachers in touch with fellow teachers and educators in their disciplines (Honey, Culp, & Carrigg, 1999).

By providing tools for construction the Internet promotes constructivism in learning by scaffolding varieties of authentic learning activities for students (Dede, 1996). Through these tools the Internet also supports the development of higher-order cognitive skills such as transfer and knowledge application (Jacobson & Spiro, 1995). For example, students are able to demonstrate their conceptual understanding by constructing products such as web pages. Learners can access a wealth of resources often with greater currency than their class texts and participate actively in meaningful interactions with the information generators to construct their own understanding of the world (Wilson & Lowry, 2000). For instructional activities, the Internet also has the added advantage of being adaptable for both individual learning and group strategies such as cooperative learning (Crane, 2000).

**Limitations and constraints for Internet-based lessons**

Though offering a myriad of pedagogical benefits, there are also a number of caveats that educators need to bear in mind. Being aware of any
possible pitfalls in conducting Internet based lessons, teachers can more easily invest in plans which ensure that the learning experience for their students is a meaningful and stimulating one. Herring (2001) found that students generally go straight to the Web without waiting for guidance from a teacher or librarian, little time is spent reflecting on the task before it is begun. This results in students ineffectively navigating the Web and not locating appropriate information relevant to the learning task (Ebersole, 2000). The problem is further compounded by students placing blind faith in the legitimacy of the Web sites they visit and from which they extract information (Vansickle, 2002). Students often fail to differentiate between authentic websites and sites that contain biased and inaccurate information and masquerade as reliable. Rarely do students ever check the source and owners of particular sites (this is also true for more sophisticated users). Teachers are thus faced with the challenge of teaching the students not just about a wealth of information at one’s fingertips in the Internet but also the need to improve their individual ability to perform searches efficiently and effectively, and be able to choose legitimate information sources.

**Research Methodology**

A total of 54 students from 7 different schools participated in this study. These students were asked to work in pairs to collaborate on an information problem solving task. Students were asked to go online to seek out relevant information on the Internet and put together the gathered information as an artefact using a particular genre. Students’ online movements were digitally recorded in video format using a screen capturing device, Snapzpro and the videorecordings subsequently analysed. Each pair of students was given 25 minutes to complete the assigned task. The following Science task on ‘Measuring Length’ was given to the students:

*You may have learned how vernier calipers (and micrometer screw gauges) are used to measure length.*

- Do an internet search to find out the industrial applications of these instruments.
- Illustrate the range of examples by collecting resources and summarise the examples in a paragraph. You might care to use MS Word or PowerPoint.

The video recordings of students’ web movements were parsed to mark meaningful time-dependent events or activities that impacted either directly or indirectly their ability to complete the given task. These micro-events were identified as the units of analysis and involved mouse clicks to move to or select objects, the keying in of words that helped to trace students’ trajectories through web space, or the manipulation of functions and objects in the web browser and artefact construction. The codes for these events were conceptualized and created based upon careful observation and investigation of each video recording and the previous work by Ellis (1993), who suggested six characteristics of information-seeking behaviour:
Starting — the initial search for information
Chaining — following chains of links or referential connections
Browsing — semi-directed or semi-structured searching in an area of interest, such as broadening, narrowing, etc.
Differentiating — using differences between sources as filters on the nature and quality of material examined.
Monitoring — maintaining awareness of a field through monitoring of particular sources.
Extracting — systematically working through a source to locate material.

Subsequently the codes were entered into an MS Excel database. Descriptive statistical computations were then undertaken to summarise students’ preferred patterns of navigation and information-seeking activity.

Results

The total achievable score for the information problem solving task was 20 which was scored using the following rubric. This rubric was formulated based upon a synthesis of the items found in HSA rubric for constructed-response items, Florida Comprehensive Assessment Test (FCAT) Science scoring rubrics, the Science rubric for Maryland high school assessment program and MCPS Science rubrics:

<table>
<thead>
<tr>
<th>Category</th>
<th>4 points</th>
<th>3 points</th>
<th>2 points</th>
<th>1 point</th>
<th>0 point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of problem</td>
<td>The context of the problem is well-determined and the problem is rigorously analyzed by being broken down into component parts.</td>
<td>The context of the problem is identified and the problem analyzed essentially correct.</td>
<td>The context and analysis of the problem lacks little or no precision in understanding.</td>
<td>There is no response or the response conveys an entirely erroneous analysis of problem and understanding of context.</td>
<td></td>
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| Relevance & Accuracy of Details/Evidence | Student’s work provides relevant, accurate and pertinent information. | Student’s work yields information generally relevant and accurate. | Student’s work offers information with very little or no relevance and accuracy. | No work was submitted or the work provides completely irrelevant and inaccurate information. |

| Synthesis & Student’s work       | Student’s work                                    | Student’s work                                    | Student’s work                                    | No work was submitted or the work provides completely irrelevant and inaccurate information. |
Organization of Information reflects a complete, comprehensive synthesis and organization of information from multiple information resources. reflects some synthesis and organization of information from a sufficient number of information resources. provides little or no synthesis and organization of information from a minimal number of resources. marginally addresses the task-specific questions. submitted or the work provides completely incorrect information.

Use of Accurate Scientific Terminology The use of accurate scientific terminology enhances student’s work. The use of accurate scientific terminology strengthens student’s work. The use of accurate scientific terminology may be present in student’s work. The use of accurate scientific terminology is not present in student’s work. No work was submitted or there is use of completely inaccurate scientific terminology in student’s work.

Communication of Ideas Clearly and effectively communicates rich and vivid ideas using creative and diverse means. Clearly communicates valid and appropriate ideas in customary ways. Communicates some ideas but generally makes inadequate attempts to communicate and failing to address key issues. Unsuccessful attempt in communicating ideas with key ideas being omitted or ideas articulated being flawed. No student product submitted or no attempt whatsoever in communication of ideas.

16 pairs of students (59.26%) obtained a score between 0 and 5, 6 pairs of student (29.63%) obtained a score between 6 and 10, 4 pair of students (14.81%) obtained a score between 11 and 15 and 1 student pair (3.70%) obtained a score between 16 and 20 for the task.

![Figure 1: Score range vs No. of students](image-url)
Student participants employed Internet search strategies a total of 194 times. A majority of the attempts (136 times = 70%) were keyword search engine strategies. Students used a general knowledge strategy 17 times (9%); a boolean search engine strategy 23 times (12%), a wide search engine strategy 8 times (4%), a direct typing access strategy once (1%) and a directory browsing strategy 9 times (5%).

![Search strategies vs Frequency](image_url)

Figure 2: Search strategies vs Frequency

Student participants accessed Internet search engines a total of 190 times in the course of searching for information. While students were provided with links to four different types of engines: Yahoo, Google, Mamma and Ask Jeeves, they did not stay much beyond the list even though they had been encouraged to try. Out of these attempts, students accessed Yahoo! search engine to source for information 91 times (48%). Google was the next most popular search engine and was accessed a total of 63 times (33%). Ask Jeeves was accessed a total of 5 times (3%); Mamma was accessed a total of 18 times (9%); MSN was accessed 4 times (2%); and a few other miscellaneous search engines made up the rest (9 times = 5%).
Out of the 27 pairs of students who participated in the studies, 10 pairs of students (38%) used only one search engine throughout the experimental session to conduct their information searches. Another 8 pairs of students (29%) used two search engines with another 5 pairs of students (19%) using a total of three search engines to organize their information searches. Only four pairs of students (14%) managed to use a total of four or more search engines during their experimental sessions.
Discussion

Only 18.51% of the total number of participating student pairs in the study managed to achieve a score beyond the passing one of 10 with the overwhelming remainder failing the given task. Over 50% of the students attained a score of 5 and below. This indicates that most students need support in their information literacy skills. This finding directly impacts the curriculum decisions that need to be made with regard to the learning activities employing the Internet as an inquiry tool.

In the majority of information-seeking attempts, students employed the keyword search strategy to look for information most frequently (70%). This finding could be attributed to students’ familiarity and comfort with search engines as one of their everyday interactions with the Internet for mainly non-educational purposes. It also highlights students’ lack of awareness and limited repertoire of other available search strategies that could have been used to yield more effective and fruitful search results. Having no prior knowledge and understanding of the different search techniques, most of the students did not establish a comprehensive search plan with explicitly stated search goals to guide their searches. Upon receipt of the task worksheet most students immediately plunged into the search activity without caring to analyse the information requirements of the task. Each pair often resorted to the convenient keyword search technique to engage in the search for information, favouring less of the other search strategies which though cognitively more demanding could have increased their success rates for locating the desired information. The evidence in this study supports similar findings provided by other researchers, such as by Nachiamas and Gilad (2002) who established that keyword searching using search engines was generally found to be inefficient in novice or untrained Internet users. On the other hand use of general knowledge and the use of computer conventions such as boolean operators to refine the search were found to be more effective search strategies, each of these strategies enhanced the search attempts to become more focused and better defined for producing relevant search output.

Students’ lack of general cognitive capacity to organize a search and execute it properly, backed by a working knowledge of the use of different Internet tools is supported by the result that an overwhelming majority of students (81%) used a total of one or at most 2 search strategies only during the entire learning activity. Narrowing their options in terms of navigational approaches, these students often arbitrarily and unsystematically conducted their searches using the limited number of search strategies with which they were familiar and which repeatedly yielded non-satisfactory results. Rarely did these students ponder to review or question the productivity of their search actions and choice of search tactics during the course of the task execution.

An overwhelming 98% of student participants not surprisingly chose the suggested search engines of Yahoo, Google, Mamma and Ask Jeeves to carry out their information searches. The majority accessed Yahoo and Google. Tabs for each engine were linked to their web pages and had been configured to be displayed beneath the title bar in the browser window.
Students accessed these specified search engines rather than consider the host of other search engines that are available on the Web. Moreover a significant number (67%) of the student pairs used the services of either one or at most two of these specified search engines throughout the entire task to execute their searches. The huge popularity of the four flagged search engines also demonstrated students’ lack of understanding that different search engines function with different operational algorithms which may mean that there are best matches with particular tasks. Thus students were not aware that different search engines would display different search results for the same query and no one particular search engine entirely fulfils an information need.

Conclusion

This study clearly supports that effectively searching for information on the Internet and manipulating the accessed information for specific pedagogical contexts is a non-trivial and complex skill that requires the integration of a number of specialized abilities. These information gathering skills are not easily mastered by ‘trial and error’ or by self-taught attempts but are better acquired systematically through a sequence of carefully planned learning activities. Asking students to independently find information on the web without sufficient scaffolds does not facilitate the process of effective acquisition of information search skills and the resultant products are limited in their complexity. There is a need to design, develop and implement responsive Internet-based instructional programmes that cater to the differing needs of students. Students need to understand intentional information search techniques to successfully searching for and retrieve relevant information that in turn can be used to construct learning artefacts.

References


