

The Impact of e-Learning on Students in Junior Science and Physics at a State High School in Queensland, Australia

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INTRODUCTION

Since the dawn of the twentieth century educators worldwide have done their best to incorporate technological advancements to improve teaching and learning outcomes. Following the widespread success of the Internet, e-learning or Internet-enabled learning offers real hope for educators to vary and deliver their lessons in a user-friendly manner. According to Evenson and Himelo, Demail & Berge and Salmon (as cited in Naidu, Cunningham, Jansen, 2002, p. 23) with this technology teachers can perform the role of "facilitators of learning" rather than "deliverers of content".

Millions of dollars are spent globally to acquire this technology. Most Australian schools are connected to the Internet, which is used for teaching and learning across the curriculum (Dowling, 2002). Since 2001, all state schools in Queensland have an Internet connection (Beattie, 2001). Classroom teachers have to find innovative teaching methods to use this resource not only to optimise student-learning outcomes but also to address some of the lingering issues in relation to science education.

Over the years, student interest in science in high schools apparently has declined and some researchers believe that one of the reasons for this trend is in the way the subject is taught. According to Harrison (as cited in Roberts, 2002), science "was in danger of becoming an optional snack in a smorgasbord of subjects". Some scientists believe that by the year 2020, "almost no Year 12 students will be studying physics, chemistry and advanced mathematics" (Fynes-Clinton, 2002, p.5). They believe that there was a need to review and rejuvenate school science. Can e-learning reinvigorate student interest in this subject? Can it positively influence learning outcomes?

Arsham (2002, p.4) pointed out that "a Web based class is a more effective learning experience, since the learner is participating in learning process and receives individual attention....The Web-based learning atmosphere allows more effective interaction between students and instructor....it can be as effective as traditional classroom learning environment where space, seating, etc. could be inadequate.". The impact of e-learning on student learning outcome is still unclear. While research has focussed on the effects of computer-based learning, there was a "lack of reliable knowledge about what works, why and in what ways? (Naidu, Cunningham & Jansen, 2002, p. 23). Godison (2002) investigated pupils' perceptions of learning with ICT at primary level and concluded that the potential of the Internet as a learning tool had still to be fully developed. Chan, Hodgkiss, and Chan (2002, p. 318) developed a website to teach students freshwater ecology. While no comparison was done between web-based and traditional practicals, they reported that students "enjoyed learning in a student-centred environment and their interest in the subject was enhanced." (<http://webwarper.net/www/~GZ/ubmail.ubalt.edu/~harsham/interactive.htm>)

Building on this previous research, the purpose of the research described in this paper was to address the issue of the impact of a teacher designed website on students.

## METHOD

### Subjects

This study was conducted at a state school in Queensland, Australia. It focussed on two groups of science students neither of which had any previous experience with e-learning through teacher designed websites. The Year 10 group consisted of 245 students from nine science classes. The school had two-year 11 physics classes A and B with 25 and 27 students respectively. Class A fully participated in this study while the participation of Class B was on an ad hoc basis. The year 12 physics class had 16 students – 15 males and 1 female.

### Learning Materials

*GetSmart*, a teacher designed website was created for students involved in this study. Its primary purpose was to consolidate the work done in normal lessons through regular review and practice. The website had the following features:

- It had a password login, which enhanced security and gave valuable information on login times for further analysis.
- It had numerous well-designed pages with suitably drawn graphics. Each page highlighted key aspects of a topic and was closely related to the work done in class, the work covered in the textbook, and the requirements of the work program.
- Each page focussed on a concept. It was also linked to a variety of other sites on Internet. This provided students with an opportunity for research and for further enhancing their understanding.
- Each page was also linked to a multiple-choice test, which gave instant feedback by marking student responses and gave a score out of 10.
- The website also gave students an opportunity to email a question or query. This was ideal for those students who were too shy to ask a question in class or did not get time to see teachers to sort out their difficulties. Parents were also encouraged to send emails.
- Students in Year 11 and 12 Physics had access to a private chat room, which gave them an opportunity for a group discussion after school in real-time. These students also had an opportunity to post their answers to questions on the student forum. (The chat room and the student forum was accessed through Education Queensland's Learning Place website).

The subjects were divided into the following e-learning topics:

YEAR 12 PHYSICS – ELECTRONICS Semi conductors, more on doping, diodes, capacitors, common electronic components

YEAR 12 PHYSICS - ATOMIC PHYSICS History of the atom. The hydrogen atom, Frank-Hertz Experiment, Radioactivity, Binding Energy

YEAR 11 PHYSICS - OPTICS Plane mirrors, Reflection in a curved mirror, Ray diagrams (concave mirrors), Ray diagrams (convex mirrors), Mirror formula, Practice ray diagrams (mirrors), Mirrors chapter summary, Refraction, Convex Lens, Concave Lens, Practice ray diagrams (lens), Lens formula, Optics revision

YEAR 10 SCIENCE - ROAD SCIENCE What is speed?, What does a graph tell us?, What is acceleration?, Reaction time and reaction distance, Inertia, Force, mass and acceleration, Road Science Revision(1), Road Science Revision(2)

YEAR 10 SCIENCE - SPACE TRAVEL How does a rocket work?, Space Exploration, Space Travel Revision

In term 2, 2002, students had access to the Internet for 35 minutes once a week in school time. They could also access computers during their lunch and morning tea breaks at school if they were interested. A survey showed that more than 90% of the students had Internet access at home and accessed the website from home as suggested by the login data. Prior to each lesson, students were also given a fill in blanks worksheet, which was related to the lesson. This worksheet also served as a summary of the topic at hand. Students were encouraged to send emails with their thoughts on this approach to learning and other concerns in relation to it.

## RESULTS

A total of 171 emails were sent by students in which they expressed their views on not only the website, but also on how it could be improved. A variety of different opinions were expressed and the majority of the students saw the value in this type of learning. Student email responses suggested that e-learning and website is beneficial for the following reasons:

- a) It is an effective learning resource.

"Thank you for your efforts in creating the web pages. It helped me to quickly find another source of reference if I didn't understand the text book."

Year 11 Physics student (female)

"Your site helped me immensely. It simplified the concepts that are presented in the textbook and explained them in a way that was easy to understand. I found the chapter summaries most helpful."

Year 11 Physics student (female)

"Thank you very much for your efforts in the year 11 optics unit. I have improved significantly by revising with your site. The pictures helped to make the information stick to my brain."

Year 11 Physics student (female)

"Your website really helped me...if it weren't for those extra questions my study wouldn't have gone nearly as well as it did...they provided me with new material so I didn't lose focus so easily. Also it pointed me in the right direction for my study."

Year 11 Physics student (male)

"I think that e-learning will eventually become the way of learning in the future."

Year 12 Physics student (male)

"I think that the website definitely is great and fully improved my marks dramatically last term. I used it mainly at school to complete the worksheets, from which I studied heaps leading up to the exam and hence did well, but that still came from the website and improved my results."

Year 11 Physics student (male)

"You are doing a great job, and I am thrilled with my improvement by 30% in the knowledge bit (knowledge section of the exam)."

Year 11 Physics student (male)

"I think that if you miss a class at school, for example, you were sick then you can go on the net and get the information that you missed, that is a very helpful tool."

Year 12 Physics student (male)

"I use it after school if I have trouble with my work."

Year 11 Physics student (male)

"The thing I liked about e-learning was the multiple choice tests at the end of each page. By doing them, it was easier for me to learn physics and by seeing which questions were right or wrong."

Year 12 Physics student (male)

"Just writing to say that I found the website useful for my study of Physics outside the classroom. The test pages were of much use as they gave me an idea of which areas I needed to spend more time on."

Year 11 Physics student (male)

"I would like to, in particular, emphasise to you the significance of the quizzes that follow after each Internet lesson. Every time when I have answered something incorrectly on the science quizzes, I would have gone through the internet lesson I was on and re-do the quiz again and again until I have scored perfect. The quizzes had undeniably helped me gather the information that I needed to know to excel in science, and I am positive that I am not the only person who have had taken advantage of this marvellous feature of your website."

Year 10 Science student (male)

"I think that your website is so cool, it really helps us learn a lot about science step by step and it's easy to follow. I enjoy doing the quizzes at the end of each lesson because it really shows us how well we're coping with the work."

Year 10 Science student (female)

"I believe the e-learning concept of lessons accessible after school hours to be a great idea. To be given the option of learning at my own pace with no distraction of friends and to be able to access the web site when I like and be as comfortable as I want."

Year 12 Physics student (male)

"The idea of e-learning is a very good concept since that is the way the world seems to be moving. It is good to get the opportunity to take advantage of this as it makes it easier process to learn."

Year 12 Physics student (male)

"The unit revision in the end and the individual tests were very helpful for me to practice questions and the notes section made it very convenient to access and review stuff. So thank you for that."

Year 11 Physics student (male)

"Hi sir, your website is interesting because instead of copying work off the board, we get the information of the Internet.... it is easier to learn with the computer and it is helping me through science."

Year 10 Science student (female)

"This site is really good and I learnt a lot from this site. It made me more interested in science."

Year 10 Science student (male)

"Learning occurs at students' pace."

"It is more convenient to learn at your own pace, and at a time convenient to you. You do not have to attend classes, and therefore have more time to do the things we want."

Year 12 Physics student (male)

"Geismart is a great site with allows us to learn science independently and to experience different types of teaching and learning. It has all the information we need to understand the science we are learning. I prefer it better than being taught in a class room because there are no mishaps and you can learn at your own pace."

Year 10 Science student (female)

"Chat sessions are very interactive."

"I must admit, however that the chat sessions were quite helpful. It forced me to keep up with the work being covered in class and presented some more stimulating questions."

Year 12 Physics student (female)

"The afterschool chat tutorials were quite helpful in REINFORCING what we had learnt already."

Year 12 Physics student (male)

Useful for exam preparation.

"I have found that the information on the web pages to be useful in my exam preparation, because it goes into more depth (in some cases) than the text."

*Year 12 Physics student (female)*

l) Initiates further discussion on a certain question or concept between student and teacher.

"In the diagram above (diagram not reproduced), what is the correct ascending order of the refractive indices of the five media?"

- (a) 2, 3, 5, 1, 4 (b) 4, 1, 3, 5, 2 (c) 2, 5, 3, 1, 4 (d) 2, 5, 3, 4, 1 (e) 4, 1, 3, 2, 5

I choose (b) because it is from least dense to most dense. I thought the denser the object, the higher the refractive index. I also thought ascending means from the smallest to the largest number.

But the answer is (c). Please tell me what's wrong with my choice."

*Year 11 Physics student (female)*

"I've done the revision questions from the website. I'm having some difficulty with the harder questions at the end. I was wondering if it's possible that I could meet you tomorrow after school and work on the questions then. Sorry to do this on such short notice."

*Year 11 Physics student (male)*

j) Learning science via the Internet is more interesting.

"We think your program is an excellent way to learn as it is not so BORING."

*Year 10 Science student (female)*

"GETSMART is a nice website for learning Science and I have to say that not many teachers do things like this for their students."

*Year 10 Science student (male)*

"I thought the site is pretty good. It is interesting and I enjoyed doing the work sheets. I prefer doing the work sheets and work from the computer, than to be in the classroom doing it."

*Year 10 Science student (female)*

"This site is great because it makes science easier to learn and it is a lot more interesting than you writing it up on the board. It is also less boring than working in class."

*Year 10 Science student (male)*

"I have found your WebPages a pleasant change from ordinary lessons. I think it is well structured and I believe that this method of teaching is interesting and more enjoyable than classroom lessons. The feel in the computer room is more laid back and there is less stress on everyone. I don't think there is much to be improved on this site. I think it is a pretty comprehensive study guide."

*Year 10 Science student (female)*

"I like your website. It is good.... at least we get to use the computers and not sit in boring science!"

*Year 10 Science student (female)*

Students were quick to point out errors on pages. They also pointed out constructive ways in which the website could be improved. Their main areas of concern and suggestions were:

a) The website is dull and should be made more interactive.

"The overall layout of the site is very dull, so one would quickly lose interest if it were not for some of the multiple choice tests and the chat room. Suggestions for improving the site include using Flash and / or Java to improve the interactivity and the look of the site."

*Year 12 Physics student (male)*

"If it is possible, the website should include animations of theories, diagrams, etc, as I find them easier to understand."

*Year 11 Physics student (male)*

b) There should be a variety of questions and exercises.

"More Complex Reasoning style questions should be put on a webpage within the site..... Short Answer questions marked by you personally via e-mail would also greatly improve the functionality of the site."

*Year 12 Physics student (male)*

"Lastly, Get Smart has been of great assistance to us all in semester 1. However, I believe that your site can help the students achieve at an even better level if there are more exercises we can work through after each Internet lesson."

*Year 10 Science student (male)*

"The website is good but if there should be more than one test per each topic."

*Year 11 Physics student (male)*

c) The website should have more examples and additional links to other sites.

"I enjoyed using the online tutorials, and I think it was beneficial to my learning as well. I think the site could be improved by adding more examples with their solutions, and also with more links to other sites."

*Year 12 Physics student (male)*

d) Errors on pages with suggestions for corrections.

"There is an error on the Scalars and Vectors Test page (Question 1)

Which one of the following is a scalar quantity?

- (a) deceleration (b) velocity (c) force (d) momentum (e) speed

The computers answer is (d) momentum, when it should be (e) speed, because speed is a scalar quantity and momentum is vector quantity.

*Year 11 Physics student (male)*

"In the test for conservation of momentum, question 3 has west as an option where it should be east. I'm might not be right but I thought I should tell you in case."

*Year 11 Physics student (male)*

A small proportion of students could see the value of this approach to learning, but felt that the face-to-face interaction was better suited to their needs.

a) "To be perfectly honest, e-learning has not particularly suited my learning style. As a more hands-on-paper person, I find that generally I am not able to absorb information as well from a computer screen as from a book... All in all, I think that e-learning works well to complement in-class learning, but I do not feel that it can take the place of it. A better understanding of concepts, for me, is obtained by physical interaction with teachers and peers, not interaction with a computer screen.... I encourage you to continue your work on this innovative, futuristic view of education. I believe that there is a balance between online and in class learning which, when achieved will work best to optimize educational outcomes."

*Year 12 Physics student (female)*

- b) "There is no substitute for the interaction of a student with a teacher in class, and I do not believe that e-learning could ever replace this. I think that e-learning should complement our classroom learning where the concentration of teaching and learning should be, not on the Internet. I think that e-learning is an excellent innovation and I would like to continue with it but some changes need to be made".

*Year 12 Physics student (male)*

From the teacher's point of view, some responses gave an insight on concepts which students were having difficulties with. This in turn gave an opportunity to re-visit the concepts in class.

"I was just wondering if we needed to know all of that stuff about short and long sightedness. For example; Myopia for short sightedness and Hypermetropia for long sightedness, etc. because Z\*, S\* and I had no idea what the question was talking about."

*Year 11 Physics student (female)*

"I would like some help with acceleration. The 3rd example in particular."

*Year 10 Science student (female)*

## DISCUSSION

While student responses were varied, they all suggested that the website did have a positive impact on their learning. The design and the content of the pages made it useful for the students. All except 1 of the 171 responses suggested that e-learning via the website was making a difference to their learning in one-way or another.

For many years the teaching and learning process has been dominated by the interaction between educators and learners in classrooms (Figure 1).

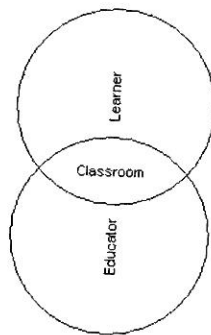


Figure 1:  
*The traditional teaching and learning approach.*

The Internet has opened numerous other doors, which can supplement the traditional teaching and learning process. As shown in the diagram below (Figure 2) both the learner and the educator can have access to this medium independently (1 & 2) outside the classroom and at times convenient to them. They can also use this medium to interact with each other in real time via a chat facility or in a computer laboratory (3).

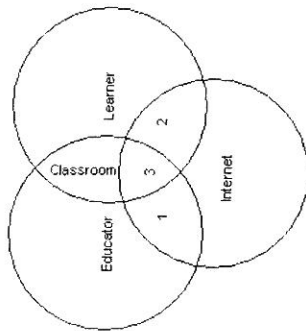


Figure 2:  
*Key elements of e-learning.*

How much of the interaction occurs via the Internet depends on different situations. Each classroom and each educational institution is different. Hence, the degree of interaction between these three elements of e-learning will depend on factors such as types of learners, their learning styles, the availability of resources and so on. Further research has to be done to explore this further.

In this research, the overwhelming positive response of the students suggests that the Internet and the website *Getsmart* was widely accepted and this high level of acceptance can be used to enhance student learning. According to Gagne (as cited in Yu, Chang, Liu, & Chan, 2002), positive outcomes for instructional objectives were dependent on the practice of desired skills. Researchers such as Buchanan, Montelpare & Williams, Spellman (as cited in Chan, 2002) have found that such a model not only improved academic outcomes but also led to longer learning retention and improved learning behaviour. A website such as *Getsmart* enables students to review their work regularly. Thus, it has the potential to influence of enhancing learning outcomes.

Further data analysis is currently being done to ascertain if the high approval rating of e-learning (as reflected in students e-mail responses) translates into an improvement in student learning outcomes (such as exam results).

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