

Supporting high level learning through research-based methods: A framework for course development

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Introduction

The Technology-Enhanced Learning in Research-Led Institutions (TELRI) Project, funded by HEFCE under phase 3 of the Teaching and Learning Technology Programme and based at the Universities of Warwick and Oxford, was developed as a means of encouraging academic staff in research-led institutions to make effective use of learning technologies in their teaching. The project team needed to deal not only with the usual problems in such innovations, but also the particular challenges of a research-led institution, in which staff are highly research-orientated and incentives are heavily weighted towards achievement in research. The team sought to do this by encouraging academic staff to make explicit links between their research and their teaching, making use of learning technologies to do so. An educational framework for course design was devised as a means of assisting staff in this process.

The Research and Teaching Link Debate

The team were conscious of the highly politicised debate about supposed links between research and teaching. Many staff in research-led institutions claim that research beneficially informs teaching. This belief has been widely held for many years (Robbins, 1963; Centra, 1983) - and see Ramsden and Moses (1992: 274) and Hattie and Marsh (1996:511) for a rehearsal of these arguments. However, the literature is not particularly encouraging for this view. It has been argued that studies are inconclusive (Brew and Boud, 1995: 262) or that the correlations are not statistically significant (Feldman, 1987) or that correlations have not been found (Elton, 1986: 299; Hattie and Marsh, 1996) or else that there are correlations (between Teaching Quality Assessment and Research Assessment exercises) but that this is an error of "deducing causation from correlation" (Jenkins, 1997: 8) and that a third factor is in play. Others find a weak negative correlation between the level of research activity and student satisfaction (Ramsden and Moses, 1992), although the effect on student learning was not a factor in the study. A later study tested for cognitive and affective development too, and found negative correlations (Astin, 1993). Others again are adamant that there is no link at all (Gibbs, 1997). Certainly the gap between rhetoric and reality is often a large one (Entwistle, 1998).

However, there have been counterclaims that students see advantages as well as disadvantages in their lecturers' research activity, and that the former have been misrepresented in previous studies. The problem is one of research management (Lindsay, 1997). Elton criticises the validity, reliability and naivety of many studies (1986: 300), since both teaching and research are "complicated human activities". He proposes that quantitative methods will not do, claiming that to understand the relationship at departmental or institutional level requires a historical and ethnographic approach. Brew and Boud list methodological difficulties in such studies (1995: 263). From a meta-analysis of 58 studies, Hattie and Marsh (1996) conclude that the relationship is zero but that future goals could be to adopt strategies that enhance the potential benefits of linking research and teaching.

Some Possible Links

What does seem clear is that the belief that research informs teaching persists, even in the face of detailed studies appearing to indicate the contrary, as has been noted (Webster, 1985; Neumann, 1992). A number of claims are commonly made. Firstly, it might be argued that active researchers can incorporate the fruits of their research into the curriculum. Arts and social studies academics often thank their students for insights derived from seminars and will claim that their teaching and research are closely linked. The claim is harder to sustain in the sciences, where researchers often believe that their research is too remote from the undergraduate curriculum to make transfer feasible. Secondly, one might argue that the existence of a link depends on the type of learning considered in terms of acquisition of knowledge and skills, abstraction of meaning, interpretation, inquiry and creativity. Feldman (1987) found higher relationships between research and teaching in the social sciences and humanities than in the sciences. Reich, Rosch and Catania (1988) found that the common factors of teaching and research were disseminating and communicating knowledge, whereas integrating knowledge and applying knowledge were more specific to teaching, and discovering and creating knowledge were more specific to research.

A further, very pragmatic, argument is that research attracts resources - better libraries and equipment, more expert staff - and that these inevitably feed into the undergraduate experience. Another suggestion may be that a research environment socialises students into the ways of a research community and the culture of inquiry and innovation. These are difficult outcomes to measure, but they may nonetheless be valuable, and are probably worthy of more detailed research than has yet been attempted.

In considering the directions for future research in this area, Hattie and Marsh (1996) suggest analysis of possible links on the basis of the differing conceptions or 'orientations' of teaching (Wilson and Wilson, 1972) and of learning (Marton and Saljo, 1976b; Marton and Ramsden, 1988). Larsson (1987) distinguishes between teaching that involves the preparation of content that requires little interpretation by the student, and teaching which aims to involve students in the process of interpretation and structuring. Hattie and Marsh (1996) believe that it may be most valuable to "ascertain the whether students conceive of learning more as reproductive or constructivist, to ascertain the teachers' belief system" and compare these to the "conceptions of research" held within the discipline. Brew and Boud criticise the "poverty of conceptions of teaching and research" in the studies, and argue that the link is in "the activity of learning" (1995: 261).

Since the construction of new knowledge and understanding is inherently a part of research, we believe the most fruitful area to explore is that of the *processes* which research and student learning may have in common. It could be argued - and we do so here - that many research processes are good learning processes that have a more general application. If that is so, then the more institutions can encourage their undergraduates to think and work like researchers the better. There are certainly supporters of this view. Elton argues that there are three activities in universities: teaching, scholarship and research. Scholarship - "new interpretation of what is already known" (Elton, 1986: 301) - is a feature not only of teaching but of much research, particularly in the humanities. Only in "experimental search for new knowledge" is there a weak link with teaching, but even in such a case, "research in a narrow field requires scholarship in a wider field" (ibid: 302). If research is to inform teaching, it must do so through scholarship. In this sense, Kingman proclaimed that "it is the duty of every teacher to engage in a form of research which benefits teaching, but it does not mean that teachers have to engage in 'fundamental' research" (1993: 15).

The TELRI Approach

The TELRI team believe that in research-led institutions it is more productive to seek ways to help one activity to enrich the other than to see teaching and research as unrelated activities or as permanently opposed claims on academic time. Of course, effective learning does not require a research environment. There is not a great deal, in terms of the processes of learning, that is necessarily unique to research activity. As has been pointed out "Autonomy of enquiry and the recognition of the uncertainty at the heart of knowledge do not ... belong to an exclusive group" (Ingrid and Moses, *date*). However, the team believe that certain environments, of which research-led institutions are an example, are a particularly valuable *potential* resource for the purpose, if exploited effectively (Roach, Blackmore & Dempster, 2000). It is reasonable to suppose that those experienced in researching and other rigorous professional applications of a discipline will have developed capabilities that require, or are informed by, a range of higher level cognitive skills. The processes they themselves use to learn in research and scholarly practice can help them to understand and structure students' learning and to assess the development of such capabilities in others. It would clearly be beneficial if students were themselves to develop these skills, in a research-like approach to learning that could help them in their current studies and lay a foundation for future activity within and beyond the discipline.

The focus of the TELRI project is therefore on what research and teaching share - a *culture* of personal inquiry, the *process* of inquiry and *learning* (Light, 1999). At present the potential benefit of academics' research expertise for teaching and learning approaches is not always exploited fully, and this will only change if a conscious effort is made that it should do so. We would claim that if research-led institutions can learn to be more explicit about the ways in which research can inform teaching, there may be benefits across the sector, since the nature of higher level learning in general will be illuminated.

The TELRI Project has focused on the cognitive skills of researchers, defined some of them, and suggested how they can be developed and assessed. The educational framework described here is intended to provide a general insight into some of the dynamics of learning observed and experienced by academics and students in research-led institutions. They reflect and extend established educational theories of learning and effective teaching and learning practices.

In particular, we highlight two essentially complementary forms of learning. The first is **adoptive learning**, which is essentially a reproductive process and is appropriate after a situation has been defined. It requires the application of well-understood knowledge and the mastery of tools, techniques and procedures in bounded situations. Adoptive learning can produce immediately impressive results but may be less transferable to other, less familiar situations. Adoptive learning approaches do not (and were not designed to) foster the *development* of an individual's understanding, but serve to transfer established, well-understood concepts by the learner's adoption of rules, structures and procedures. The second is **adaptive learning**, which requires higher level thinking in more open situations and is inherently a creative, generative and reflective process that requires and develops higher cognitive processes. We argue that researchers tend to engage in adaptive learning, since research activity by its nature provides opportunities for innovation that develop higher cognitive abilities and foster creativity. Apart from the clear recognisable benefits, adaptive learning also forms the basis for transferable learning. Adaptive learning approaches would be extremely valuable in undergraduate teaching by enabling a student to develop a *skill of transfer* and transfer their capabilities to new situations, thus developing as an expert as opposed to a competent practitioner.

The identification of different products of learning has been discussed by Dreyfus (199x) who observed that nurses who were trained to undertake specific tasks were not necessarily capable of transferring the adopted skills into novel situations where qualitative judgements were required for adaptation, such as the prioritisation of actions. Indeed, the test commonly referred to as the "Turing test" (Turing, 1950) which seeks to identify and differentiate a human subject from a computer subject purely by questioning, addresses the question of the detection of "understanding" (in this case by falsification). Adaptive learning, in many cases, may only be determinable by a professional expert since the criteria for identifying levels of "expertise" in others are complex and often require judgements that are not readily reduced to simple rules (Dreyfus, *ref*).

At the heart of contemporary discussion on transferable skills is a wish to identify capabilities that have a wide application and to develop them through the curriculum. Cognitive skills are particularly important in enabling the transfer of capability from one situation to another, both because they are less context-dependent than some other human abilities often referred to as skills, and because they can themselves aid transfer. There would be wide agreement that they are transferable, at least within a discipline. For example, mathematicians would probably agree that a set of abilities to "think mathematically" would be developed through a degree course. Transfer beyond a discipline is more problematic, and it is probably safer to say that transfer is more likely in direct relation to the degree of similarity between contexts.

The TELRI framework aims to provide generic, cross-curricular approaches for designing courses that facilitate the development of research-orientated capabilities. The two forms of learning assist in the distinction between those adoptive skills and abilities, which *may* be applied in particular contexts, and the adaptive 'capabilities to transfer', which facilitate the recognition of unfamiliar contexts and enables understanding and innovation to be applied appropriately. Individuals whose professions require the rigorous application of a discipline, such as researchers, are highly effective in adaptive learning and are potentially well placed both to assist others in developing similar expertise and to assess the presence of such capabilities in others.

Principles of the TELRI educational framework

The educational framework developed for the TELRI Project deals with the support for, and assessment of, adaptive learning. Although the general ideas and descriptions of the learning issues discussed will be familiar to academics, some terms may have more familiar descriptions in a particular discipline.

There are several underlying propositions on which the framework is based:

1. One of the primary purposes of a degree course at a research-led university is to assist in the **development of students' expertise in a subject discipline**. This provides the students with the intellectual skills to perform effectively when presented with a wide range of problems in continually changing environments, albeit with a discipline-related perspective.
2. The **purpose of a course** (and thus its nature) is influenced by the *assessment criteria* while the **quality of a course** is determined by the *support offered* to students in working to attain those criteria.

3. **Students' study approaches are significantly influenced by the perceived purpose of the course.** The extent to which the course aims to develop adaptive (or adoptive) learning processes should be reflected not only in the rhetoric of the aims, objectives or learning outcomes, but also as importantly in the teaching, learning and assessment methods actually used. Students' perceptions of the purpose of a course will significantly influence the way they engage intellectually with course activities (e.g. an active or passive approach to lectures or resource-based learning).
4. The quality of the learning process is largely determined by the nature of the assignment task, particularly the extent to which its components are unfamiliar to the student.
5. **Adoptive methods establish adoptive processes while adaptive methods develop adaptive and creative processes or approaches.** The development of lower level learning processes, such as following set methods or recalling facts, is not a foundation for the later development of higher order learning processes such as reasoning, analysis or creativity. The capabilities required are different in nature. At any level of study, adaptive learning processes can and should be encouraged to develop alongside adoptive learning.

Terminology

The team were cautious of introducing the novel terms “adaptive” and “adoptive” but could find no existing terms that precisely expressed the difference described above. There is of course a superficial resemblance between these terms and “deep” and “surface” approaches to learning, on which there is a substantial literature (Marton and Saljo, 1976a; Ramsden, 1992), as shown in Figure 1. The terms “deep” and “surface” have proved to be immensely useful in analysing learning approaches, and seem to be widely generalisable (Boud, 1988: 64). There are some disadvantages in using them in the context of TELRI, however.

Adaptive	
Open situations Extending knowledge and techniques Understanding and insight	
	Deep*
	Depth of knowledge (i.e. dense but closely related information). Intention to understand Relate previous knowledge to new knowledge Holistic Internal emphasis
Adoptive	
Bounded situations Established knowledge and techniques	
	Surface*
	Breadth of knowledge (i.e. broad area of information) Rote learning Focus on unrelated parts of the task Atomistic External emphasis

Figure 1: Comparing terminology (* quotes from Ramsden, 1992)

Firstly, such courses or aspects of courses which may require the adoption and implementation of complex strategies or processes do not readily lend themselves to categorisation in terms of deep and surface learning. As Ramsden points out, "the conclusion reached by the research into student learning is that ... the meaning of the distinction has to be reinterpreted in relation to different subject areas" (2000). This has led to difficulties in identifying the nature of 'deep' learning in individual subject areas and, therefore, methods by which 'deep' learning can be encouraged in each field.

We argue that a more useful description is provided if the surface and deep forms of adoptive and adaptive learning are identified, as shown in Figure 2. Both of the categories termed adoptive and adaptive exhibit the familiar deep and surface learning aspects, but the distinction between deep adoptive and deep adaptive has proved useful in identifying, supporting and encouraging high level learning across the disciplines.

	Deep*	Surface*
ADAPTIVE Open situations Extending knowledge and techniques Understanding and insight	Highly developed reasoning Deep understanding, insight and creativity formed	Developed general ideas and vague approaches Developed a narrow focus
ADOPTIVE Bounded situations Established knowledge and techniques	Developed knowledge and concepts to a high degree Strategies formed	Developed a breadth of knowledge Poor strategies formed

Figure 2: Identifying commonality in terminology of forms of learning
(*adapted from Ramsden, 1992: 46)

The distinction may be drawn by considering the case of a very high quality training course in, for example, how to produce a drawing with a computer-aided design package. This would not necessarily be surface learning, since the learner might have a self-chosen task in mind or an "internal" motivation, which could lend purpose and depth to the learning. The learner would be highly likely to relate the learning to previous learning, perhaps of other design software, and examine the logic of the package rather than simply to internalise sequences of key presses. None of this sounds like surface learning, yet it would be adoptive learning, since the situation is bounded and the knowledge and techniques required would be well established.

Secondly the terms "deep" and "surface" now have particular connotations. The literature of deep and surface learning is now so extensive, and the ideas are now so widely advocated in "popular" teaching and learning literature, that much of the detail of the discussion has been edited out of many accounts. Indeed, Ramsden cites this as an example of "seminal ideas (that) ... acquire a common-sense significance remote from their original meaning" (1992:44). In some accounts "deep" and "surface" are now almost interchangeable with "good" and "bad". Ramsden himself, for example, comments that "Surface approaches have nothing to do with wisdom and everything to do with aimless accumulation ... it leads down the same desolate road in every field" (ibid: 60). He associates deep learning, in contrast, with a long list of virtuous scholarly traits.

The pejorative meaning of "surface" and the loss of subtlety in popular definitions of deep and surface learning are not always helpful when working across a range of disciplines. As Ramsden also points out, "deep" learning looks different from one discipline to another. In

particular, in “fact-heavy” disciplines, “an initially narrow concentration on detail and logical connections as part of a deep approach is common in subjects typified as cumulative, paradigmatic, replicable, and capable of being summarised in terms of general laws” (ibid: 49). It seems unwise to approach academics in such disciplines using a vocabulary that appears to be critical of what many of them will believe to be a fundamental feature of the epistemology of their discipline.

For TELRI, therefore, the term “adoptive” is not a pejorative one, but is simply descriptive of a form of learning. We do, however, point out that a diet solely of adoptive learning leads to competence rather than expertness. For this reason, we prefer to draw a distinction by considering that the learning of propositional knowledge is adoptive in nature while the development of 'transferable' learning or true understanding and insight requires an adaptive approach.

Distinguishing capability on the basis of adaptive and adoptive learning

Using the categories of adoptive and adaptive learning to distinguish the capabilities to be developed by students can assist in reviewing or evaluating the nature of a proposed or existing course. The two forms of learning are prompted by different assignment tasks and must be assessed differently. A form of categorisation of the cognitive processes involved in each of these two forms of learning is offered in Figure 3.

ADOPTIVE LEARNING	ADAPTIVE LEARNING
Knowledge and Practice of...	Formation and Generation of...
Facts, Assertions, Rules and Laws	Personal Interpretation, Meaning and Expression
Language and Protocols	Evaluation, Decisions and Justification
Techniques and Procedures	Arguments, Reasoning and Explanations
Organisation, Structure and Strategy	Synthesis, Conceptualisation and Understanding
Established Relationships and Principles	Originality, Creativity and Innovation

Figure 3: Adoptive and adaptive learning outcomes

Assessment of adaptive learning requires that we check whether students truly understand the knowledge and concepts or simply adopt an established structure or explanation in the accepted format of the discipline as a strategic response to a familiar assignment. While the absence of understanding might be identified through an incorrect statement or ill reasoned relationship, the presence of understanding can only be tested for by extensions to a knowledge base, i.e. through the formation and generation of new ideas and knowledge, and thus by creativity. Assessment of those new extensions therefore requires an open process. Where assignments fall within the existing knowledge framework, and are so assessed, they call for pre-defined and established structures. The students respond by adopting a strategy with little need to engage in adaptive learning. Both deep and surface adoptive learning can therefore be a strategic response since they are propositional knowledge-based and associated with following and recognising structure, albeit at differing levels of breadth or depth (Kirschner, et al, 1997). Adaptive learning is research-based and associated with creating structure, at any level. The link between teaching, research and learning is determined by whether the development of adoptive or adaptive learning capabilities is intended. Adoptive learning is

knowledge-based and can be taught, adaptive learning is research-based and must be personally undertaken by the student.

This conclusion is implicitly supported and widely documented by several research studies into learning. The most explicit view is shown by Kuhn (1981) with the term 'anticipatory scheme' and implies that understanding is reliant on the student's ability to "create form" from the information received and this has to occur before any process of identification, comparison or differentiation of the existing forms takes place. The examination of adaptive learning, however, emphasises that development of, or the ability to develop, such internal representations is a creative process. In this sense, creativity can be argued to be fundamental to the development of understanding and expertise in any discipline area. It should be noted that the provision of form and structure in teaching can actually be counter-productive to encouraging the creative process (Marton & Saljo, 1984; Ramsden, Beswick & Bowden, 1986.) Sarup (1993) reminds us that "It is imagination which allows one to either make a new move (a new argument) within the established rules or to invent new rules", reminiscent of the conclusions of Penrose (1989).

We therefore propose that encouraging students in the process of creating form (adaptive learning), with less emphasis on providing form (adoptive learning), together with a supportive environment for such processes, will go some way towards improving the quality of courses and the transferability of a student's learning. Since research-led institutions are active in the area of the creative production of new knowledge, this provides a significant potential (whether realised or not) for encouraging students in such adaptive learning processes.

The extent to which the development of adaptive capabilities complements adoptive learning outcomes will determine a student's ability to respond effectively to undefined and unfamiliar situations within and beyond the discipline context. In conjunction with particular "transferable skills" such as interpersonal and organisational skills, we believe adaptive learning encapsulates those capabilities that employers are increasingly seeking to obtain from university graduates.

Motivating Students to Think Adaptively

There is a natural propensity to use previously formed concepts before developing new ones. It must be appreciated, therefore, that students will try to use the least amount of effort and intellectual energy to complete assignments. This can lead to strategic learning, that is, they fall back on adoptive learning approaches. The development of strategies that can be used for a series of assignments demonstrates the students' ability to recognise a common form in such assignments, even deep and complex problems or issues. This is sometimes displayed by surface or superficial problem based learning courses (Boud, 1988). It is not being implied that this form of learning (or indeed either learning form, adoptive or adaptive) is inherently a degenerate form of learning. The point is that if the form of assignments is familiar, then the students do not need to use adaptive learning. The emphasis for adaptive learning is that the form of assignment, and therefore response, is not explicit and familiar. It is then that the student has to use adaptive learning, i.e. create structure where there is none apparent. For this reason, the motivation to learn adaptively is greatly influenced by the familiarity of the assignment scenario and will determine the type of intellectual processes engaged in by the student. In order to engage students in higher level learning, assignments must therefore provide novel and open scenarios that require new ways of looking at a concept or new concepts to form in the students' minds. Within course assignments, students' own perceptions,

interpretations and ideas would require supportive evidence and be clearly argued and justified. This indeed is the nature of research.

However, many students are unsure or unaware which skills and abilities are called for, and valued in assignments. Assessment methods, marking systems and feedback to students should make transparent the criteria for assessing and rewarding the level of achievement of specific learning outcomes. For example, in an assignment based upon an essay format of "discuss" or "compare", the grade may be weighted to reflect the importance of a student's own ideas, or reasoning skills, presentation of established subject knowledge or ability to undertake specific techniques. When learning outcomes are provided, such as "the ability to develop an argument" are used, the students benefit from some explanation or example of what this means and can more easily adopt study approaches that develop the appropriate learning processes required and thus attract good marks.

Assessing Adaptive Learning

In assessment practice, it is important to find ways of differentiating between well-presented expression of established knowledge and methods and the kind of subject understanding, appreciation and reasoning demonstrated by an 'expert'. The identification and assessment of adaptive learning will be based upon the intended aims of the course and the academic ability of the course tutor, as "expert". If assessment is designed for adoptive learning, students will tend to use and develop adoptive learning processes, while if it is designed for adaptive learning students will use and develop higher cognitive processes (to the best of their ability). The course design should therefore aim to balance the adoptive and adaptive components of the course assessment criteria to reflect the overall intended nature of the course.

Course assignments can be used as part of the learning support in general as well as for assessing the extent to which a student has developed particular capabilities (Fig. 3). In terms of developing adaptive learning or assessing the extent to which a student has developed expertise, four basic questions act as a guide:

1. Will the assignment task enable expertise to be demonstrated?
2. Does the task allow students fully to demonstrate their level of expertise?
3. Are students in a position to judge the quality of their work before it is assessed?
4. Could students complete the assignment successfully through purely adoptive learning?

Although academic experts are often intuitively aware of appropriate assignments for determining the students' level of expertise, some generic guidance is suggested below that may assist in making more explicit statements about the assessment process. Assignments that assess expertise have the following characteristics (among others for each discipline):

- **There is no unique, established solution or correct response.** Assignments tend to be open, novel and discursive in nature and form (at least for the students) with no fixed approach.
- **No purely procedural, 'algorithmic' or learned response will suffice.** The assignment thus requires modelling such that the student must bring unidentified structure to a problem.
- **Judgements of value, likelihood and probability are required.** These require the development of a view, perspective or approach and a coherent trend of reasoning with supportive evidence.

- **Originality, innovation, creativity, insight, personal interpretation, contemplation and reflection** are required. This requires qualitative, descriptive, information-rich approaches based on a broad remit.
- **Tasks are concerned primarily with the nature of the subject** as opposed to the substantive content of the subject.
- **Creative scope is provided** so that the students can demonstrate fully their level of expertise.

The interpretations of these generic descriptions will clearly be subject-specific, but the basic learning outcomes (Figure 3) are surprisingly subject-independent. This cross-discipline commonality is a reflection of the transferability of a student's ability to create form from information, situations and knowledge.

Supporting Adaptive Learning in Courses

Adaptive learning requires students to engage in novel scenarios within and beyond the discipline context. While the *purpose* of a course, and thus its *nature*, rests with the course assignments, the *quality* of a course is determined to a large degree by the support provided for students to undertake those assignments and attain the desired learning outcomes. Explicit statements of learning outcomes do not inherently give the student an insight into the learning processes required. Teaching, learning and assignment support should be designed to make more transparent those learning processes that are most effective in achieving, or working towards, the intended learning outcomes.

To support this, the course should provide students with opportunities for obtaining feedback on their ideas and their approaches through debate and discussion and sharing of work, as well as providing an environment for reflection. Extending this to peer assessment, students can learn valuable lessons when given access to the work of their peers by engaging in the evaluation of what is and what is not good quality work in their subject area, using the same open-ended approaches the tutor might use.

The emphasis of the course design thus needs to be placed firmly on supporting the activities of the students and highlighting the capabilities to be developed rather than on the subject content of the course. Specific learning outcomes can only be developed and assessed by offering the students the opportunity to undertake specific and appropriate learning activities. The requirement in research-led teaching is to provide assignments and activities that allow the demonstration of the adaptive learning capabilities and qualities in a student's work. By nature, such assignments tend to be more open, challenging and motivating than those that require the demonstration of established knowledge and procedures, characterised by adoptive learning outcomes (Ramsden, 1991). By offering such designed activities early in the course, the students are not only made aware of the course module expectations, but also supported in developing the required capabilities and making appropriate use of the learning resources, guidance, feedback and opportunities for reflection provided. In turn, students themselves can contribute to the course, bringing in resources that support the formation and expression of their ideas and justifying these. In general, the nature and effectiveness of the course support will influence the students' learning experience, and more importantly, will determine the overall quality of the course.

Technology Enhanced Learning

There has been much written on the subject of how information and communications technologies (ICT) can best support specific learning processes (Laurillard, 1993; Ellington, Percival & Race, 1993); French et al, 1999; Fry et al, 1999; McConnell, 2000). Emphasis is often placed on categorising teaching approaches, for example as collaborative learning, group work, self-directed or independent student learning, and so on.

Figure 4 serves to illustrate how typical traditional and ICT-based methods can support adoptive and adaptive learning. The choice and combination of methods and assessment practices will determine, or preferably be determined by, the bias of the course towards adoptive or adaptive learning.

	Learning resources	Learning support	Assessment	<u>Integration medium</u>
<u>ADOPTIVE learning</u>	Provision of course materials	Feedback and guidance on knowledge and practice of .. (see Fig. 3)		Virtual Learning Environments
Traditional	Lectures Guidance notes Books Journals	Seminars Group classes Lab work	Essays Work/lab books Multiple choice tests	
ICT-based	Web-based resources CAL, simulations Bibliographic databases Internet sites	Interactive CAL Simulations Applications software <i>E.g. spreadsheets, statistical or textual analysis, CAD, 3-D modelling, multimedia</i>	Electronic marking Computerised tests, CAL, simulations (that include marking)	
<u>ADAPTIVE learning</u>	Availability of published & peers' work and debate	Feedback and guidance on the formation and generation of .. (see Fig. 3)		
Traditional	Discussion of work in progress Distribution of marked work	Seminars Group classes	Essays Reflective journals Lab reports Open-ended problems/issues	Virtual Learning Environments
ICT-based	Web publishing Discussion archives	Web publishing & commenting Email lists & newsgroups Discussion boards Conferencing packages	Published work Discussion contributions	

Figure 4: Integrating traditional and ICT-based learning resources and learning support

The potential benefits of ICT in courses have been shown over the years to be difficult to demonstrate unless the learning processes the course intends to support are made explicit. Cost-benefits of using technology above traditional methods can only be evaluated properly when the intended aims of the ICT intervention have been identified. A clear overview is needed of the learning processes required for the students to achieve specific learning

outcomes and develop specific capabilities. Without this framework, there is a tendency for ICT methods and use of materials to be “bolt-on”, time-consuming to develop or implement, and the benefits often remain unclear or dubious. With or without technology, identifying learning processes, and the appropriate corresponding assignments, support activities and resources, assists in enhancing the quality and cost-benefits of a course.

Using the distinction of adoptive and adaptive learning to make explicit statements about intended outcomes, technology solutions may be categorised in a new way. From this, new systems can be designed to enhance specifically the desired learning processes that the course aims to develop in students.

Conclusions

Promoting and supporting the development of expertise is predominantly governed by the degree and quality of the course support provided by discussion of the learning objectives and feedback on learning development. It allows students to gain a better insight into the assessment criteria of the course in terms of the nature and quality of the work expected, e.g. what is required to get a first, what will give you a 2-2 or a third. Consequently, the quality of students' work tends to increase, thus enhancing the overall course quality. The effectiveness of using C&IT approaches will be determined by their integration with the use of other course support activities and resources.

Using the distinction of adoptive and adaptive learning outlined in the TELRI educational framework provide a means of:

- making powerful and robust decisions and justification for teaching, learning and assessment methods and use of resources;
- enabling more explicit statements to be made concerning student learning outcomes;
- establishing coherence in content, structure, methods of delivery, assessment, student progression, support and guidance;
- suggesting ways of revising course processes and assignments to enhance learning and course quality.

Effective practice in embedding or integrating new teaching approaches, including ICT-based ones, with traditional methods of teaching, is a continuing activity of academic development. Nevertheless, it is clear that the communication aspects of the course support as a whole, that is the sharing and discussion of students' ideas and work, are vital to promoting and facilitating adaptive (rather than adoptive) learning.

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