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Spaces for learning: effective design of online resources

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At CDU Information Technology is taught using web-based learning materials in technology-rich learning spaces which focus on active and experiential learning experiences for students. These online resources developed for a face-to-face teaching situation are also required for students learning at a distance. This paper outlines the development of online resources for a first year unit *Database Concepts* that are appropriate for these disparate learning requirements. Central to the development was a clear learning design, iterative development processes, a focus on usability and allowing for choice in learning. The unit detailed in this paper was the winner of an ASCILITE Best Small Project in 2006.

Keywords: active learning; new learning spaces; online resources

The teaching and learning of Information Technology (IT) subjects at Charles Darwin University (CDU) in recent years has seen many changes from the traditional ‘sage on the stage’ approach to a more facilitative ‘guide on the side’ approach. The initial catalyst for these changes was an Hewlett Packard (HP) philanthropic grant of tablet computers and the subsequent development of technology-rich learning space (Tutty, White & Pascoe, 2005). At the same time there was a strategic thrust to maximise student numbers by making the undergraduate degree available externally (Evans, Tutty, & White, 2004). A key aspect to support both these initiatives was the development of effective online resources that could be used in both contexts. This paper will describe the challenges faced in creating an online resource for a technical first year unit *Database Concepts*. The resulting resources proved very successful enhancing the unit delivery for both face-to-face and distance students.

Database Concepts was developed using a user-centred development framework (Norman, 2004; Rogers, Sharp & Preece, 2007) which begins and ends with a focus on the users. Rubin (1984) describes three principles of this approach. The first principle stresses an early focus on users and tasks with the use of structured information gathering processes. The second principle is the measurement and testing of product usage focusing on ease of learning and ease of use: prototypes need to be tested with actual users. The last principle requires iterative design processes that allow for the complete overhaul and rethinking of design by early testing of conceptual models and design ideas. Product modifications and subsequent testing should be done as needed.

Information gathering

In line with Rubin's first principle, the first step in this development was a contextual analysis (Beyer & Holtzblatt, 1998; Holtzblatt, Wendell & Wood, 2004) that investigated the following five aspects:

- the users: who will be using the resource and what are their needs?
- the context: where and how will the resource be used?
- the purpose: what are the goals for this resource?
- the current artefacts: what resources are already being used to teach this unit?
- the pedagogy: what pedagogical approach should this resource represent and why?

Users: who and their characteristics

Charles Darwin University does not have large numbers of students who are school leavers. More than sixty percent of CDU students are part-time, with the average student age of thirty. A small study of first year IT students identified four distinct student groups (Tutty & White, 2005):

- mature learners: In IT, mature students often study part time to further their career prospects while working full time. They are often not experienced or confident learners; juggling work, life and study commitments is a major challenge for this group.
- school leavers: Constituting about 30% of the IT cohort, this group of students are usually highly literate users of technology and demonstrate many of the characteristics attributed to net gen learners (Brown, 2002; Prensky, 2001; Oblinger & Oblinger, 2005)
- vocational students: CDU is also a dual-sector university and in IT a significant number of students articulate from the vocational to the higher education program. This group of students usually have very good practical and technical skills, but are less proficient in the traditional academic skills (e.g. writing, analytical and critical reading skills).
- external students: IT has a growing number of external students. The majority of these students (80%) live locally, but find it difficult to get to class. As with most distance students, flexibility of the resources and chunking of activities to enable efficient use of the time available to study were the major design requirements identified.

The other users of this resource would be the two teaching academics, who were experienced teachers with industry experience in database development. Both had strong views on what worked and what didn't when it came to teaching databases and required materials that were easy to use; easy to find; used real life examples and were well structured and sequenced.

Context: the new learning space

Most IT teaching at CDU is now done in a non-traditional, technology-rich learning space that resembles a very low cost version of the learning and teaching spaces of the future (JISC, 2006; Scottish Funding Council, 2006; Oblinger, 2007; Radcliffe et al. 2008). The CDU learning space (see Figure 1) is wireless enabled, seats 50 students, has desks grouped for 6–8 students, uses tablet PC computers, and enables students to use web-based learning materials as a central resource. In IT, three hour workshops seamlessly integrate traditional lectures, tutorials and practicals and provide many opportunities for engagement between students, academics and online resources in a manner not possible in more traditional contexts (White, Tutty & Finegan, 2006). In workshops where there are more than 25 students, two lecturing staff collaboratively teach the unit.



Figure 1: Learning space

From prior experience teaching in this space, we knew that structured, flexible online learning resources enabled the integration of theory and practice very effectively. Three requirements in particular became guiding considerations in the *Database Concepts* development:

- **Findability:** how can all students quickly find the particular learning task required? Information in the web resource needed to be organised in one place and readily retrievable. Web-based learning materials can be information dense, and pages can go on forever. It impacts considerably on the flow of a workshop if it takes students even 5 minutes to find a resource.
- **Flexibility:** our experience in this new space had shown that a facilitative learning approach requires the ability to respond to learner needs as they arise. Any learning resources developed need to have enough structure and inbuilt flexibility to enable different teaching approaches and if required, a complete change of direction in the workshop.
- **Interactivity:** highly interactive and engaging learning tasks were both more successful and more valued by IT students than reading large passages of text online.

Purpose: subject matter needs

Database Concepts is a first year subject and a core unit in a number of technology focussed undergraduate degrees. Students completing this unit should be able to analyse, design and develop a robust database from a set of often vague and sometimes conflicting requirements provided by a client. This subject requires a degree of technical competence as well as an in-depth understanding of the importance of the data design issues.

Current artefacts: available resources

The academic database lecturers had a range of resources that they had developed for previous modes of teaching. In particular, there were two databases that they could see useful in any interactive or practice context. One, the Invoice database was small while the other, a library database, had 30,000 records which could expose students to a range of issues associated with a realistically sized database.

Pedagogical considerations

The development of the new learning space as well as learning design underpinning *Database Concepts* draws heavily on a situated learning approach proposed by Lave and Wenger (1991). Lave and Wenger (1991) contend that learning is not seen as the acquisition of knowledge by individuals so much as a process of social participation. There is an emphasis on active participation, social interaction and collaboration while engaging with authentic learning tasks in realistic contexts. Two principles have defined the learning design:

knowledge needs to be presented in an authentic context; and learning requires social interaction and collaboration.

Traditional database teaching often begins with the conceptual and analytical: from a set of client requirements, students design a database. Teaching then examines implementing and retrieving information from databases. The progression is often strictly linear. While this is an efficient and effective approach for professionals in industry, for many students with limited previous experience of databases, it can be overwhelming. Designing databases with no prior knowledge or understanding of “how databases are put together” does not provide students with experiences to relate to the design concepts. In particular they can struggle to identify the relevant issues and pertinent facts, let alone understand the implementation ramifications of the design decisions they take. The academics involved wanted to use an approach which built from the known to the unknown rather than starting from a conceptually difficult place.

Applying this situated learning model to the database unit, students would start by extending or adapting existing databases before being asked to do more complex tasks. Students would begin by experiencing a working database, interrogating it, learning the query language and the fundamental concepts as part of this practical process. This experience provides an authentic context for then learning about database design often the most challenging aspect for students. The learning tasks would build in complexity across the unit with assessments becoming increasingly demanding. This approach transforms the learning into a challenging set of investigations supported by real examples of databases used in a professional context.

The database resources developed by the lecturers previously are central to this approach. The sample databases represent the “expert knowledge” that students initially extend and adapt. This approach provides authentic activities that allow students to weave from the concrete to the abstract and to integrate the concepts and skills across the topics.

Detailing the requirements

At the conclusion of the contextual analysis, the following high level requirements were identified:

- student and academic user groups required well structured, sequenced learning materials that included opportunities for feedback. Students could choose to use or ignore these.
- the usability of the interface needed to be developed to ensure findability and flexibility
- learning tasks needed to be clearly defined and organised for self paced learners as well as workshop use
- active learning tasks and not copious amounts of text needed to be the focus of the resource
- a specific sequence of learning tasks were required by the database lecturers
- a situated learning approach was to be used with the two database resources to be integrated into the final product to help provide an authentic context.

These requirements guided the design and development of the learning resource.

Design and development

In line with Rubin’s (1984) principles for user centred development, the resource evolved through an iterative model of development. Different conceptual designs and prototypes were tested and successively refined until the final product was developed. A team of four people were involved: two content experts, an educational designer and a web developer.

The initial concept development and educational design was four months in duration while the software development took a further two months. As lecturing staff wrote content, the educational designer turned this into a series of paper prototypes to understand how the content would transform into learning tasks and how it would appear to students. Through ongoing discussions, the detailed content framework, interaction elements and initial web page structures were determined. In conjunction with the web developer paper prototypes became web-based prototypes. Navigation systems were developed and tested with users. Accessibility issues associated with interactive elements investigated and then tested with users. Initial user tests were with academic staff. The next iteration of testing was with students studying web development, an informed audience and the first group of students who would be using the resource in the subsequent semester.

Throughout this process, ensuring that the learning design was educationally sound was a major challenge. Two frameworks used to inform the learning design process were Agostinho *et al.* (2002) elements of a successful learning design and Boud and Prosser's (2002) four principles for a quality learning design. These two frameworks will be used to describe how the design of the materials emerged. The final consideration was the usability processes, critical in a user centred design.

Learning design overview

The first step in creating the learning design was the creation of a conceptual model of the concepts, skills and processes to be learned (Figure 2). This formed the basis for the site navigation and the structure of the learning tasks. Each "chunk" of information follows a similar developmental process that starts with an overview of the chunk being provided and a graphic that orients the learner to the type of concept being developed. Briefly, new information to be learned is presented through a series of linked resources signposted by large icons. These icons signal both graphically and textually what type of information resources is available (textbook, lecturer developed reading or online journal) and what type of activity is required by the learner (reading, computer project, work through problem). Theoretical information is provided by using a commercial textbook, rather than trying to put copious amounts of text in an online environment

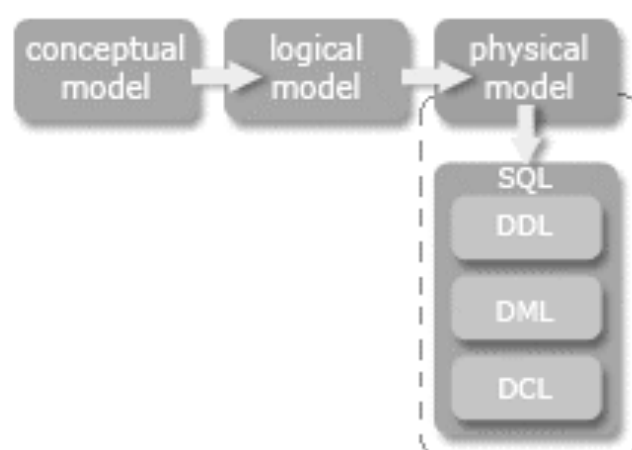


Figure 2: Conceptual model for learning design

Learning tasks, learning resources and learning supports

Agostinho, *et al.* (2002) propose that the elements in a successful learning design are learning tasks, learning resources and learning supports.

In *Database Concepts* learning tasks are structured in two ways: *have a go* and *get your hands dirty* activities (Figure 3). *Have a go* activities are designed to check students understanding of the new content presented relating it to what they already know and understand. These activities are always presented in new browser windows that sit on top of the main learning sequence so that students can refer to the original resources to complete the activity presented. The second type of activity *get your hands dirty* is organised into a series of tabs at the end of each page and contains the 'guided practice' activities that support students integrating all the ideas presented in a practical application. Generally in these activities problems and investigations are presented for students to solve. In the first module, the focus is on writing queries for the existing databases while in the second the tasks require students to learn how to analyse and design a database using a modelling process represented in entity-relationship diagrams. In the final module, the tasks are now much more complex, and students are required to write queries to extract complex data retrieval and understand security issues.



Figure 3: Activity signposts

Learning resources comprise the textbook, lecturer developed readings, online readings and two working databases provided by lecturers. The resources students are expected to use are clearly indicated graphically and textually using a series of icons and associated labels (Figure 4). Databases have also been identified graphically for students with the Invoice and Library databases also having unique images developed.



Figure 4: icons for learning resource

The major learning support is an interactive set of materials created about how to use Oracle for the novice learner. The nature of the discipline requires that information on software setup and use be provided and learning how to negotiate these is also part of the role of the IT professional. Called *Oracle Links*, this learning support is organised using a tabbed layout and popup windows which illustrate the micro procedures within a macro process, enabling a large amount of complex information to be presented simply and clearly. Before the website was developed, setting up Oracle access had been a major frustration for students. Trialing this support with students demonstrated its efficacy: students could set up their access to Oracle and transfer data as needed.

Three other learning supports were also included in the website: assessment details, sitemap, and a resource section. The assessment details incorporated a calendar presentation so that students could clearly see what was due when as well as the details of the assessment. This reinforced the importance of planning your work. The sitemap provided an overview of all pages in the site to make searching for information more efficient. Finally the resources section had software which supported the students learning activities.

Four principles for a quality learning design

Boud and Prosser (2002) put forward four principles for a quality learning design: engaging learners, acknowledging the learning context, challenging learners and providing practice. Briefly, these principles informed the design of *Database Concepts* as follows:

- To encourage learner engagement, user control is a feature of the website. Students make decisions on their own learning process as all activities have built in choices. For example, answers and feedback to activities are available before students do the activity. Interestingly in a recent survey of students looking at how they use this particular feature, sixty percent of the students indicated that they actually did the activity before they checked the answer.
- The context has been acknowledged. Prospective students for this unit have been collaboratively involved in the design. Links to IT profession are explicit in the pedagogical model that is based on industry tasks. Rationales are also provided to students explaining the relevance of the unit content and our delivery decisions. For example we explain why Oracle is the database technology of choice for this unit.
- Learners are challenged through the interactive activities. Have a go activities encourage students to question their current understandings and evaluate what they do or do not understand. Getting your hands dirty activities challenge learners to combine ideas presented and solve a range of problems in relation to the use of databases in business contexts. Authentic assessment tasks developed over a number weeks facilitate students' integration of the range of concepts and skills.
- Practising the concepts, processes and skills using guided supporting frameworks is central to the design of the resource. Students are provided with many examples with which to develop their ideas in a graded approach where the initial activities are more supported, progressing through to less supported with a level of challenge commensurate with the task being undertaken

Usability processes

The final quality of the materials developed was directly influenced by the collaboration with students. Various usability exercises using the *Database Concept* website as the focus were undertaken by students enrolled in a web development unit. This included usability testing on two iterations of the page design with individual and a whole class participation, and an online survey requesting feedback on a range of design and presentation issues using Nielsen's (2003) usability components (easy to learn; efficient; memorable; error tolerant; and finally pleasant to use.) Student feedback impacted significantly in two areas: page layout and interactivity.

Strong visual elements were important to students. Finding information quickly on a web page was as significant for students as it was for the lecturers. Students indicated that they needed to be able to quickly scan a page and find the task they were being directed to. Initially page layout did not facilitate this to the students' satisfaction. While icons for activities were used, the feedback was that they were too small and had too much text surrounding them. Using the robust student feedback the web pages now feature bold signage indicating the type of student activity required. Text has been significantly reduced and icons dramatically increased in size.

A similar process occurred with the interactive exercises. Initial student feedback indicated that interactive activities were not interactive and required too much reading! Where possible

they should be designed so students were engaged and thinking critically and creatively about various problems to be solved. Students wanted to work on the computer – not on paper. Another issue of concern with interactivity was working between multiple web page windows. The usability literature often suggests that this is bad practice, but student feedback indicated that having multiple windows open working on different aspects of the learning task was helpful.

Lessons learned

This design and development process provides a range of strategies for enhancing the learner experience, especially when considered in the context of teaching in new learning spaces.

Establish a clear theoretical position

The importance of explicitly identifying the underpinning pedagogy and advantages of the new approach cannot be understated. Without this understanding however incomplete, the chances of influencing the new learning and teaching environment by building on successes or not repeating failures becomes much less. We recognise that given the complexity of learning any understanding will be imperfect and subject to continuous change and rethinking.

Curriculum design

The student learning experience can firstly be enhanced through the curriculum design. Depth rather than breadth is the focus of the learning outcomes, the learning activities that the students engage with, and the assessment requirements. Through the use of focused and explicit learning outcomes, designing engaging learning tasks that require a range of student activity is more readily achieved. Students are able to study a smaller set of concepts and constructs in depth, practising and applying these in structured, authentic, supportive contexts. This is in contrast to a traditional lecture curriculum design where breadth of content coverage is usually the focus requiring many students to rely on memory or surface learning techniques to be successful. We have found that students respond positively to this curriculum design approach and the quality of work assessed is of a high standard.

Findability

Another factor that enhances the student learning experience is a focus on findability in the design and layout of any web resources (LMS or specially developed pages) that are used in new spaces. Findability is very important to the flow of the learning process. Resources and activities need to be quickly found and strong visual design elements used consistently throughout pages enable this. Students, as partners in our page design process, insisted on the bold use of icons and graphic cues so that they can quickly locate and understand the different type of tasks being required of them. Other strategies implemented to support this findability that students identified as being important to them included:

- a clear, visual page hierarchy that enables skimming and scanning
- carefully chosen headings which provide a map of the key ideas on each page
- the strategic use of white space to enable a separation of content and activities
- layering of tasks using pop-up windows that enable students to complete an activity in context while reducing page length
- visual devices to break up the linearity of the information flow on the page, and
- tabbed sections that enable a sequence of learning tasks to be shown horizontally without increasing page length requiring excessive scrolling.

Authentic interaction

The other feature of the online learning activities that students heavily influenced was the nature of interactivity that occurred. Students told us that to be helpful the interactivity needed to be genuine and appropriate to the content being taught. Point, click and read are not interactive from a students' perspective. The ability to interrogate, manipulate data and solve problems online is important to students. Our students were very clear that they didn't want to have to read material online and then complete activities on paper later! We worked at enhancing the student experience using some of the latest techniques for presenting and manipulating information online. This included libraries and frameworks (e.g. Javascript libraries such as Scriptaculous and Prototype) that enable a degree of interactivity that is quick and easy to develop.

Flexibility

Finally, flexibility within the resources is essential. It is important in any teaching context to be able to respond to different learner needs. Teaching in new spaces, in particular with new approaches, leads to many surprises and in our experience the learning environment evolves rapidly. To ensure that learners are not disadvantaged through being part of an educational innovation, learning materials should enable both learners and teachers to make choices and decisions about the learning process. The types of choices includes helping students who have not understood a concept, do some extra practice; helping students who may have come late catch up; or extending students who have quickly grasped the concept presented.

Conclusion

This paper details the development of online resources to be used both with distance students and face-to-face students in a new generation learning space. While there is a wealth of literature outlining design considerations for online distance learning resources, there is relatively little written about online resources used to support a facilitative teaching role in a non traditional teaching space. For us, three characteristics that enhance the student experience and are particularly important in developing online resources for these new learning environments were: findability, flexibility and interactivity. Iteratively usability testing the successive interfaces with students enabled these characteristics to be developed so that they were useful for all user groups: students and staff. Equally significant is explicitly identifying the underpinning pedagogy as this provides a framework for evaluating activities undertaken in the new learning and teaching environment enabling successes to be identified and mistakes not repeated.

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