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Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE)

Adelaide, Australia
7–10 December 2003

Editors
Geoffrey Crisp, Di Thiele, Ingrid Scholten, Sandra Barker, Judi Baron

Citations of works should have the following format:

Author, A. & Writer B. (2003). Paper title: What it's called. In G.Crisp, D.Thiele, I.Scholten, S.Barker and J.Baron (Eds), *Interact, Integrate, Impact: Proceedings of the 20th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education*. Adelaide, 7-10 December 2003.

ISBN CDROM 0-9751702-1-X WEB 0-9751702-2-8

ascilite
Australasian Society For Computers
In Learning In Tertiary Education

Published by ASCILITE www.ascilite.org.au

A FRAMEWORK FOR USING LEARNING TECHNOLOGIES IN HIGHER EDUCATION TO ENHANCE THE QUALITY OF STUDENTS' LEARNING OUTCOMES

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Abstract
This paper proposes that projects to integrate learning technologies into higher education learning environments should be justified prior to integration. An important basis for justification should be whether integration is likely to improve the quality of students' learning outcomes. The paper draws on the findings of the student learning research to suggest that improvement is only likely if learning technologies are used as part of learning environments likely to be perceived as encouraging deep learning approaches. A framework is presented to assist with justification. The framework requires subject teachers to match the capabilities of a list of learning technologies with a list of learning environment factors found to be perceived by students using deep learning approaches. The use of the framework is illustrated.

Keywords
Learning technologies, higher education, student learning research, deep learning approaches

Introduction

The use of learning technologies in higher education is expanding in response to promotion and financial support from many sources. The amount of financial support needed to integrate learning technologies into a curriculum has meant that structured evaluations are commonly a condition of the support (Oliver, 2000). This situation is reflected in a debate in the literature over the types of evaluations that are appropriate for justifying learning technology integration projects. Proposed means of justification commonly involve summative evaluations of one or more variables which may include cost, impact, practitioners skills, organisational change, learning technology usage and aspects of student learning (Oliver, 2000; Conole, 2002).

This is a conceptual paper which argues that in most learning technology integration projects justification should occur *before* commencement of the project. Further, justification should be based on whether integration is likely to enhance the quality of students' learning outcomes. The paper proposes and illustrates a framework which can be used at the level of individual subjects or topics to consider whether learning technologies can be used to enhance students' learning outcomes. If the likelihood of enhanced learning outcomes cannot be demonstrated it is proposed that financial support and other resource expenditure cannot be justified. Exceptions to this argument are possible, for instance, situations in which the technology can provide distance access to education, or provide an advantage to students with disabilities, or where learning the skills to use learning technologies is an appropriate educational aim.

Background

If the integration of learning technologies into higher education learning environments is to be justified on the basis of likely improvements to the quality of learning outcomes then the nature of high quality learning outcomes needs to be investigated. High quality learning outcomes usually considered appropriate for higher education include meaningful learning (Novak, 1977), conceptual change (Biggs, 1999; Ramsden, 1988), understanding (Entwistle, 1998) and development of more complex ways of experiencing or seeing phenomena (Bowden & Marton, 1998; Marton & Booth, 1997). Common to these descriptions is conceptual development.

Research into how conceptual development learning outcomes can be achieved has been an aim of the student learning research. This research investigated students' perceptions of their own learning experiences, in particular learning environments, approaches to learning and learning outcomes. The findings have provided powerful insights into how teaching and learning can be structured to bring about conceptual development (Biggs, 1999; Marton & Booth, 1997; Prosser & Trigwell, 1999). A number of the key findings of the student learning research form the basis of the framework presented in this paper for justifying the integration of learning technologies into learning environments in higher education. These key findings will now be summarised.

One of the most consistent findings has been that students' approaches to learning can be broadly categorised as either surface or deep (for example, Booth, 1992; Cope, 2000; Crawford et al., 1994; Eizenberg, 1988; Entwistle & Ramsden, 1983; Hazel & Prosser, 1994).

Surface learning approaches involve a focus on a learning task in isolation. The content associated with a learning task is viewed as a source of knowledge which needs to be attained for recall in upcoming assessment situations. Preferred learning strategies are used to gain the knowledge. Strategies commonly involve repetition leading to memorisation. The repetition may involve reading, writing, reciting, etc., or combinations. The recall in assessment situations is commonly of memorised text, acronyms, procedures, problem solving strategies, etc. Success in upcoming assessment tasks is the main focus of surface learning approaches.

In contrast, deep learning approaches involve an intrinsic interest in and awareness of developing an understanding of the content associated with a learning task. The bigger picture is intentionally sought, with upcoming assessments in mind but also understanding for personal interest, beyond the academic setting. A student uses preferred strategies to gain understanding. Underlying all strategies is the seeking of meaning associated with the content through relating the content to previous understanding; to the content in other learning tasks in a subject; and, in more sophisticated deep learning approaches, to the content in other subjects and in personal experiences both within and outside the academic setting. How an understanding is viewed and strategies to achieve understanding can vary. In some instances understanding can mean having a clear picture or a completed puzzle and strategies involve graphically representing knowledge. In other instances understanding involves constructed scenarios, having one's own version of the content, being able to give an explanation "off the top of the head" or being able to apply concepts in new situations with competency. Strategies for achieving this view of understanding are more text based. Conceptual development is the main focus of deep learning approaches.

In numerous studies the relationship between approach to learning and quality of learning outcomes has been investigated. In these studies, surface learning approaches were associated empirically with poor quality learning outcomes featuring little or no conceptual development. Deep learning approaches, in contrast, were consistently associated with the types of quality outcomes appropriate for higher education (for example, Crawford et al., 1994; Hazel, Prosser & Trigwell, 2002; Prosser & Millar, 1989; Prosser, Walker & Millar, 1995; Trigwell & Yasukawa, 1999).

The question now arises of how students can be encouraged to use deep learning approaches in a particular learning environment? Answers to this question come from two sources. First, researchers have logically analysed the nature of deep learning approaches and how these approaches are likely to lead to conceptual development learning outcomes. Secondly, the student learning research has empirically studied the question through investigating students' perceptions of learning environments and correlating the findings with learning approach.

Deep learning approaches include an intention to understand through trying to seek and relate the meaning inherent in different perspectives on some content. This intention implies an awareness of the learning experience, both a developing understanding and the processes being used to develop understanding (Cope, 2000). Consequently a deep learning approach requires an active learner, one who seeks to bring new perspectives to bear on some content, one who looks for relationships between different aspects or experiences of the content. A student adopting a surface learning approach only considers isolated aspects of the content they are learning. There is no intention to seek any relationship between the different aspects of the content. Conceptual development for such a learner is unlikely. A student adopting a deep learning approach, in comparison, opens themselves up to the possibility of conceptual development through trying to see how the parts form a whole, through trying out their understandings in different situations, through relating what they are learning to other parts of the subject, other subjects and their personal experiences. The awareness of a student adopting a deep learning approach is dynamic. There is the possibility of conceptual development (Booth, 1997). The process is described (p.147):

> Different contents of learning and different types of learning task give rise to different kinds of opportunity for developing awareness. Discussion between peers brings the individual to consider different perspectives to bear on an object of thought in one way; a research task, a project or problem, gives the chance to follow up questions that arise when thematic fields jar with one another; laboratory exercises give the student the opportunity for new personal experiences to be brought into contact with earlier scholarly considerations. Deep approaches are indicated by students who take these opportunities to develop awareness in such ways. It demands an openness to variation, a willingness to tussle with the resulting perspectives, a point of reference in personal experience, and a clarity to maintain focus on the object of thought.

Based on Booth's (1997) description of a deep learning approach, Marton and Booth (1996) have proposed that bringing about deep learning approaches requires learning activities which "thematise both the act and the content of learning". Students need to be encouraged to be aware of their approaches to learning and developing understanding. Marton and Booth propose two teaching principles to underlie attempts to encourage deep learning approaches. The first is the need to provide learning tasks which build a relevance structure for students. With relevance comes motivation for a student and the critical intention to understand which is at the core of deep learning approaches. The second teaching principle is to design learning tasks around the "architecture of variation" (p.185). A key to deep learning approaches is the seeking of different perspectives on the content being studied and the seeking of meaning in each perspective. Learning tasks need to provide variation in perspective or tools with which to seek variation in perspective.

A contribution to how students can be encouraged to adopt deep learning approaches comes from the student learning research. In studies involving many thousands of students across many different subjects, students were found to perceive the same learning environment in different ways. Students using deep learning approaches were found to be more likely to perceive good teaching, clear goals, independence in learning, and timely and appropriate assessment feedback. Students using surface learning approaches were more likely to perceive too high a workload and assessment which was perceived to require rote learning (Entwistle, 1998; Entwistle & Ramsden, 1983; Hazel, Prosser & Trigwell, 2002; Higgins, Hartley & Skelton, 2002; Lizzio, Wilson & Simons, 2002; Prosser & Trigwell, 1999; Ramsden et al., 1997; Trigwell & Prosser, 1991). These findings suggest that to encourage deep learning approaches, learning and assessment tasks, as key components of a learning environment, need to reflect good teaching, clear goals, choice in learning, and assessment techniques that require the demonstration of understanding.

We now return to considering justification for the integration of learning technologies into higher education learning environments. Using learning technologies as a means to source and commit to memory a broader range of information more quickly (a surface learning approach) is not likely to enhance the quality of students' learning outcomes. It seems logical that the use of learning technologies can only be justified if they are used by teachers to encourage students to use deep learning approaches and students use the learning technologies as part of these approaches. Consequently learning technologies need to be used to promote the learning environment factors perceived by students who use deep learning approaches, and to assist students to seek the meaning in different perspectives on the content associated with learning tasks.

The Framework

The findings of the student learning research and the logical analysis of deep learning approaches have been combined to develop a framework which can used to design and justify learning technology integration projects. The framework comes in the form of a two column table (Table 1). The first column lists some of the learning technologies which are likely to be available in higher education learning environments. The second column lists factors to be incorporated into the learning environment and learning and assessment tasks which are known or proposed as being likely to encourage deep learning approaches. The factors were derived from significant contributions to the student learning literature (Biggs, 1999; Booth, 1997; Gibbs, 1992; Martin et al., 2000; Marton & Booth, 1996, 1997; Ramsden, 1988, 1992).

To use the framework in Table 1, a group of subject teachers needs to brainstorm how a particular learning technology in the left column can be used to implement or improve the implementation of a factor in the right column. In the brainstorming it is important to consider the advantages provided by learning technologies over other teaching and learning approaches. Only if the implementation of a majority of factors can benefit from integration of learning technologies is integration justifiable.
The importance of using the table at the single subject or topic level lies in a further finding of the student learning research. While the general nature of deep learning approaches and the learning environment factors more likely to encourage deep learning approaches are known, research findings show that the details are specific to individual subjects and topics (Gibbs, 1992; Gordon & Debus, 2002; Prosser & Trigwell, 1999; Ramsden, 1992). That is, a deep approach to learning about physics, for example, may be different in detail to a deep approach to learning about humanities or IT. Also, the learning environment factors found to encourage a deep approach to learning about physics are similar in general but may be different in detail to the factors likely to encourage a deep approach to learning about humanities or IT, for instance.

Using the Framework

As discussed in the previous section, the outcomes of applying the framework to different subjects or topics are likely to differ in detail. However, a general discussion on whether important learning technologies can provide advantages more likely to encourage deep learning approaches is worthwhile as a means of illustrating the use of the framework. In the discussion, figures in brackets (for example 1b) refer to a specific learning environment or learning activity factor in Table 1.

CD ROMS (multi-media)

The appropriate use of multi-media CD ROMS can provide advantages to learning environments and activities which are likely to encourage deep learning approaches. Multi-media CD ROMS take considerable effort and resources to design and develop. The design and developmental processes require thought about the goals to be achieved by students using the CD ROM and the organisation of the content necessary to achieve these objectives (1a, f). Video and audio clips of real-world situations can be used to provide a relevance structure for the content being taught (2b), to incorporate real world problems (2c), to encourage students to relate to contexts beyond the academic setting (2e), and to expose students to different perspectives on the content (2d). The interactive nature of the media, for instance question and answer sessions, can be used to encourage students to seek meaning in the content being considered (2f). Multi-media CD ROMS also allow students to work at their own pace and have some control over the content explored (1c).

Digital cameras
The use of digital cameras can help make learning activities more active (2a). A digital camera could be used by a student in a learning or assessment activity to take photos of situations outside the educational context which relate to something learnt in the classroom (2e). Photos could be used to demonstrate understanding or portray different perspectives on a topic which, through group interaction, would allow other students to experience the different perspectives (2d, h). Deciding what to photograph to demonstrate understanding encourages students to reflect on the content being learnt, an important part of a deep learning approach (2f).

Leaning technologies	**Factors associated with students using a deep learning approach** (Cope, Staehr & Horan, 2002)
CD ROMS (multi-media) Digital cameras Video conferencing Graphics software CAL software Photocopiers Colour printers World Wide Web E-mail Bulletin Boards MindTools	1. *The learning environment* The following factors are important to achieving a learning environment likely to encourage deep learning approaches: a. The subject is well organised and has clear goals b. Teaching approaches support the explicit aims and objectives of the subject c. The student has responsibility for their own learning including some control over the content and approach to learning d. The workload is manageable e. The student is given help in learning within the context of the subject matter f. The teaching makes the structure of the individual topics, and the subject as a whole, explicit g. The teaching identifies and builds on what students already know h. A supportive classroom environment is provided where students feel comfortable to openly discuss their understandings and learning approaches i. The emphasis is on depth of learning rather than breadth of coverage j. The teaching is stimulating and demonstrates the lecturer's personal commitment to the subject matter and stresses its meaning and relevance to the students k. Assessment feedback is appropriate and timely 2. *The nature of learning and assessment activities* The following factors are important in the design of learning and assessment tasks. These tasks should: a. Be active and experiential b. Provide a relevance structure for students c. Tackle real world problems that are compatible with the experiences of the students d. Expose students to different perspectives on a topic e. Encourage students to relate the learning to situations outside the educational context f. Encourage the student to reflect on the content and the learning process g. Use group interaction to expose students to variation in the ways other students understand the content and approach their learning h. Assessment tasks require the demonstration of conceptual understanding

Table 1: Framework for justifying the integration of learning technologies into higher education learning environments

Video conferencing
Exposing students to different perspectives on some content can be a key initiator of a deep learning approach. Video conferencing can be used as a means of accessing experts in an area or people with different views on a topic under consideration (2d). It is important to note however that exposing students to different perspectives in itself will not encourage deep learning approaches. The follow-up activities which encourage reflection on the different perspectives are crucial.

Colour printers
Colour printers are an example of the value of learning technologies being subject specific. They may

well be of use in some subjects (for instance Art) but, in general their use cannot be linked to better implementation of the learning environment and learning and assessment activity factors likely to encourage deep learning approaches. Using colour printers to produce assignment work in colour, for instance, is unlikely to be able to be linked to encouraging deep learning approaches.

World Wide Web

A common use of the WWW in learning environments in higher education is as a content delivery service and/or a means of displaying subject goals and organization (1a). Used in this way however, the WWW has minimal advantages over printed media that are likely to encourage deep learning approaches. Deep learning approaches happen in the head. It is what a student does with the content, aims and organization that is important.

One advantage of the WWW is the ability to imbed links to other sources of information on a web page. Used in this way the WWW can efficiently provide different perspectives on a topic for students (2d) but, once again, it is what students do with the different perspectives that distinguishes surface and deep learning approaches.

E-mail

Uses of email likely to encourage deep learning approaches are limited. Email could be used as a tool to allow more efficient and timely access to teachers for assistance with the reflection on content and learning approach aspects of deep learning approaches (1e, 2f).

Bulletin Boards

Bulletin boards can be used in educational settings to support deep learning approaches. Through teachers encouraging debate on relevant topics using a bulletin board, students can be exposed to different perspectives on issues (2d) and be able to respond comfortably and openly behind the security of the internet or an intranet (1h)

MindTools

The generic name MindTools is used by Jonassen, Peck & Wilson (1999) and Jonassen (1996) to describe a suite of computer applications which have been designed to assist students to organise and seek meaning in the broad array of information now available to them. Using MindTools students search for information, reflect on the meaning of the information and construct knowledge bases which represent their understanding. The knowledge bases may be in the form of spreadsheets, databases, semantic networks, concept maps, etc.

MindTools are a learning technology ideally suited to encouraging deep learning approaches. Learning using MindTools is an active process (2a) where students clearly have to take responsibility for constructing their own knowledge (1c). The tools are structured to provide some help with the learning process (1e, 2f). For instance, concept maps encourage students to look for the relationships between key aspects of a concept they are studying. Seeking meaning through relating different perspectives on some content is a critical aspect of deep learning approaches. The knowledge bases developed by students can be used for assessment purposes. This type of assessment clearly indicates to students that assessment requires the demonstration of understanding (2h). MindTools also support learning in groups. Constructing knowledge bases is a time-consuming, complex activity that can benefit from the multiple perspectives and insights provided by an interactive, co-operative team (1h, 2g).

Conclusion

The framework in Table 1 and the discussion based around its use in the previous section indicate that integration of learning technologies into higher education learning environments needs to be a considered process. Unless integration leads to learning environments more likely to be perceived by students as encouraging deep learning approaches and conceptual development learning outcomes the necessary resource expenditure cannot be justified.

Some learning technologies, in particular multi-media CD ROMS and MindTool applications can clearly contribute toward encouraging students to use deep learning approaches. These learning technologies support the learning processes which are at the core of conceptual development learning. Other learning technologies may well be misnamed. Colour printers, photocopiers, digital cameras, email and the WWW for instance, can be used in a myriad of ways that support surface rather than deep learning approaches. These technologies only become learning technologies when used by students in appropriate ways designed by teachers to encourage deep learning approaches.

The discussion in the previous section also indicates that a weakness in the use of most learning technologies in higher education learning environments is lack of support for the "reflection on learning" aspects of deep learning approaches. Key aspects of a deep learning approach are an awareness of the learning process (metacognition) and a motivation to seek and try out different types of learning tasks when learning about a topic. The focus of the use of most learning technologies is on content. Research is needed into how learning technologies can be used to stimulate an awareness of the learning process in students.

This paper is conceptual and the ideas have not been evaluated in a structured way. Indeed there are only a few published reports of learning environment interventions which have succeeded in encouraging more students to use deep learning approaches (Case & Gunstone, 2002; Eizenberg, 1988; Gordon & Debus, 2002) and these interventions did not involve learning technologies. Research is required which integrates learning technologies into higher education learning environments in a systematic way and monitors changes to students' learning approaches. Evaluation of students' learning approaches is not a difficult task as a number of validated, generic questionnaires are available (for example, ASI - Entwistle & Ramsden, 1983; SPQ - Biggs, 1987 a, b; ASSIST - Tait & Entwistle, 1996).

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