COMPUTER HARDWARE FUNDAMENTALS USING MULTIMEDIA: THE SEQUEL

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ABSTRACT

The Faculty of Engineering and Physical Systems subject Computer Hardware Fundamentals (81120), is hardly recognisable to those students enrolled before 1997. The evolution of this subject is comparable to the metamorphosis of a caterpillar into a butterfly. Previously a print based subject for first year on-campus and distance education students, 81120 is now delivered via a web site or CD-ROM with second generation multimedia components which enhance the learning experience for the student.

During 1997 a media analysis was conducted on the subject which saw the creation of twenty-five animations (animated gifs) to enhance learning of conceptually difficult topics within the subject. This project, also known as stage 1, was the focus of papers presented throughout 1997 (for example see Stewart and Cardnell 1997). Based on feedback received regarding stage 1; stages 2 and 3 were implemented during 1998. These stages included the upgrading of animations to commentated Quicktime movies and the development of an innovative self-assessment tool. The self-assessment tool is available on all delivery media allowing distance education students the same experiences as on-campus students. The tool also enables the students to measure their knowledge before and after exposure to the material and from nearly every page within the 81120 learning environment.

This paper will present the latest Computer Hardware Fundamentals story. It will provide the history and rationale behind the decision to augment the subject initially and briefly describe the resultant project stages. It will then present the results of research carried out during stages 2 and 3 and draw conclusions based on this research regarding the effectiveness of the multimedia components.

KEYWORDS

Animations, assessment, multimedia, distance education, tertiary education.

1. COMPUTER HARDWARE FUNDAMENTALS

Computer Hardware Fundamentals is a core subject of the Bachelor of Information Technology and Bachelor of Engineering Technology at Central Queensland University. The content of this subject deals mainly with the operation of computers at the component level. It takes a block diagram approach to teaching the dynamic systems that comprise a computer workstation, covering topics such as: central processing unit, memory, direct memory access, floppy disks, keyboard, printers, video display, sound card, and CD-ROM.

Over the past two years the subject has undergone significant learning resource changes. The development team have implemented these changes in small, discrete stages. The staged approached allowed reflection and proof of concept at each implementation.

1.1 STAGE 1 – ANIMATIONS AND FLEXIBLE DELIVERY

Computer Hardware Fundamentals (CHF) began to undergo changes in 1997. The lecturer saw the potential for improved learning by the introduction of animations, particularly for distance education students who do not experience face-to-face contact. The animations were to demonstrate conceptually difficult content areas within the subject. Stage 1 of the augmentation is described in detail in Stewart and Cardnell (1997) and encompassed the introduction of twenty-five animated gifs distributed on floppy disks. These animations accompanied the printed study guide which for the most part contained the instructions to explain each frame of the animation. Obviously students have difficulty watching a looping animation on screen whilst following what is happening by reading the text from a book in their lap. As explained in Stewart and Cardnell (1997) these limitations were predicted and resulted in the problem of split attention source (Chandler and Sweller 1991). However it was perceived the implementation of this stage would allow concurrent events:

- researching the student technological facilities
  It was found the students were technologically rich, which is to be expected but not assumed of computing students.
- judging the reaction to the benefit of animations
  Overall, student feedback was positive on the educational benefits of the animations. However the students were adamant regarding two suggestions for improvement: users needed control over the animations; and either audio commentary or text captioning on all animations would be beneficial.

Data collected during this stage provided input to the design phase to improve the animations. Options were also assessed of how to do so most effectively, based on student technological facilities.

Flexible delivery was also implemented during this stage. Students were asked to enrol in the subject and nominate how they would prefer to receive their study materials. The choices given were: 1) print; 2) print and disks (for the animations); or 3) the world wide web. Overwhelmingly, the students chose print and disks, even though the majority were connected to the internet. Implementing flexible delivery was extremely administratively intensive for what appeared to be, in hindsight, no significant improvement for the student. Therefore the development team reflected on the rationale behind this feature and decided to withdraw the notion of flexible delivery choices. During stage 2 with flexible delivery abolished each student received all subject resources, similar to resource based learning.

1.2 STAGE 2 – ENHANCED ANIMATIONS

The following decisions were made for the development of stage 2 in light of the research carried out during stage 1.

- Enhance the animations by:
  - enabling user control.
  - adding an audio commentary.
- Change the distribution media to CD-ROM.

Enhancing the animations was carried out by converting sixteen of the existing animated gifs into Quicktime movies. In addition, two new animations were introduced resulting in eighteen Quicktime movies in total during stage 2. Quicktime movies enabled the fulfilment of both enhancement criteria. Consequently, the file size grew exponentially and therefore necessitated the change of distribution media to CD-ROM. It was ascertained in the initial research that CD-ROM was a viable distribution media matching student technological facilities; a fact we were not sure of before the first augmentation of this subject. More detailed information on how and why the animations were upgraded can be read in Cardnell and Stewart (1998).

1.3 STAGE 3 – INTERACTIVE SELF ASSESSMENT TOOL

The development team for the augmentation of this subject did not stop at stage 2. It was determined that further animation enhancement would not be beneficial. This decision was based on the fact that all conceptually difficult diagrams had been animated and student feedback concurred. Therefore it was decided to improve the self assessment throughout the subject. Prior to this stage the student was presented review questions at the end of each chapter of the printed study guide as is traditional. With the assistance of a Teaching Development Grant an optional interactive online self assessment tool was developed with the incorporation of a 'knowledge map'. Extending the subject resources in this manner in turn increased the technology the student would need to fully benefit from the improvements.

1.3.1 The interactive self assessment tool

The interactive self assessment tool implemented pre and post tests for each chapter of the study guide. The pre test could be selected before reading the chapter material; the post test at the end of the chapter. Both tests were identical for this first implementation for several reasons, including time restraints. Additionally it was the opinion of the development team at the time that identical tests would provide 'more scientific' data.

The tests were multiple choice format as part of the existing web pages. The student was required to enter their student number, name and password for validation purposes. Once the test was completed, it was submitted to the file server for marking. The student received immediate automatic feedback on their performance. At this point in time feedback is very rudimentary. Currently the feedback system is undergoing upgrading based on investigation into similar online systems, for example Charles Sturt University. However, the technology is being tested at this stage. Student learning outcomes will be improved as we progress by extending the testing facility and providing a random selection of questions. This is much the same development ethic as we have taken from stage 1 (step-by-step).

1.3.2 The knowledge map

Linked with the interactive self assessment tool principle is the concept of a 'knowledge map'. The knowledge map is a record of the student's success percentages to date on any completed pre and post tests. This map is available from almost every page of the study guide enabling the student to access a graphical representation of their results at any time. It provides an instant picture of their success through the entire unit material, as measured by their responses to the pre and post tests. A knowledge map is illustrated in figure 1.

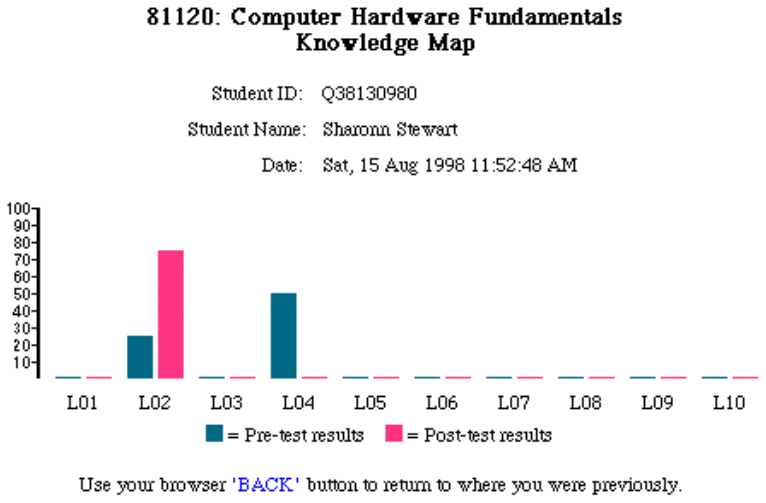


Figure 1: Knowledge Map

1.3.3 Technological requirements

Initially, there was much debate over how the assessment tool should operate. The primary issue was whether data should be kept or not on the attempts the students made. The decision was made in the affirmative which necessitated implementation via a web server in the University. There was philosophical debate over who was the system for the students, or us the lecturer and researchers? Ultimately however, we needed a starting point which could be improved upon later based on student feedback and development team reflection.

Therefore the student needs to be online in order to participate in the interactive self assessment system. The final option of a test is the request to submit. If the student is offline when the submit command is initiated the system will indicate an error has occurred. This requirement means that the testing component has to be optional.

The self assessment system is supported by an underlying invisible database created and maintained using Frontier software. The server database enables the automatic marking of each test as it is submitted and provides the student with instant feedback. The database is also available for the lecturer who can monitor student performances and determine the effectiveness of the process.

2. RESEARCH AND EVALUATION

Research and evaluation has been implicit during all stages of Computer Hardware Fundamentals, formerly known as Fundamentals of Computer Technology (Hardware). During stage 1 the student population were polled on their computing experience and available computing facilities. The research question ‘What computing facilities do the students have access to on a regular basis?’ provided information which meant that the distribution of data on CD-ROM was possible. Additional student feedback inferred a change to Quicktime movies for the animations; the move to CD-ROM distribution enabled this inference to become an implementation.

An important question to ask was ‘Did the animations (stage 1 or stage 2) improve student learning?’. Throughout stage 2 data was acquired in order to carry out comparative analysis. The data was provided from exam scripts dating back to 1996. A large amount of data is available due to both student numbers in the unit, and it being offered twice a year since 1997.

Research on stage 3 is taking place throughout the current Winter Term. It is focusing on the implementation of the interactive self assessment tool. What we need to know are:

- Do the students think it is an effective learning tool?
- Should the tool only be online?
- Should the tool record information for the lecturer?
- Is pre and post testing an efficient learning tool in this situation?
- Is this assessment system contributing to improved scores on the final exam?

3. RESULTS

Data collection has been completed on exam scripts from 1996 to 1998. Preliminary analysis has shown some interesting results.

3.1 EXAM FORMAT

The format of the Computer Hardware Fundamentals exam is flexible and raises further research questions. The exam accounts for 75% of the student’s final grade. There are usually five questions on the exam, each totaling twenty-five marks. The student can answer any three questions in order to obtain maximum marks. Obviously some exam questions relate to theory which has been presented using animations. We have conducted data analysis to answer the following questions.

- Are students choosing the animation related questions more frequently?
- Is the performance on animation related questions improving?
- Do the animations improve the performance of all students?
- Do the animations improve the performance of those students who would normally do poorly?

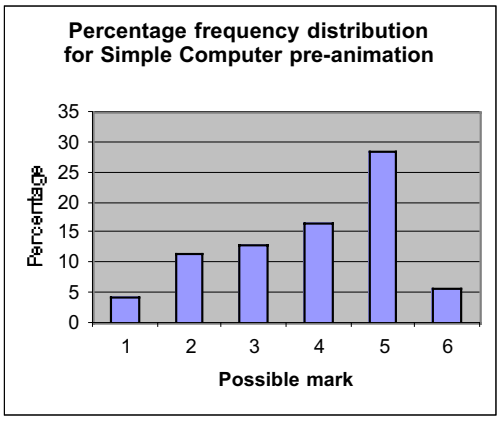
3.2 SPECIFIC RESULTS

Two questions have appeared consistently over the three exam periods researched. These are questions based on the operation of the 'Simple Computer' and the 'IBM PC keyboard'.

3.2.1 The Simple Computer

This question asks the student to explain the operation of the simple computer in relation to a specific diagram which they recognise from the study guide. Since Semester 2 1997 this diagram has also been an animation. Therefore, the data collected provides results pre and post animation.

Figures 2 and 3 illustrate the percentage frequency distribution of marks attained in this question. A visual comparison of the two graphs indicates a population shift of students who performed poorly. The percentage of students who performed poorly has decreased while the percentage of students who performed well has increased overall.



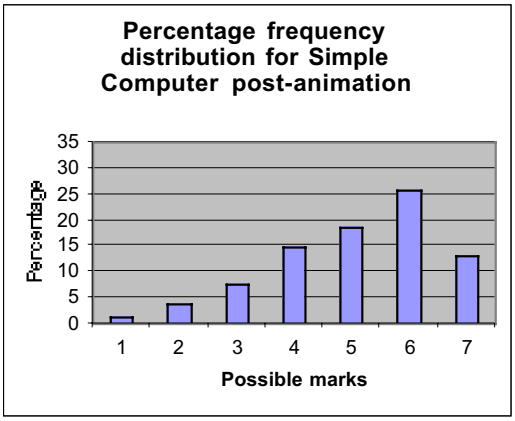


Figure 2 **Figure 3**

In addition, the data indicates a movement from a pre animation average of 3.83 and a maximum of 6 out of 6; to an average of 5.1 and a maximum of 7 out of 7 post animation. The percentage of students choosing this question has not changed significantly. Pre animation, 80% of students chose this question compared to 84% post animation. These results indicate that the same number of students are choosing the question, but on average their performance has improved.

3.2.2 The IBM PC keyboard

This question asks the student to explain the operation of the IBM PC keyboard including an explanation of 'make' and 'break' codes. The question asks for explanation in relation to a specific diagram which is also recognised from the study guide. Again, since Semester 2 1997 this diagram has been an animation. Therefore, the data collected provides results pre and post animation.

Before the animations were implemented, the students scored an average of 6.5 and a maximum of 9 out of 15 for this question. Only 46% of the student population chose to attempt this question. However, after the implementation of the animations, students scored an average of 8.2 and a maximum of 15 out of 15 on the same question. Significantly, the percentage of the population choosing to attempt the question rose to 63%.

Preliminary analysis indicates that the students have benefited significantly from the implementation of the animations. A more rigorous analysis is being carried out to determine if this conclusion is valid. Further data acquisition and analysis will be conducted over the coming years to monitor whether the student performance is sustained.

4. CONCLUSION

In conclusion, it appears that the use of animations to demonstrate conceptually difficult content areas in the subject Computer Hardware Fundamentals has had a significant impact on the students learning. Therefore the original goal of this project has been achieved.

The experience and knowledge which has been acquired thus far in the development of animations for Computer Hardware Fundamentals can now be applied to many other subjects within the University. The continuing development of CHF does not inhibit the immediate application of acquired experience to another field. This experience has provided a step-by-step developmental approach which can be implemented confidently in a single phase for future applications. It must be stressed however that the planning process undertaken in future projects must be exhaustive. This is to ascertain which techniques we have developed as a single package from CHF, are in fact required in the new project.

In addition, there are many issues and questions which have been uncovered and will provide a basis for future debate. Perhaps the biggest issue is the effective use of technology and the impact of resource based learning in the current climate of globalisation. With the introduction and subsequent abolishment of flexible delivery in this project it was proven flexible delivery is not as important as ‘maximum delivery’. Maximum delivery is the provision of resources which maximise student learning. Delivering a one hundred page study guide via the web was not an effective use of the technology, even though it contained 25 animations. It would follow therefore that an effective learning package, and certainly Computer Hardware Fundamentals in the future, may include several delivery methods: study guide in print, animations on CD-ROM, assessment system from a subject page on the world wide web.

This in turn raises the question and extremely contentious debate of why in the tertiary sector we make a distinction between internal and distance education students? The rationale being, if students can be provided a maximum learning package without four hours scheduled contact per week why are we putting so much time into face-to-face contact?

5. REFERENCES

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