Self-directed learning with web-based sites: How well do students’ perceptions and thinking match with their teachers?

by Wan Ng

With research consistently showing that students can be motivated to learn with ICT, this case study sought to investigate Year 7 students’ learning about simple machines in an ICT-enhanced environment where they could self-direct their own learning with minimal intervention from the teacher. The study is focused on how well do students and teacher’s perceptions of self-directed learning with ICT match one another. The results indicate several mismatches in this regard. The implications of these findings are discussed.

Introduction

The amount and variety of resources freely available on the World Wide Web (WWW) at no cost to students and teachers have increased dramatically over the last ten years. This makes independent research and learning possible for a wider number of learners. The potential applications of web-based technologies in science learning have been reviewed by Scanlon (1997) and Ng (2006). These applications include collaboration, virtual experimentation, virtual field trips, project work and distance education. Numerous reports, books and articles have been written on the impact of ICT on learning, the relationships between student engagement and interaction with Web-based resources and the nature of content understanding and pedagogy (for example Becta, 2002; Candy, 2004; Linn & Hsi, 2000; Trucano, 2005; Hoffman, Wu, Krajcik & Soloway, 2003). These reports indicate that the impact of ICT on learning remains debatable as measures to assess impact are still undefined. However there are indications that positive impact on learning can occur when ICT is linked to pedagogy (Awang, 2006; Kiboss, Ndirang’u & Wekesa, 2004). The Becta (2002) report has also indicated positive associations between ICT usage and National test scores for science at key stages 3 & 4. A consistent report from many publications is that motivation to learn using ICT is generally high and positive.

This research paper reports on a case study that investigates the use of information communication technology (ICT) as a teaching tool for Year 7 students’ learning of simple machines. It seeks to explore how the students will motivate and self-direct their own learning with the aid of selected websites and with little intervention from the teacher. The focus of the study is a comparison of the perceptions of the students with that of the class teacher’s in terms of how they perceived:

- the usefulness of the websites,
- how well learning has taken place,
- how beneficial is self-directed learning in science?

Self-directed learning with technology

Two factors that characterise our society today are: the abundance of information on the World Wide Web (WWW) and the availability of information and communication technologies for easy retrieval of information and communication of ideas. Teaching students to capitalise on these factors and to be technologically literate to learn independently prepares them to be self-directed life-long learners. Being technologically literate combines both physical manipulation skills and mental processing skills and an understanding of the benefits and the limitations of computer-based tools or software in supporting learning (Ng, 2006). The mental processing skills of technology literacy is the ability of the individual to use technology appropriately to seek, manage, analyse, evaluate and integrate the information into problem solving tasks or to synthesise new information from web-based or software materials. Frequent opportunities should be created in the classrooms for these important skills to be developed to assist students to become independent learners with ICT.

A benefit of self-directed learning is the development of autonomous learners who are able to control and take responsibility for their own learning.
Candy (1991) defines self-directed learning as an awareness of alternative choices and being able to pursue a learning goal without being affected by external factors. Furthermore Candy (2004) asserts that self-directed learning is a vital part of the digital revolution. Sinitsa (2000) argues that in training students to be self-directed and lifelong learners, and to cater for differences in background and expertise, there need to be flexibility in both the diversity of resources offered and freedom for the learners to select learning materials. The enormous amount of material on the WWW has the potential to offer variety and choice to cater to individual’s learning preferences and style.

The study reported in this paper utilises Candy’s (1991) definition of self-directed learning where the Year 7 students could make choices about the way (s)he prefers to pursue. As transition from traditional structured teaching to allowing for autonomy in students’ learning is not easy for teachers (Crow, 1991), this research compares the teacher’s thinking of self-directed learning and compare it with those of his students.

Participants

The participants in this study were from a small, co-educational government school located in a suburban area of lower socio-economic status in Victoria. The class of Year 7 students consisted of twelve boys and seven girls who displayed a range of academic abilities. The teacher with a science/engineering background had recently sought a career change by pursuing a qualification in education. He was in his third year of teaching at the time of this research and was a Physics/Maths method teacher who was skilled in using computer technologies.

Self-directed learning

The Year 7 students studied the topic of simple machines over six 48 minutes lessons. Several websites (see Appendix) containing simple machines content were provided to the students. The web-based materials were presented in different formats, for example static, non-interactive versus dynamic, multimedia and interactive.

The students self-directed their own learning with the materials on these websites to construct understandings of simple machines. There was little teaching from the teacher but they could ask the teacher questions at any time during their learning. The websites provided information as well as exercises for students to test themselves. They could learn about this topic in the manner they chose, for example, choice of websites and content to learn. Suggestions were provided by the teacher in terms of how they could learn, for example they may wish to write some notes down as they learned from the websites or they may want to visit 2 websites at the same time to learn about the same simple machine. As there are many websites on the World Wide Web with simple machines content, the students were also given the option of going beyond the websites provided to search for more information in class and at home.

Data collection and analysis

Baseline data was obtained in terms of students’ attitudes toward science learning and their prior knowledge of simple machines before commencing their self-directed learning. Observations and informal interviews were conducted during the self-directed learning process. At the end of the learning period, the students were surveyed for their opinions on learning science with computers. While assessment was not the focus of this research, a short quiz containing seven multiple choice questions and three open questions were administered to the students to elicit some basic understanding. Twelve volunteer students were interviewed to elicit further their perceptions of their self-directed learning with the computer.

All surveys (closed and open) were conducted on the Moodle online management system where students logged onto the website to place their responses during class time. The responses from the Likert-style survey were analysed quantitatively using SPSS software and to check for internal consistencies. The open responses from survey and interviews were qualitatively analysed. The teacher had input into the design of the investigation. He was interviewed at the end of the research period to obtain his opinion on the self-directed learning exercise. A comparison of how he viewed the students’ learning and how the students viewed their own learning is made in this paper.

Year 7 students’ general attitudes toward science

As shown in Table 1, this group of students viewed science positively overall. Most of the students agreed that science is a useful subject, that learning science was not a waste of time in school and that everyone should study some science. About three quarters of the students liked the experiments that they did in science, and enjoyed finding out about how things work. About 69% perceived themselves as good at science although a smaller percentage (46.4%) thought that science was not difficult to learn and 52.6% said that science was an easy subject. There appears to be a relatively high percentage of students who were unsure of their thinking toward science for example more than a third of the students were unsure if science was one of their favourite subjects or if science was fun and interesting. For these students there could be competing subjects that they liked and the uncertainty could also be related to having experienced science activities that were sometimes interesting and fun and other times not.

<table>
<thead>
<tr>
<th>Table 1. Year 7 students’ general attitudes toward science. (N=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>I think science is a very useful subject</td>
</tr>
<tr>
<td>Science is one of my favourite subjects</td>
</tr>
<tr>
<td>Learning science is fun and interesting</td>
</tr>
<tr>
<td>I am good at science</td>
</tr>
<tr>
<td>* I think science is (not) difficult to learn</td>
</tr>
<tr>
<td>I enjoy watching science programs on television</td>
</tr>
<tr>
<td>I like the experiments we do in science</td>
</tr>
<tr>
<td>I enjoy finding out how things work around us</td>
</tr>
<tr>
<td>I am curious about how things work</td>
</tr>
<tr>
<td>Science is an easy subject</td>
</tr>
<tr>
<td>* Learning science is (not) a waste of time in school</td>
</tr>
<tr>
<td>Everyone should study some science</td>
</tr>
</tbody>
</table>

Cronbach alpha = 0.741

* These responses are reverse coded
Students’ views on the self-directed learning exercise with websites

The Year 7 students were overwhelmingly positive about the use of computers in helping them learn the topic on simple machines. As shown in Table 2, nearly 85% of the students agreed or strongly agreed that learning science with the computer was a good way of learning the subject. Ninety percent indicated that learning with the computer was fun, 95% saying that they enjoyed learning at their own pace with the computer and 90% saying that learning with the computer was not a waste of time. Ninety percent of the students preferred reading screen-based information rather than text-based, although a lesser number (58%) said they liked reading the written materials on the websites. Nearly three quarters of the students thought some of the websites had too much written information.

Table 2. Students’ perceptions of how they learned with websites on simple machines

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean</th>
<th>Std Dev</th>
<th>% SA/A</th>
<th>% NS</th>
<th>% D/SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning science with the computer is a good way of learning the subject</td>
<td>4.14</td>
<td>0.7703</td>
<td>84.3</td>
<td>15.8</td>
<td>0</td>
</tr>
<tr>
<td>I liked reading information from the computer rather than from text books</td>
<td>4.36</td>
<td>0.7449</td>
<td>89.4</td>
<td>10.5</td>
<td>0</td>
</tr>
<tr>
<td>I liked the way the websites explained the different types of simple machines</td>
<td>3.64</td>
<td>1.2157</td>
<td>68.4</td>
<td>21.1</td>
<td>10.6</td>
</tr>
<tr>
<td>*Learning with the computer (does not) waste a lot of time</td>
<td>4.29</td>
<td>0.9139</td>
<td>89.5</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Interacting with the materials on the website helped me learn a lot about simple machines</td>
<td>4.07</td>
<td>0.8287</td>
<td>89.4</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td>The thing that helped me learn about simple machines from these websites is the written information</td>
<td>3.00</td>
<td>1.1094</td>
<td>42.1</td>
<td>31.6</td>
<td>26.4</td>
</tr>
<tr>
<td>I liked reading the written materials on the websites</td>
<td>3.29</td>
<td>1.2044</td>
<td>57.9</td>
<td>15.8</td>
<td>26.4</td>
</tr>
<tr>
<td>*Learning with the computer is (not) boring</td>
<td>4.07</td>
<td>0.9973</td>
<td>73.7</td>
<td>15.8</td>
<td>10.5</td>
</tr>
<tr>
<td>Some websites were more interesting than others</td>
<td>4.57</td>
<td>0.5136</td>
<td>94.7</td>
<td>5.3</td>
<td>0.00</td>
</tr>
<tr>
<td>The interactive websites were the ones that I learnt the most from</td>
<td>4.71</td>
<td>0.4688</td>
<td>100</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>*I found the explanations on the websites (not) difficult to understand</td>
<td>3.57</td>
<td>0.9376</td>
<td>57.9</td>
<td>31.6</td>
<td>10.5</td>
</tr>
<tr>
<td>The thing that helped me learn about simple machines from these websites are the interactive quizzes</td>
<td>4.14</td>
<td>1.0271</td>
<td>73.7</td>
<td>15.8</td>
<td>10.5</td>
</tr>
<tr>
<td>I had fun learning with the computer</td>
<td>4.43</td>
<td>0.6462</td>
<td>89.4</td>
<td>10.5</td>
<td>0.00</td>
</tr>
<tr>
<td>Some websites have too much written material in them</td>
<td>3.71</td>
<td>1.2667</td>
<td>73.6</td>
<td>5.3</td>
<td>21.1</td>
</tr>
<tr>
<td>I enjoyed learning at my own pace at the computer</td>
<td>4.43</td>
<td>0.6462</td>
<td>94.8</td>
<td>5.3</td>
<td>0</td>
</tr>
<tr>
<td>I learnt just as much from each of the websites</td>
<td>3.07</td>
<td>1.3281</td>
<td>27.8</td>
<td>38.9</td>
<td>33.4</td>
</tr>
<tr>
<td>I learn well when I get feedback quickly on a task or question that I have done</td>
<td>4.07</td>
<td>1.1411</td>
<td>78.9</td>
<td>15.8</td>
<td>5.3</td>
</tr>
<tr>
<td>I revisit websites to get information that I have learned but have forgotten</td>
<td>4.21</td>
<td>0.6993</td>
<td>83.4</td>
<td>16.7</td>
<td>0.00</td>
</tr>
<tr>
<td>I learned a lot from the websites about simple machines</td>
<td>4.29</td>
<td>0.7263</td>
<td>83.3</td>
<td>16.7</td>
<td>0.00</td>
</tr>
<tr>
<td>I understand the different types of simple machines now</td>
<td>4.21</td>
<td>0.8018</td>
<td>83.3</td>
<td>16.7</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Cronbach alpha= 0.825
*These responses are reversed coded

The majority of the students agreed that the websites were different from each other with some being more interesting than others but that the explanations on the websites were not too difficult to understand. However, it was not the written material that helped them learn most but the interactivity—the latter had 100% agreement from the students. The quick feedback on a task or question the students have tackled helped them learn better. Over 80% of the students revisited websites for information they had forgotten. A similar number of students thought that they have learned a lot from the websites and that they now understood the different types of simple machines.

The Edheads website was voted by 100% of the students interviewed as the best website due to its interactive, multimedia features and because it had ‘simple machine games and quizzes’ (student 5), and that there were choice of activities which were ‘everyday/lifestyle sort of stuff’ (student 13). Many of the students in the class spent most of their time on this website.

Researcher: Why do you like that one? Stu 1: Because you can actually do stuff and choose what you want to do.
Researcher: So you knew nothing much about simple machines and you went straight to answering the questions, why? Could you answer those questions or was it just guesswork?
Stu 3: I could but it was fun because it showed you the answer when you answered it, and if we answered it wrong it would show us the actual answer and why.

In terms of demonstrated understanding, the post-learning quiz indicated that 94% and 67% of the students were able to identify the simple machine in an alarm clock and a cricket bat respectively while 89% could identify the 3 simple machines in a wheelbarrow. Sixty one percent of the students answered a question on first class lever which only 17% could relate number of threads on a screw with the least effort. A limitation of this study is the non-rigorous assessment to elicit higher order thinking associated with the learning.

Teacher’s views on the students’ self-directed learning

The teacher saw the students’ learning as a hands-off approach for him in order to allow for totally self-directed learning. His role was to offer technical support and learning support.
if the students asked questions and to act as policeman to make sure they did not go to websites that were not part of simple machines'. He stated that the students' engagement and interest in this self-directed learning exercise with the computer was high but understanding was low. He cited a student who had a headphone on and was systematically exploring all the pages on Edheads site that 'this is the longest he has been on task in science'. While he acknowledged that ‘kids felt good and excited with this type of learning' he was disappointed with the results when he questioned the students informally.

Teacher: I think this topic would be better taught the traditional way..... Edheads is the simplest and I’m least happy with it. It is better without technology....better with physical kinaesthetic demonstration with what’s going on, push this, pull that, for example you can take a ramp and show something rolling down and accelerating and there is momentum.

Discussion

The computer as the ‘teacher’ for Year 7’s self-directed learning

The 12-year-old adolescents in this study viewed science and science learning positively. The data showed that these students could be involved in self-directed, independent learning with technology with initial guidance and websites provided. However, choices made appear to be toward a preference that avoids wordy text-based sites. The ‘freedom’ to explore and learn from selected websites motivated them immensely to be engaged with the tasks. Novety is always a factor to be considered but in an ICT-enhanced learning environment where students are able to self-direct and have ownership of their own learning, reasons for motivation to learn to be increased are provided excerpts from the interviews.

Researcher (in response to students saying that the learning is good/better): Why is this type of learning better?

Stu 2: Because you don’t always depend on the teacher and you find things by yourself.

Stu 3: I reckon it’s better because you can go at your own rate, like if you don’t understand something you can go over it or re-read it until you understand or ask someone else about it.

Stu 7: We teach ourselves as we go.

Stu 8: Yeah because you can concentrate more and work at your own pace.

Stu 9: Yeah because if you don’t get something you can read through it again on the computer, whereas if the teacher were speaking you’d have to keep up.

you can’t stop him.

Stu 10: This is a lot easier to do because you can click on stuff and remember it because the teacher talks fast.

The computer and websites served as the students’ teacher in this self-directed learning activity. If the different format and display of content materials on the websites are likened to the different types and quality of human teachers, it is not surprising that the Year 7 students voted unanimously for the multimedia Edheads as the best website. The website had sound and speech, animations, quizzes and instant feedback to responses. More importantly the website was viewed as fun, game-like, interesting and provided learning in familiar contexts such as in the kitchen and bedroom. It also allowed them to learn at their own pace without having to ‘run after’ or keep pace with the teacher’s instructions or their peer’s too-quick-or-too-slow learning. In this regard, such websites are able to cater for diverse interest and ability.

How well did the perceptions and thinking of students and teacher match with one another?

Both parties agreed on the motivation and the willingness to engage with the learning when provided with the opportunity to self-pace, self-direct their own learning with content from selected websites. However different perceptions were found:

• Thinking mismatch one: the Edheads website was voted to be the best website for learning by 100% of the students interviewed but was disliked the most by the teacher.

• Thinking mismatch two: the students overwhelmingly agreed that this type of self-paced learning, particularly with multimedia interactive materials, was better than traditional method of teaching although they indicated that they would have liked some hands-on activities as well. The teacher thought this topic would have been better taught the traditional way.

• Thinking mismatch three: most of the students perceived having learned a lot about simple machines while the teacher thought that they have learned little and did not meet his expectations.

Implications of mismatches between students’ and teachers thinking

In the first mismatch, there was distinct disparity in perceptions of the website of choice. The website most preferred by students was the one their teachers were least happy with the reason being that it was the simplest of all the websites. However, if all students are to be motivated to learn some of the basic concepts of a topic and in order to cater for a diverse population of students, it is necessary to begin with simplicity in order to ensure some success for all students. It would be useful to capitalise on such websites to assist students to begin understanding simple machines concepts, the different classifications and how they differ from each other in terms of physical features and the manner each helps to make work easier. The second mismatch is that the teacher believed that the topic of simple machines was better taught in the traditional way whereas the students thought that the self-paced, self-directed method of learning had merit. Catering to individual abilities in science is often difficult when the teaching style is traditional. The ability to ‘rewind’ and listen/read the materials already ‘taught’ on a computer and the instant feedback was an attractive option for many of the students.

In addition there are limitations in demonstrating complex and abstract concepts with traditional teaching. The multimedia features of interactive websites offer a dimension that traditional teaching is unable to offer. The teacher’s citing of ‘rolling something down a ramp to see acceleration’ may have its limitations in terms of visualisation in real time. With simulated animated objects, the capacity to stop the object rolling down the ramp at any time where the motion is illustrated with numbers (speed) to show acceleration at different points is possible and would help make abstract concepts of speed and acceleration more concrete. The benefits of learning with such simulations with Year 10 students studying motion has been discussed by Ng (2005).

Learning with real objects and in real-time is important. Hence a blend of technology and traditional means of teaching is not only effective but necessary if we are to consider the characteristics of current generations of students. These students belong to commercially-labeled generations Y and W (Ligerakis, 2003) or are called ‘digital natives’ (Prensky, 2001) and
are characterised as consumers who are technologically tuned and who are also products of the online world and keen to explore new innovations. In the classroom, pedagogy reflecting these generational changes would help with students’ learning.

The third mismatch reflects different perceptions of how much learning has been achieved by the students and the teacher. Through informal assessment, the teacher made a judgement of a lack of ability of the students to define concepts of simple and compound machines, perhaps using highly technical terms of science. The students on the other hand, appeared to think that they have learned a lot, at least about simple machines and the different types of simple machines.

The researcher discussed this disparity with the teacher. The response from the teacher was:

I agree with your comments about the disparity between teacher and student expectations. I think this comes about as there was not enough direction from the teacher in terms of what was expected to be learned. There was minimal teacher feedback provided to guide students to my expectations.

The teacher’s response is entirely valid. However a too directive approach would leave little flexibility for students’ learning. Caution needs to be made in expecting students to be able to grasp concepts such as acceleration and momentum at the Year 7 level. Hence to be able to explain these in language suited to Year 7 students is crucial if the learning is to be inclusive. In adopting several websites to teach students, a variety of ways of demonstrating and explaining complex concepts is made possible and could potentially reach more students. The teacher’s response in terms of providing clearer guidelines and scaffolding in facilitating the learning with technology to assist with learning is clearly important. There are numerous research reports that support this (for example Krajcik, Blumenfeld, Marx, Bass, Fredricks, Soloway, 1998; Singer, Marx, Krajcik, Chambers, 2000; Linn & Hsi, 2000).

Conclusion

This research study shows both benefits and limitations in allowing Year 7 students to self-direct their own learning in science within an ICT-enhanced environment. It also highlights the disparity in the class teacher’s perceptions about teaching traditionally the topic of simple machines to his students, and his students’ perceptions of the advantages offered with learning in a self-paced, self-directed manner. For the teacher, the inability of the students to express understanding to his expectations when assessed informally was perceived as ineffective learning with this type of method. For the students the opportunity to self-direct their own learning in a self-paced manner with the computer meant that they could ‘rewind’ learning as often as they liked, and to go over concepts as many times as they liked was seen as an advantage. The instant feedback that they could receive was another advantage perceived.

The disparity in students and teacher’s thinking highlights desires and expectations that are not quite in tune with each other. This type of conflict may not create harmony between teaching and learning processes and could hinder learning. The computer is able to offer a wider variety of teaching formats at the one time, catering for different learning styles, interests and abilities. Hence, teaching students to ask appropriate questions when in doubt and how to search for answers from various resources are important skills that will help develop them into better self-directed learners.

Providing clear guidelines to scaffold students’ directing of their own learning with the computer is important. Hands-on experiments are also necessary in learning science. Hence a carefully designed blend of technology-based and traditional teaching would be beneficial for learning science inclusively. Based on the data of the study reported in this paper, an initial exploratory learning of simple machines in a self-directed manner would motivate learning and enable students to develop a basic understanding of simple machines. Intervention and scaffolding of learning beyond this could include directing students to websites that will take them to the next level of learning, conducting real-time experiments and project work. But providing opportunities for exploratory self-directed learning with appropriate and motivating technology aids could greatly enhance the learning.

Appendix

http://www.cosi.org/onlineExhibits/simpMach/sm1.html
http://www.mikids.com/Smachines.htm
http://www.eduheads.org/activities/simple-machines/index.htm
http://home.earthlink.net/~kandyhig/sm/

References