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## Coping with diverse student backgrounds in a first year engineering computing subject

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# Coping with diverse student backgrounds in a first year engineering computing subject

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**ABSTRACT:** Each year, students enrolled in the subject *Engineering Computing 1* at the University of Wollongong, Wollongong, Australia, are surveyed on the first day of classes in order to assess their prior knowledge of the subject content. The survey results show considerable diversity in students' backgrounds. On average, about 10% are not familiar with the use of personal computers (PCs), 5% have never used e-mail/World Wide Web, 30% have not used spreadsheets and 60% have not programmed in a high level language. However, within these averages are some students with advanced skills and others with quite limited skills. Many of those students with a limited knowledge of computers come from developing countries, including Sudan, Indonesia and the Indian subcontinent. In the paper, the authors discuss how computer based training (CBT) packages are utilised to form the basis of a student centred self-learning system. These CBT resources allow the lecturers to better manage class-time by having a mechanism to bridge the skills gap between those students with little or no experience in the subject content, and those who enter the course with higher-level skills.

## INTRODUCTION

The subject *CIVL196: Engineering Computing 1* is offered to first year engineering and science students at the University of Wollongong, Wollongong, Australia [1]. *CIVL196* is a core subject to civil, mining and environmental engineering, and is also taken by students from other courses, including physics and informatics. The topics covered are as follows:

- The University's e-resources;
- Microsoft *Word*, including equation editor preparation of technical reports;
- Microsoft *Excel* to analyse experimental data and solve numerical problems;
- Writing computer programs to solve engineering problems using *MATLAB*.

There has been continuing development of this subject for student-centred learning over several years [2]. In this paper, the authors describe the latest developments.

Each year, students are surveyed on the first day of classes to assess their prior knowledge of the topics. Results of the 2004 survey show considerable diversity in student backgrounds. For example, about 10% of the 2004 students are not familiar with the use of personal computers (PCs), 5% have never used e-mail/World Wide Web, 30% have not used spreadsheets and 60% have not programmed in a high level language.

Most of those students with limited knowledge of computers come from developing countries, including Sudan, Indonesia and the Indian subcontinent. Various interactive teaching tools have been incorporated into the subject in order to provide a flexible method of learning so that students can acquire the basic skills demanded by the *CIVL196* subject.

In this paper, the authors discuss how the *Smartforce Word* and *Excel* computer-based training (CBT) package is used to form the basis of a student centred self-learning system. In addition, a special CBT package has been developed at the University of Wollongong to provide students with foundation level programming concepts in *MATLAB*. These CBT resources allow the lecturers to better manage class-time by having a mechanism to bridge the skills gap between those students with little or no experience in the subject content, and those who enter the course with higher-level skills.

The authors also describe the development of the course, with an emphasis on flexible learning, and additionally detail the development of the special CBT package for teaching *MATLAB* programming concepts. The *MATLAB* CBT was internally funded via a Faculty Service Agreement between the Centre for Educational Development and Interactive Resources (CEDIR) and the Faculty of Engineering at the University of Wollongong. The basic development tools utilised were Macromedia *Flash 6* and Adobe *Photoshop*.

## STUDENT CENTRED SELF-LEARNING APPROACH

The subject *CIVL196* is offered over a 13-week semester as a four-hour hands-on class in a computer laboratory. Students are given regular breaks during each laboratory session. A PC laboratory session involves a mix of online CBT, additional notes on selected topics, worked examples and tutorial problems. Because all notes, tutorials and CBT resources are accessible via Web Course Tools (*WebCT*), students may preview the week's material ahead of class time if they choose.

The weekly topics and linked resources used in *CIVL196* subject are summarised in Figure 1. The Web-based approach is not intended as remote learning.

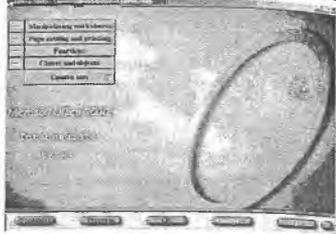
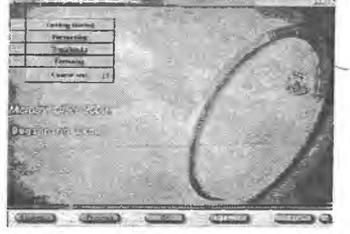
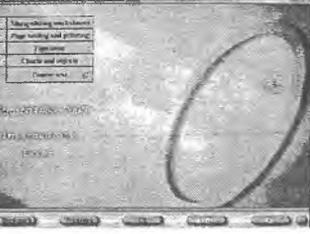
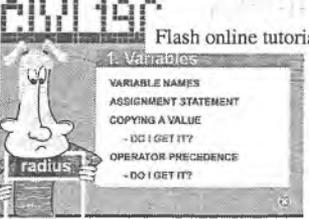
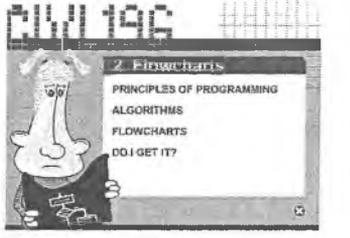
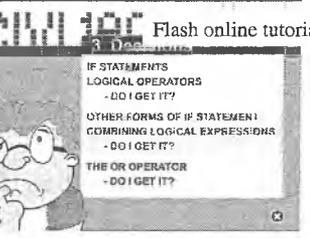
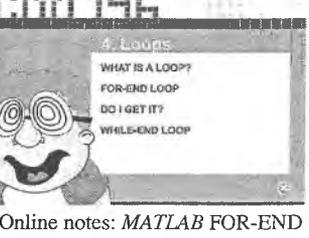
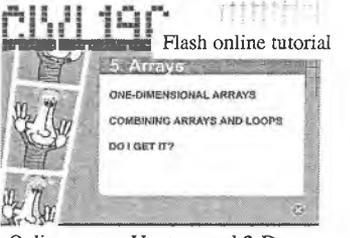
<p><b>Week 1: University's e-resources</b></p> 	<p><b>Smartforce Beginning Word CBT</b></p> 	<p><b>Week 2: Smartforce Intermediate Word CBT</b></p>  <p>Online notes on:</p> <ul style="list-style-type: none"> <li>Equation Editor</li> <li>Drawing tools</li> </ul>
<p><b>Week 3: Smartforce Beginning Excel CBT</b></p>  <p>Online notes on:</p> <ul style="list-style-type: none"> <li>Commenting cells</li> <li>Importing text files</li> </ul>	<p><b>Week 4: Smartforce Intermediate Excel CBT</b></p>  <p>Online notes on design of worksheet</p>	<p><b>Week 5: MS Excel</b></p> <p>Online notes on:</p> <ul style="list-style-type: none"> <li>IF function</li> <li>LOOKUP functions</li> <li>COMBO, Scroll Bar and Option button</li> </ul>
<p><b>Week 6: MS Excel</b></p> <p>Online notes on:</p> <ul style="list-style-type: none"> <li>Designing worksheets</li> <li>Nested IF function</li> <li>AND/OR operators</li> </ul>	<p><b>Week 7: Laboratory test on weeks 1-6 materials</b></p> <ul style="list-style-type: none"> <li>Problems solved on a PC</li> </ul>	<p><b>Week 8: MATLAB CBT Variables Module</b></p>  <p>Online notes: Using <i>MATLAB</i></p>
<p><b>Week 9: MATLAB CBT Flowcharts Module</b></p>  <ul style="list-style-type: none"> <li>Online notes: Principles of programming</li> </ul>	<p><b>Week 10: MATLAB CBT Decisions Module</b></p>  <ul style="list-style-type: none"> <li>Online notes: <i>MATLAB</i> IF-ELSE-END construction</li> </ul>	<p><b>Week 11: MATLAB CBT Loops Module</b></p>  <ul style="list-style-type: none"> <li>Online notes: <i>MATLAB</i> FOR-END construction</li> </ul>
<p><b>Week 12: MATLAB CBT Arrays Module</b></p>  <ul style="list-style-type: none"> <li>Online notes: Vectors and 2-D graphics</li> </ul>	<p><b>Week 13: Laboratory test on weeks 8-12 materials</b></p> <ul style="list-style-type: none"> <li>Problems solved on a PC</li> </ul>	

Figure 1: Linkages between weekly topics and resources.

To this end, students are required to attend scheduled PC laboratory sessions, but can access the subject material from home or other locations. The Web-based approach allows self-paced learning, providing students with concise information at the time and place that they need it. Both the *Smartforce* and *MATLAB* CBT packages explain the subject topics to students at their own pace. The CBT online tutorials conclude with self-evaluation quizzes that assist students in consolidating the core concepts and to test their understanding.

### Smartforce CBT

The University has a contract, which expires this year, with *Smartforce* that provides students and staff with access to various online CBT packages, including Microsoft productivity packages. *Smartforce Word* and *Excel* CBT are used as part of the *CIVL196* subject materials, providing basic concepts to students with limited background knowledge.

Students with higher-level skills can rapidly complete this material, while testing their skill levels in the evaluation quizzes. The CBT provides an option to demonstrate the necessary steps required to accomplish an activity. Each module concludes with a course test for self-assessment.

### MATLAB CBT

The *MATLAB* resources focus on providing students with foundation computer programming concepts. The five *MATLAB* modules of the system are Variables, Flowcharts, Decisions, Loops and Arrays (see Figure 2).

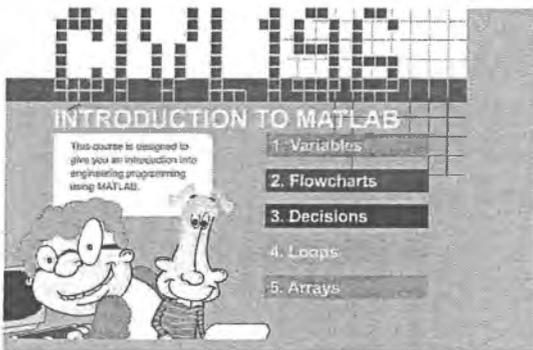


Figure 2: *MATLAB* CBT modules.

A modular approach has been used so that students concentrate on those topics in which they require support. The online tutorials finish with self-evaluation quizzes called *Do I get it?*; these enable students to test their level of understanding.

Colour diagrams and *Flash* animations are extensively used in order to explain difficult concepts. The developed *Flash* animation/online tutorials are linked to the tutorial problems set for the week, and may be attempted at anytime by students. The following elements underpin such an approach:

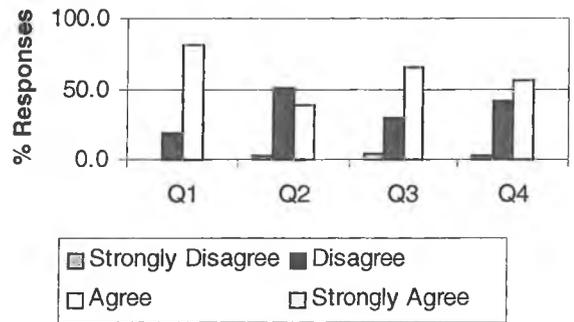
- Active learning;
- Flexible individual online learning with a choice of pathways;
- Regular opportunities for self-assessment and feedback as a way to develop concepts in students with a range of prior skills and abilities.

A key objective in developing the *MATLAB* CBT was the use of friendly, lively and humorous approach, so as to add a level of enjoyment to the student learning.

Students spend the last hour of most classes doing an assignment. *WebCT* provides the flexibility to control submission dates of assignments. Students submit soft copies of their assignments via *WebCT*, which gives immediate acknowledgement of the submission. Assignment feedback is provided online via *WebCT* and students may view their progressive marks via the Web.

### SUBJECT EVALUATION

During autumn 2004, students will be surveyed on the usefulness of *Smartforce Word* CBT, *Smartforce Excel* CBT and in house *MATLAB* CBT. Figure 3 shows the survey results of *Smartforce Word* CBT.



- Q1: *WebCT* presentation has been effective;
- Q2: Presentation of this subject kept me involved and interested;
- Q3: *Smartforce Word* CBT was effective;
- Q4: My knowledge of *MS Word* has improved after taking this subject.

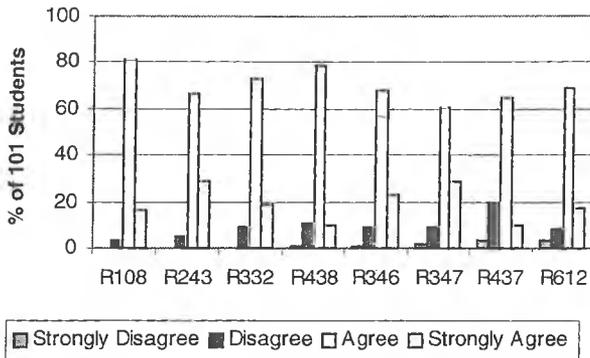
Figure 3: Autumn 2004 *Smartforce CBT Word* survey.

Despite the fact that most students were familiar with *MS Word*, the results in Figure 3 show that *Smartforce CBT* was effective in further developing their skill levels. This is reinforced by comments from students, as shown in the selection below (for *Microsoft Word* after two weeks of the course):

- *The Word CBT was interesting but it taught me most of what I already knew.*
- *The course showed me a number of operations in Word that I was unaware of that will help with my Word usage in the future.*
- *The fact that Smartforce showed me many operations of Word, especially the equation maker, was very helpful.*
- *It was good, but a bit slow. It was interesting for me and I enjoyed learning most of the new stuff. It was great.*
- *Although I found the work extremely boring, Smartforce was good because you can work at your own pace. It was only boring because of the content. And just reading is boring. I am hanging out to actually do some work.*
- *Civil 196 is a good subject for people that haven't had a lot of computer experience. It will provide good grounding. However, it might be a bit boring for more advanced computer users.*

- Some of the earlier stages of the Smartforce Word program were a little basic, however provided a solid revision on how to use the program.
- CIVL196 subject is great for the understanding of Word, especially for beginners. Being a more advanced computer student (completing IT Certificate 2), the Word part of this course is just refreshing my mind, which has been good, yet lengthy.

Students were surveyed on a trial version of the *MATLAB* CBT learning materials in Session 1, 2003. The survey results are presented in Figure 4. Most of the students surveyed found the *MATLAB* CBT to be useful, except for a small number who had more advanced skills.



- R108: Different aspects of the subject worked well together to help me learn;  
 R243: The subject overall workload was reasonable;  
 R332: Materials available from the Web site allowed me to control the pace of my learning;  
 R438: The presentation of the subject material kept me involved and interested;  
 R346: The computer-based materials allowed me to practice what I had learnt;  
 R347: I was able to navigate easily through the CBT content;  
 R437: I found the CBT self evaluation quizzes in this subject useful to my learning;  
 R612: The laboratory classes in this subject helped me to develop skills relevant to my vocational/professional needs.

Figure 4: CIVL196 Engineering Computing 1 2003 MATLAB CBT survey.

The subject assessment includes writing a *MATLAB* code for a simple engineering problem and testing the code. *MATLAB* final examination marks for autumn 2003 and 2004 are shown in Figure 5. The figure shows a significant increase of percentage of students passing with higher examination marks since the introduction of *MATLAB* CBT modules.

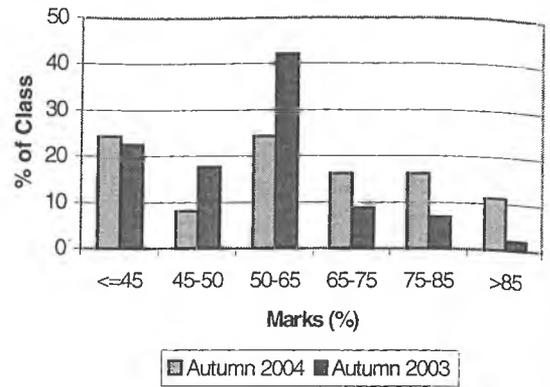


Figure 5: CIVL196 Engineering Computing 1 MATLAB final examination marks.

### CONCLUDING REMARKS

The Web-based delivery of the *CIVL196* subject has been found to enhance the learning outcomes of students at the University of Wollongong. It is a flexible approach and allows for the self-paced learning of students with diverse backgrounds. Students can move quickly through the materials, or can revise as much as necessary. Fewer academic tutors are needed to provide the same level of assistance to students, especially with large class sizes, without sacrificing the learning outcomes of students. The Web-based delivery approach has improved the subject pass rate from 82% in 2000 to practically 100%. Students are generally enthused by such a modern approach of learning. The delivery of a subject such as *CIVL196*, which has a high PC requirement, depends upon the University's PC laboratory resources and support, which must be kept up-to-date and must be well maintained.

### ACKNOWLEDGEMENT

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