

Integrating worldware in blended learning environments

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Abstract

At residential universities one often finds that technology supported courses blurring the boundaries when incorporating elements drawn from distance-style and the more traditional face-to-face modes of teaching. Educators adopting these approaches regard them simply as pragmatic ways of teaching and rarely carry labels such as blended, flexible learning or e-learning. While there have been considerable developments in providing generic software tools, often integrated in course management systems, these can sometimes be seen as constraining rather than liberating pedagogically driven design of courses. We describe a scenario, involving tutorial style learning, where generic technology tools addresses most needs. Then we consider how a tutorial workflow can automate assessment to address some of the difficulties in using conventional approaches. Generalising these ideas we suggest that worldware, the widely used software applications such as Excel, needs to be integrated into campus wide learning environments to support more flexible forms of blending needed to support the tutorial-style learning at residential universities.

Introduction

In technology supported courses at residential universities, it is common to find a blurring of boundaries between elements drawn from distance-style and the more traditional face-to-face modes of teaching. To many residential university lecturers these approaches are simply pragmatic ways of teaching and rarely carry labels such as blended, flexible learning or e-learning. These labels are though increasingly being used in research, policy and planning documents, generally to encourage a better utilisation of time and resources while offering students greater flexibility (e.g., Smit 2001, Lazenby 2002, Czerniewicz 2004).

In our experience, educators at residential universities have often had overoptimistic expectations of blending often expecting it to be easy to pick-and-choose e-learning teaching strategies. The hope is that it can avoid many problems in the teaching of large classes by adopting approaches understood to be used in commercial training and distance education. However, there is generally insufficient appreciation of the differences in the pedagogy and learning environments (e.g., Fox & MacKeogh 2003, Engelbrecht 2003). Even well intended efforts to provide high quality learning experiences using technology can falter often simply because the problems are challenging whether or not technology is used. While there may be a clearer understand of why changes are needed, how changes are made are less clear. The technology infrastructure often discourages change and enforces choices rather than encouraging rational choices using criteria with a sound pedagogy basis (e.g., Steyn 2003, Engelbrecht 2003, Axman & Greyling 2003, Damoense 2003).

Here, by exploring the needs for dynamic information flows across online and lab tutorial-style activities, we reflect on how lecturers perceive the pedagogy and technology options and how these can be used in evolving blended course designs. Realistically we must consider changing both how a lecturer might perceive the problem as well as changing the technology infrastructure itself to exploit the promises of a more flexible teaching and learning environment. Our particular focus is how web-based teaching and learning approaches, whose designs are influenced by distance modes of teaching, are being adopted at a

residential university. Not surprisingly, this form of blending, even when involving small teaching and learning activities can present unexpected challenges seen from both practical side of delivery and the quality of learning achieved. Generally residential universities do not provide incentives for novel forms of blending even when this is technologically feasible and pedagogically sound. Looking at a specific case we show integrating both web based and lab based environments allowed us to deliver on some of the expectations of blended environments and highlight some of the unique opportunities residential universities are able to exploit.

We begin by describing a scenario highlighting the challenges a lecturer faces. This raises questions about whether the pedagogy or technology should change when something does not work out as expected. By generalising these questions we broaden the discussion to consider what type of approach would allow for similar solutions to evolve elsewhere. We conclude by describing our broader experiences in applying this approach and consider the implications of some of the trends we see emerging with the introduction of portal-based web learning environments.

Scenario: Background

Consider the following scenario, illustrating the types of blended tutorial activities that an increasing number of lecturers are exploring at residential universities. Often lecturers are aiming to provide the learning opportunities that they would have provided in small-group tutorial activities but now to large class using technology to help scale-up the tutorial activities. By emphasising the processes followed in designing and delivering the tutorial in this scenario, we are not suggesting that other learning or content issues are less significant, but simply that discussing these would be beyond the scope of this discussion.

The course considered here is part of a senior social sciences programme that requires students to apply statistical methods to experimental data and be able to interpret the results. As student enrolment has grown from under 100 to over 300, it has been increasingly challenging to run traditional tutorials. The delivery and assessment aspects are limiting what is feasible. The lecturer had for some time been aware of the many examples of stimulating experiments that students can perform using computers, having seen examples on textbook CD-ROMs and on the web. Such examples raise expectations of how new technology can be used. Aiming to do something similar, the lecturer acquired the necessary skills to develop materials online.

This scenario looks at the first of a series of tutorial activity, which ran over four weeks, as part of a semester long project culminating in the handing-in of a written report. The lecturer had devised a psychology experiment for the students to conduct, with themselves as subjects, and developed a scaffolded series of tasks to guide students in the analyses of their results. Some of the material was placed on the website that included all the necessary instructions, background and procedures, along with the Java applet for conducting the experiment.

The students were given a brief introduction to the tutorial during a scheduled lecture. In addition they were given the tutorial's website URL and were then required in their own time to access the online readings and run the experiment to generate their data. Students could also elect to sign-up for a revision session of the statistical methods they would need to apply, which were presented in a lecture format. Two weeks later, once most students were familiar with the objectives of the psychology experiment and its analysis, further details were given in a lecture and on the website about precisely how the data had to be analysed and presented. This requires students performing correlation analyses on their own datasets using a calculator or spreadsheet and producing graphs, all of which were then handed in for assessment.

The tutorial ran successfully with the large class, in that all the students were able to use the web-based resources to complete the task using the available university infrastructure and were generally applying the skills that the tutorial was designed to develop. However, while the effort involved in delivering the tutorial materials to students was largely independent of the class size, the same was not true for the subsequent assessment process which required marking of 300 individual analyses and reports. The assessment was very time-consuming, in part a consequence of each student using their own datasets in their analysis. Since each

dataset was different, each student's answers were different, and had to be checked individually. To further complicate the assessment, since students rounded off numbers to different levels of precision, comparing the students and expected answers was not straightforward, since small difference did not necessarily mean that the student had made a mistake in their calculations.

Identifying a bottleneck

It was at this point that the lecturer began to wonder about possible weaknesses of his tutorial design, as it did not seem sustainable. Technology had made it possible to distribute the material and performing authentic experiments, but the manual assessment load negated some of these advantages. From our perspective, it was clear that the tutorial had a sound pedagogy. Building on constructivist ideas of learning, the tutorial involved performing an authentic task and the assessment focused on higher order learning skills (e.g., Oliver & Herrington 2003, Laurillard 2002, McArthur et al. 1995). The familiar approaches used in large online courses did not seem advisable alternative. Using say multiple choice questions or other indirect forms of assessment would make it difficult to assess many aspects of the students' understandings. Additionally, if students had used the same dataset or answered the same multiple choice questions, assessment would be straightforward but plagiarism would then become a concern if students worked unsupervised.

Problem similar to those described above are is very common, especially for large classes and one response would be to simply put more resources into assessment. For distance education institution, feedback on assignments is the main interactive component of teaching, so substantial resources are generally invested in assessment processes at institutions aiming to offer quality educations (Gibbs & Simpson *in press*). In contrast, there has been a reduction, over time, in the number of assessed activities and feedback at most residential universities as the numbers of students have increased. Gibbs & Simpson (*in press*) further claim that currently the UK's Open University students would receive many times the volume of written feedback when compared to students at most residential universities. The implications are not very attractive for our scenario, if we believe that now assessment should become the focus in order to make the tutorial work. One interpretation would be that adopting technology, in the ways distance education used it to distribute materials, without the adopting the accompanying approach to assessment, achieves little. However, we know there are, particularly at residential universities, many other options that could offer workable alternatives.

In practice, distance education does not employ technology to deliver the type of interactive and individualised tutorial activity as described in our scenario nearly as frequently as one might think (Britain & Liber 2004, Laurillard 2002). Rather these institutions have used technology to distribute materials to support largely independent forms of learning. As Oliver & Herrington (2003) observe, this approach was developed prior to the adoption of the web and has changed slowly in how new pedagogies using technology are adopted. Thus we might find the following to be true whether or not technology is used (Oliver & Herrington 2003):

- Materials written in the lecturer's voice
- Activities purposefully sequenced and structured
- Courses aiming to familiarise students with content
- Assessment rewarding content acquisition

This form of instruction is very similar to how a lecture might be delivered, with a narrative leading through a sequence of learning materials designed to impart knowledge. It is also how web-based materials are often developed for blended courses. While this is an effective form of teaching in some course, it provides little support for tutorial-style learning (Bork 2001). It has limited support for well founded constructivist ideas of learning and specifically the type of feedback exchanged between lecturer and students that is a highly valued part of learning. As Laurillard (2002:81) sees it, "feedback on students' actions is the weakest link" in the traditional educational process "because there is only a small amount [of feedback] relative to their learning actions" being provided. Here such feedback, in the form of a two-way dialogue

between lecturer and student, is seen as being crucial in support of the acquisition of complex concepts and the creation of conceptual distinctions that Laurillard (2002) sees as underpin university-style teaching and learning.

However, there are practical difficulties in providing the necessary feedback to large numbers of students. Blended teaching environment promise to provide many more opportunities to a lecturer so that the necessary feedback can be provided utilising traditional and technology driven approaches. There are of course many examples of creative educators achieving much more than what is generally found as implied by the above. As is often lamented, the problem is generalising these success stories (e.g., Lazenby 2002, Kolås & Straupe 2004, McArthur *et al.* 1993). An area where we consider technology will be valued is by providing the educators with more detailed and immediate access to what students are doing on the web and in the labs (Britain & Liber 2004), in much the same way that a competitive business uses say financial information to make informed decisions. In our context the corresponding decisions relate to say what type of feedback to provide and what changes to scaffolding are required. To a lecturer this will see, as quite a small aspect of delivering the course, however the point we emphasise is that this is something technology generally does well and additionally will start addressing core teaching and learning issues.

Course management systems have integrated collections of tools supporting a number of forms of online communication and course management. Generally these have been designed primarily to deliver content and provide feedback within a distance model. Familiar and commercially successful examples include WebCT and Blackboard, with many other niche and open source systems also being used (Britain & Liber 2004). The literature includes many descriptions of educators are making effective use of the functionality in course management systems (e.g., Dunne, Low & Ardington 2003). However there is comparatively little direct support for the tutorial-style activities. One can distribute material, administer quizzes, conduct online discussions and upload files, but there is generally no way to perform say statistical analyses on data generated earlier and then give feedback on the answers. For our scenario, the designers of course management systems would probably argue that they are creating general purpose systems and that other applications can be used to perform statistical tests. Thus, while course management systems will support some forms of online activities, we will need to consider other options or alternatively use what is available. Britain and Liber (2004) in surveying current course management systems functionality, were told by Blackboard that they aimed to provide the 20% of functionality educators require 80% of the time, which is true for all similar systems.

The above discussion highlighted some of the design issues one encounter when seeking solutions. Not surprisingly most of the difficult things to address, such as assessment and feedback, are universal. Generic technology solutions provide a limited set of choices and thus tend to fulfil support or enrichment roles. Similarly generic pedagogies are unsatisfactory, developing few of the valued higher order learning skills. In discussing the redesigning of tutorial-style activities to use technology more effectively, lecturers often remark at how frustrating this is, as their interest in understanding the design options is very limited. They are employed on the basis of their domain knowledge and have little time to invest in new modes of teaching, since their performance continues to be measured on the basis of their research output. There is a reluctance to change either proven pedagogy or familiar technology. Thus, where as other types of organisations could consider completely redesigning all courses, this is unrealistic in all but a few cases in a traditional residential university context.

Scenario: Towards automating assessment

It was at this point we were asked for suggestions as to how technology could help make the assessment process more manageable. Our role as educational technologists is typically in this role of problem solver rather than developers of completely new learning activities. As is frequently the case, we were only given a couple of weeks before the tutorial started. Thus we could not make changes that could impact on other aspects of the tutorial design. Fortunately, we had had some experience with developing Excel-based tutorials, including automating assessment. The lecturer heard about these and so inquired about adapting these for his requirements.

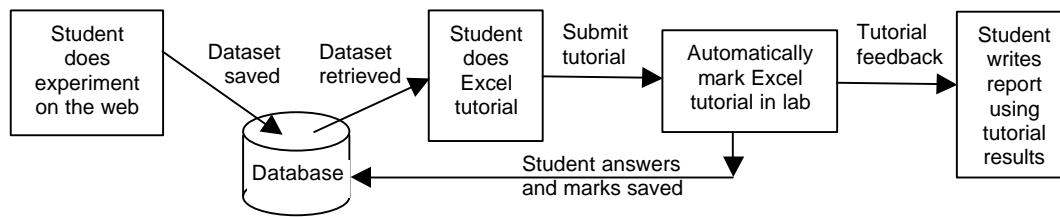


Figure 1: Simplified tutorial workflow

The approach we have been using elsewhere for some time involves exploiting the built-in office automation functionality in Microsoft Office (Deacon *et al.* 2004). This approach essentially allows us to use Excel, which already has most of the functionality needed and is familiar to students, to present scaffolded tasks and interact with the student. When the student submits their Excel workbook, the answers entered into designated Excel cells, are saved to a database. Not only is the value of the cell saved, but also the formula and formatting, so it is then possible to mark answers using both the value and formula. In addition information about charts and screenshots of charts are saved so these can be inspected and marked by a tutor.

The Java applet that previously had displayed the dataset now needed to pass it to a database. A scaffolded tutorial task, instructing the student how to perform a correlation analysis, was developed as an Excel workbook. To submit the tutorial, we again require students to be in the lab, so that the answers and final mark can be saved to database. The students could see their mark and had feedback on where they had made mistakes. Finally the routines to automate the assessment needed to be created. Excel has built-in support that enables one to implement most of this, as office automation type problems have similar unanticipated user requirements, for which Microsoft Office provides solutions (Deacon *et al.* 2004). We had already developed most of what we needed in Microsoft's VBA scripting language and it was relatively simple for us to extend this further. The workflow is shown in Figure 1. It is such workflows, involving different applications, for which there is little support currently in course management systems and such support would be most valued at residential universities.

Worldware and middleware supporting blending

The type of automated assessment we implemented is straightforward, only if one has the student answers in a convenient digital format. To work easily with digital formats essentially requires a database to store state information in order to support the type of workflows or information flows as illustrated in Figure 1. Here state information refers to the state of the student's work or assessment at different stages. Similar approaches are used in supporting most business information systems; the business of a bank is in essence managing information flows through their database. In our context, being able to access information on what students are doing, invites other opportunities in addition to assessment, including monitoring, classifying mistakes and automatically generating feedback. The need for this type of information is much less obvious with smaller classes, but increasingly important in larger classes. Our experience across a number of courses has been that at first lecturers see little value in this type of information, but when they got access to it would often remark how insightful and helpful it had been. Seen over several years, with access to the same information for the same course, we have observed how lectures became skilled at monitoring indicators to ensure that everything is on track and respond to problems.

As we saw, to check whether a student's correlation analysis was applied correctly, we performed the same calculations the student should have done on their dataset and then compared both the answers value and formula. If either did not match we checked whether a proportion of the marks allocating could be awarded, say when the correct function was used but a mistake was made in the parameters. Conceptually, it is easy to see how assessment is implemented, however a lecturer would see this as a loss of control of the assessment process since some aspects appear hidden. For our experience, this is one of the significant barriers in adopting the approaches we have described. This difficulty, in understanding the

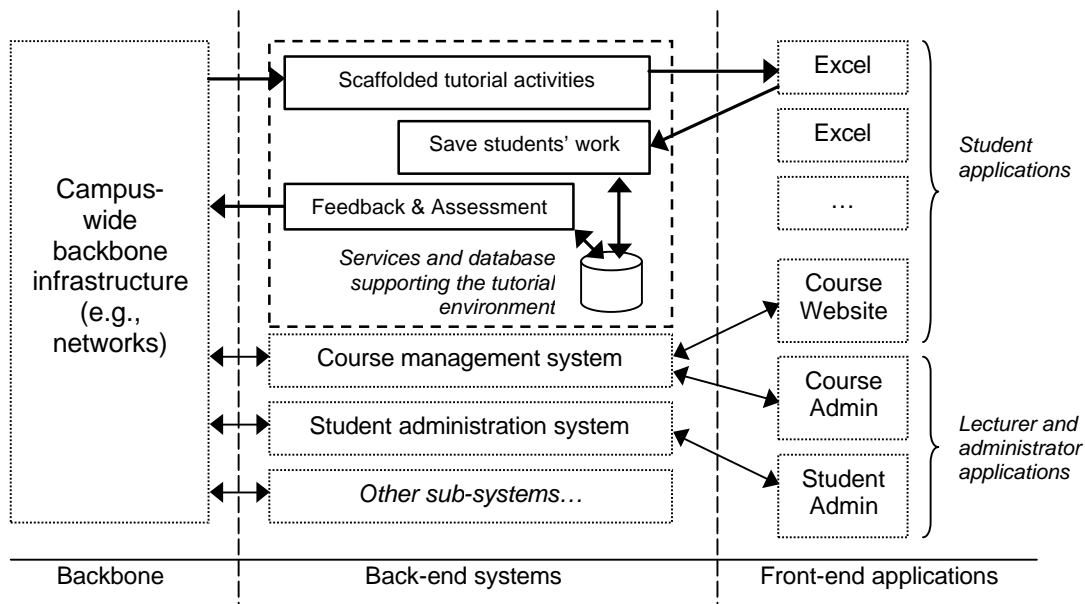


Figure 2: Architecture integrating different types of computer-based activities

bigger picture, how things fit together and what can be changes is not unique to tutorial workflows. Commercial workflow, groupware and other back office software systems have been developed to simplify and abstract such processes. Generally these are far too expensive and complex to use in university contexts. Often, the software vendors selling these to large organisations additionally require them to engage even more expensive consultants. The enthusiasm elsewhere has had positive spin-offs since there are shared interests. Interoperability and open standards are being adopted and tools developed (e.g., Dalziel 2003). As a simple example, we used Microsoft Office to access data in a PostgreSQL, an open source database system; this was made possible by open standards. Of more direct importance to the education sector in the last few years, has been the development of so-called frameworks, that show how different systems in universities and be used together and reused in different ways. The most prominent examples include IMS (www.imsglobal.org), SAKAI (www.sakaiproject.org) and JISC (www.jisc.ac.uk). An underlying assumption of each is that, if say a lecturer understands how different information and tools can be presented to students in a browser, then it becomes possible to create powerful learning environments.

This vision of a portal bringing things together is expected to become an important trend (A'Herran 2003), following that of other sectors managing large websites. The variant of this we are suggesting will become important is supporting tutorial-style activities within blended environments. While the development of frameworks and standards promise to make development of better learning environments, this still has not directly addressed the problem we highlighted in our scenario regarding how the lecturer keeps control of the electronic assessment process. This is not a problem if we, as people who have acquired the necessary skill, were to do most of the work. Acquiring such skills is not considered difficult, but the benefits would be unclear if the assessment were the only application of these skills. We had created assessment tool using with Access and Excel, to simplify the process. These allow the lecturer to see the student's answer, the correct answer and the automatically assigned mark that can be adjusted. However, in the scenario we could not use these directly, as we wanted an approach that marked students' tutorial calculations as they submitted them. As yet we had not considered created a tool to make this aspect easier.

There are many examples of educators describing procedures that have helped them manage tutorial workflows. In assessing Excel skills Dowsing *et al.* (2000), Hill (2002) and Summons *et al.* (1997) have allowed students working remotely to submit an Excel workbook that is automatically assessed. Dowsing *et al.* (2000) have a slightly different approach, using automated and manual marking, driven by scripts. The approach used by Hill (2002) and Summons *et al.* (1997) allows the lecturer simply supply a solution as an Excel workbook, and each student's workbook is compared to this, while mark weightings are supplied separately.

The advantage is that all a lecturer has to do is provide the solution, but of course this sacrifices the flexible concerning how marks are awarded. There is no correct solution to the dilemma, however looking at trends elsewhere it seems that one should aim to provide common tools and the flexibility to adapt these if needed. This relates to the 20% of functionality required 80% of the time that Britain and Liber (2004) remarked summed up the dilemma concisely.

Worldware is a convenient term to describe those software applications having a substantial market outside the educational sector that are also valued for teaching and learning (Ehrmann 1995). Microsoft *Office* is a familiar example, but there are many other equivalent applications used by professionals and researchers, including statistical packages and geographical information systems for example. Students, academics and administrators use the Microsoft Office suite's office productivity tools extensively. As these include the most widely used applications worldwide, one cannot ignore their importance by sheer weight of usage. However, we find comparatively few examples of how they are being integrated into the learning environments (examples cite here: Hill 2002, Summons et al. 1997). Generally the argument given by educators is that students must become independent and acquire the skills on their own or must have acquired them elsewhere. However, there is also a responsibility to consider how the pedagogy and software design can avoid or reduce common problems. Striking the right balance is generally an evolving process. In thinking about the technology infrastructure, we must be flexible in offering different ways to achieve the same end. Thus in building on the office automation ideas we are not suggesting the end goals should be the same; say simplifying the tasks students must perform so they can complete them quickly. Rather that we need to consider how students work with technology and where opportunities exist in supporting tutorial-style learning. Generally we have found lecturers being very opportunistic in say recognising that Excel or Word would require little introduction but less aware of opportunities to use Excel to scaffold learning tasks or improve assessment practices. This is sometimes true even when turnkey solutions are provided. We have used the approach across many courses including introductory mathematics, academic writing, information systems, media studies and economics (Deacon et al. 2004). While none of these had used the same form of tutorial, the basic components are reusable.

The opportunities in integrating lab and web learning environments are one form of blending that residential universities are able to exploit effectively. The others, which we have briefly mentioned, involve using tutors at strategic points. In our scenario, we used tutors in the lab, both for the revision of the statistical techniques and just prior to the submission deadline. This became possible since their marking duties were diminished. More importantly, the tutors could help with some of the conceptual issues and help students easily overcome impediments to learning. The tutors had been instructed what they could tell students and what the students needed to discover for themselves. This flexibility in redefining the roles of tutors and being able to intervene when students most need help certainly promotes the blended ideas. While the background materials and scaffolded activities where available electronically, the tutors played an important role in providing targeted support. This support was though optional with the tutors available at certain times over near submission time. Using the lab environment as a learning space where students could meet and discuss the tutorial, worked well and was encouraged.

Allowing lecturers to exploit the opportunities of blending traditional and e-learning presupposes an appropriate technology platform. Monolithic technology solutions are never likely to address all aspects. Rather we see frameworks for loosely integrated set of tools evolving that educators can use to incorporate appropriate computer-based teaching and learning activities into their courses (e.g., IMS, SAKAI, JICS). These particular frameworks tend to claim to be neutral concerning pedagogy, probably because it is difficult to directly focus on the less formally defined pedagogy issues. What we are essentially suggesting here is that if we are to limit how technology constrain options in making pedagogical choices, we require not only the frameworks but also software platforms on which workflows can relatively easily be created. While standard tools implement 20% of the functionality that would be nice to have, to begin supporting the remaining 80% needed, we must consider approaches involving adapting, customising and extending what we have available.

Exploring different blended approaches within the institutions context is itself a challenge, with benefits seemingly often being outweighed by unforeseen teething problems after changes

are introduced. These issues have fuelled ongoing debates around what institutional technology infrastructure, developed using a bottom-up approach, is needed to allow educators to design their courses using more top-down thinking. Successful blended learning approaches must involve closing this perceived gap between the technology infrastructure design (bottom-up) and pedagogy design (top-down) perspectives. In practice this is difficult and our role as educational technology developers, is not concerned with creating new material that teach, rather it is about problem solving in integrating teaching and learning activities within these emerging blended environments.

Scenario: future and changes

The automated assessment of a part of the tutorial made a significant impact on the marking time. The database of answers and the results provided an opportunity to reassess the weight of marks and aspects marked. When marking by hand, such detailed analysis of trends is much more difficult to collect. Having a much better perspective on how students performed, it was clear that most students were able to perform the basic calculations but did struggle with many of the conceptual issues. The impact of this formative aspect of our work is probably the more significant long-term impact than the time saving in assessment. The suggestions we discussed included providing more scaffolding were student had difficulties and more feedback to guide students beyond failure at the first few hurdles.

The frameworks and platforms we described are still evolving. However, the lecturer was immediately able to see how we could use the same basic approach and apply it to a range of courses across departments that all require one or more combinations of conducting experiments, developing new experiments, statistically analysing results and meta analysis of results.

Importance of tutorial-style activities

The underlying assumption of our ideas is that tutorial activities are not only important in residential universities and provide opportunities for blending that have yet to be fully exploited. The idea of tutorials using skilled tutors was famously employed by Socrates over 2500 years ago and in the old Oxford-Cambridge model where a student engaged in discussion with a tutor (e.g., Bork 2001, Laurillard 2002). Tutorials in other forms have continued to be important parts of university teaching. Research supports the claim that tutorials are effective when used with skilled tutors, though now rejecting Socrates approach where he first reduced his students to a state of helplessness. Benjamin Bloom's 'two-sigma paper' (1984) demonstrated that the average tutored student performed just as well as the best two percent of classroom students. Thus implying almost everyone should benefit from learning in a suitable tutorial environment when compared to a course with transmission forms of teaching. The reason why less effective teaching methods continue to be employed is because tutorial styles of teaching are quite expensive, requiring many skilled tutors.

The problems with cost and scaling of tutorial style teaching is an active research area, with technology promising much but with comparatively little widespread use to date. There is a diverse and long history of research into technology supported tutorial-style activities (e.g., Bork 2001, Laurillard 2002, McArthur *et al.* 1993, du Boulay & Luckin 2001). The most familiar examples involve computer application asking questions based on information presented, evaluating responses and then generating some form of feedback. Often they are designed to be self-paced, accommodate different levels of prior knowledge, allow branching and provide opportunities for self-assessment. What we argue here is that these do not need to be a monolithic program.

The long-standing question has concerned how much of the educators role can be automated. Tutorial environments employing artificial intelligence techniques, collectively known as Intelligence Tutoring Systems, have been researched for over four decades (du Boulay & Luckin 2001, Bork 2001). In reality few of these ideas have become widely used outside the research communities or specific contexts in which they have been developed (McArthur 1993). Thus in practice technology continues to be employed in much more of a support role by educators. Thus in our context the tutor's role remains similar to that in the traditional tutorial, in that they are expected to assist students with conceptual problems, offer assistance and provide context for example. The technology's role is primarily supporting the

tutors by automating routine tasks and providing additional information to students and the tutors that otherwise may not be possible working with large tutorial groups. This form of blending is so natural at residential universities that it is virtually the norm.

Laurillard (2002:134) observes that much of the software developed and used to support tutorials activities is little more than a multiple choice question prompter. The many variants of multiple choice question prompters are well suited to computer implementations and it is thus not surprising that they are widely employed. In addition the multiple choice question format remain an important part of assessment, particularly for larger classes. However, what Laurillard and others are objecting to is the use of this approach within tutorial-style teaching where higher-order learning is supposed to take place and students conceptual problems addressed. Otherwise the role of the computer is simply to confirm that a student has currently received a message transmitted to them where as a more student-oriented approach would focus on how well the student has understood what was being taught. The constraints on what is computationally possible make it clear that technology is less well suited to providing this type of support, although many ideas have been investigated and which in some cases have demonstrated success in supporting higher-order learning (e.g., McArthur et al. 1993).

Conclusion

The use of technology we have outlined is intended to support lecturers in engaging with student learning in tutorial style learning environments. This blending is realistic in the context of a residential university, where tutors can support student learning that is otherwise infeasible to automate. Activities will have to scaffold higher-order learning, automate simple forms of feedback and support the tutor in various other ways so as to make the best use of their time with students. Outside tutorials, tutors need access to information on what students have done so as to prepare for the next tutorial by for example addressing common misconceptions or skipping things already mastered. As Bork (2002) observes, these types of approaches are more attainable but many challenges remain.

Our vision for supporting blended teaching and learning environments is to create software platforms that enable tutorial workflows involving more than what is found in course management systems. In our scenario we integrated Excel spreadsheets and web-based activities as part of a tutorial workflow. This is made possible by exploiting worldware and various open standards and frameworks. We see this as complementing the way course management systems are used and extend possibilities. Students need to be able to work in computer laboratories with tutor supervision or on their own and possibly on their own computer. They need to build on skills that have developed and focus on skills important in the workplace. To remain flexible, the educators cannot be too dependent on generic services and often need to be able to make changes themselves.

Adopting 'mix-and-match' approaches in the hope that things work together is over optimistic. In adopting a pragmatic blended approach, we are essentially adopting a number of principles. Hocutt (2001) suggest general strategies about thinking how components should be integrated as part of a blended intervention:

- Blended learning components have a mutual awareness of each other
- Components are consistent in language, style and technique
- Components need to be appropriately redundant
- Components have to seamlessly transition from one component to the other

This strategy emphasises what is important when integrating components, which in our scenario included steps in a tutorial workflow, and does not specify how the technology is integrated but rather what the student should perceive.

At UCT we, and others, have been using the approach that integrates worldware into learning environments for several years (Deacon et al. 2004). From these experiences we have developed a pragmatic and flexible approach to building blended tutorial interventions. In effect we are suggesting one use different 'browser' for different types of content, rather integrating components by requiring every online activity to be accessed though a web portal.

In integrating different components, we are also thinking about the roles of tutors and how they can change to support learning rather than administration. There remain many practical constraints on what is feasible in a university context. The pragmatic approach has aimed to address these issues while continuing to focus on improving feedback cycles and usability within the university context.

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