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JISC e-Learning Models Desk Study 2004

Stage 2: Review of e-learning theories, frameworks and models

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Abstract:
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1: A PEDAGOGICAL DESIGN FRAMEWORK FOR E-LEARNING

This review is designed to inform practitioners, policy developers and other stakeholders who want to reflect more deeply upon their practice or gain a greater understanding about how theory and practice can be mapped together. It is argued that reforming practice requires transformations of understanding of principles that are assumed – sometimes implicitly – in the practices. This review offers a framework for understanding where a particular implementation of e-learning is positioned in the complex current landscape of technology-enhanced teaching in UK HE/FE. It does so by attempting to offer a set of questions to be posed of an e-learning development – the answers to which reveal the underlying pedagogic and pragmatic assumptions.

There are really no models of e-learning *per se* – only e-enhancements of models of learning[1]. That is to say, using technology to achieve better learning outcomes, or a more effective assessment of these outcomes, or a more cost-efficient way of bringing the learning environment to the learners. It is all the more important, when implementing e-learning approaches, to be clear about the underlying assumptions. A model of e-learning would need to demonstrate on what pedagogic principles the added value of the 'e' was operating. Where, for example, the 'e' allows remote learners to interact with each other and with the representations of the subject matter in a form that could simply not be achieved for those learners without the technology then we have a genuine example of added value. However, the role of the technology here is primarily to get remote learners into a position to learn as favourably as though they were campus-based, rather than offering a new teaching method. In such a case the enhancement should be seen as pragmatic rather than pedagogic, achieving cost effective access to learning, rather than a new way to achieve deep understanding of a concept. Even something that looks like a new paradigm for achieving learning outcomes, a peer-to-peer learner-matching tool, for example, may represent only an incremental advance in pedagogic terms, though its educational value may be enormous if it could be exploited through an educational infrastructure which integrated its use with quality assurance methods. It is important, therefore, not to take too narrow a view of what constitutes e-learning, or of where its main value might lie.

Nevertheless, the main goal of this paper is to examine the pedagogical frameworks for e-learning, and to set out the underlying assumptions about learning that should provide a rationale for the technology.

This report starts by describing a well-understood framework for good pedagogical design (or curriculum design) in HE/FE contexts (Biggs, 1999). Then, the report describes how the design decisions within that framework need to be grounded in some kind of theoretical

[1] Helen Beetham (comments on an earlier draft) has pointed out that there are models that focus directly on the affordances of the technology, but it is arguable whether these are effective models of e-learning.

assumptions about learning and teaching, as well as in pragmatic judgements about practice and costs. The role to be played by e-learning should be defined within this overall educational design process and not judged by separate criteria.

2 E-LEARNING THEORIES, FRAMEWORKS, MODELS AND TAXONOMIES

This section will define the key terms that are used in this document, see also Final Report (Draft A)/ Stage1 Master Glossary (Draft A).rtf

- **E-learning**, or 'technology enhanced learning' describes the use of technology to support and enhance learning practice.
- **Theories of learning** provide empirically-based accounts of the variables which influence the learning process, and provide explanations of the ways in which that influence occurs.
- **Pedagogical frameworks** describe the broad principles through which theory is applied to learning and teaching practice.
- **Models of e-learning** describe where technology plays a specific role in supporting learning. These can be described both at the level of pedagogical principles and at the level of detailed practice in implementing those principles.
- **Taxonomy** in this context proposes a mapping of the theories of learning, the pedagogical frameworks, and the models of e-learning.

3 THE ALIGNMENT PRINCIPLE IN EDUCATIONAL DESIGN

Biggs (1999) describes the task of good pedagogical design as one of ensuring that there are absolutely no inconsistencies between the curriculum we teach, the teaching methods we use, the learning environment we choose, and the assessment procedures we adopt. To achieve complete consistency, we need to examine very carefully what assumptions we are making at each stage and to *align* those. Thus, we need to start with carefully defined intended learning outcomes, we then need to choose learning and teaching activities that stand a good chance of allowing the students to achieve that learning, then we need to design assessment tasks which will genuinely test whether the outcomes have been reached[2]. This process is easy to state, but very hard to achieve in an informed way. Biggs'

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[2] Martin Oliver (in correspondence) has pointed out to us that Biggs does not advocate that the alignment process must always start with the intended learning outcomes, although the logic of curriculum design would clearly imply that should be the first step. Helen Beetham (in correspondence) has made the point that alignment can be achieved without the learning outcomes actually being valuable for the learner. However, adding the term 'constructive' to 'alignment' conveys the idea that the pedagogical approach being pursued would follow constructivist assumptions about the learner building a genuine framework of understanding.

book is largely about how the task of making the design decisions can be made more straightforward by adopting the assumptions of a constructivist pedagogical approach, where the focus is always on what the learner is actually *doing*: placing the learning and teaching activities (TLAs) at the heart of the process. Thus, Biggs uses the term 'constructive alignment' to indicate that in his view the guiding assumptions about learning should be based on constructivist theory. The relevant point is that the alignment process cannot proceed without first examining the underlying assumptions about learning, and then adopting teaching methods that align with those assumptions.

The overall aim of this report is to encourage practitioners and managers to make design decisions about e-learning in a principled way, which means uncovering the implicit assumptions about the role of technology, and then asking the right questions. We thus try to place e-learning models within the design framework described above. But the crucial step is the one Biggs made when he adopted a constructivist approach to ground the design decisions: there must be guidance on how to judge whether the learning and teaching processes adopted will really achieve the intended learning outcomes. For good pedagogical design, there is simply no escaping the need to adopt a theory of learning.

Much of this report, therefore, maps *learning theory* onto *pedagogical approaches.* Such a mapping is the logical and necessary precursor to any attempt to examine an e-learning implementation and position it in a pedagogical design framework. Like any pedagogy, e-learning is based on assumptions about achieving learning outcomes. In order to make principled judgements when surveying the range of e-learning models, it is important that these assumptions are clarified. The major advantage of adopting such an approach is that it discusses theory within a practical framework well understood by teachers in HE and FE.

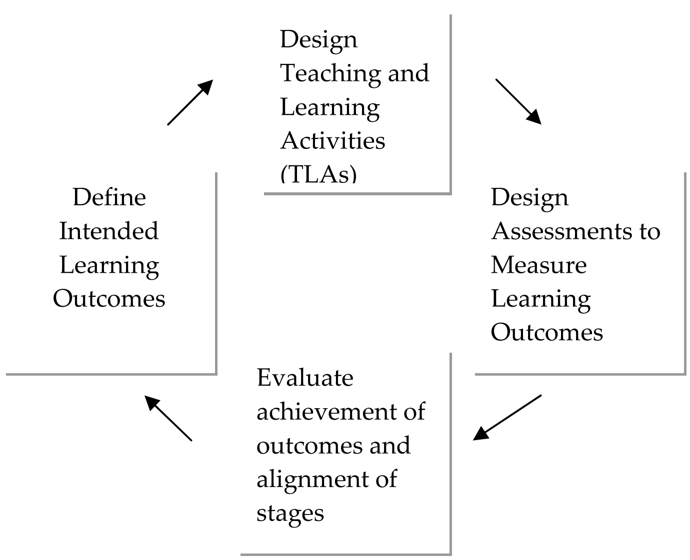

Figure 1: Diagram of the curriculum design cycle

4 THE PSYCHOLOGICAL THEORY UNDERPINNING EDUCATIONAL DESIGN

There are distinct traditions in educational theory that derive from different perspectives about the nature of learning itself.

At a theoretical level it is probably true to say that never before has there been such agreement about the psychological fundamentals (Jonassen & Land, 2000)[3]. Here, we follow the approach of Greeno, Collins & Resnick (1996) in identifying three clusters or broad perspectives, which make fundamentally different assumptions about what is crucial for understanding learning. These are:

The *associationist/empiricist* perspective (**learning as activity**)
The *cognitive* perspective (**learning as achieving understanding**)
The *situative* perspective (**learning as social practice**)

We consider how each of these has contributed differently to the design cycle of specifying learning outcomes, designing learning environments and teaching methods, and deriving appropriate assessment.

4.1 THE ASSOCIATIONIST/EMPIRICIST PERSPECTIVE

In this approach, knowledge is an organised accumulation of associations and skill-components. Learning is the process of connecting the elementary mental or behavioural units, through sequences of activity. This view encompasses the research traditions of associationism, behaviourism and connectionism (neural networks). Associationist theory requires subject matter to be analysed as specific associations, expressed as behavioural objectives. This kind of analysis was developed by Gagnė (1985) into an elaborate system of instructional task analysis of discriminations, classifications and response sequences. Learning tasks are arranged in sequences based on their relative complexity according to a task analysis, with simpler components as pre-requisites for more complex tasks.

The neural network approach views knowledge states as represented by patterns of activation in a network of elementary units. This approach has not yet been applied widely to educational issues, but is potentially significant. It suggests an analysis of

[3] Jonassen and Land, 2000, illustrate this convergence by contrasting conference programmes in 1989, where there were a large range of theoretical orientations, with those in 1999, where the constructivist/situated learning assumptions were dominant.

knowledge in terms of attunement to regularities in the patterns of activities, rather than in terms of components, as traditional task analysis requires.

In this perspective learning is the formation, strengthening and adjustment of associations, particularly through the reinforcement of particular connections through feedback. One implication is the individualising of instruction, where each student responds actively to questions or problems and receives immediate feedback on their response. This has underpinned the development of programmed instruction and computer programmes that teach routine skills. The shaping of responses through selective reinforcement relates to instruction-by-approximation (in classroom contexts skilled teachers provide encouragement as students achieve better approximation to the required patterns of performance).

Analysis of complex tasks into Gagnė's learning hierarchies – the decomposition hypothesis – involves the assumption that smaller units need to be mastered as a prerequisite for more complex units. Thus sequences of instruction are designed for students to be able to succeed by learning in small and logically-ordered steps. This assumption – that knowledge and skill needs to be taught from the bottom up - has been the subject of long controversy (eg Resnick & Resnick, 1991), but is still prevalent in e-learning. However, it is worth underlining the point made by, for example, Wilson & Myers (2000), that although behaviourism is currently widely dismissed as a serious theoretical basis for education, and mistakenly often associated with a teacher-centred model of learning, this view is seriously wide of the mark. Behaviourism was centrally concerned to emphasise active learning-by-doing with immediate feedback on success, the careful analysis of learning outcomes, and above all with the alignment of learning objectives, instructional strategies and methods used to assess learning outcomes. Many of the methods with the label "constructivist" - constituting the currently accepted consensus on pedagogy amongst educational developers in HE – are indistinguishable from those derived from the associationist tradition.

4.2 THE COGNITIVE PERSPECTIVE

As part of a general shift in theoretical positioning in psychology starting in the 1960s, learning, as well as perception, thinking, language and reasoning became seen as the output of an individual's attention, memory and concept formation processes. This approach provided a basis for analyzing concepts and procedures of subject matter curricula in terms of information structures, and gave rise to new approaches to pedagogy.

Within this broad perspective, particular sub-areas of cognitive research can be highlighted as particularly influential, e.g.: schema theory, information processing theories of problem solving and reasoning, levels of processing in memory, general competencies for thinking, mental models, and metacognitive processes. The underlying theme for learning is to model the processes of interpreting and constructing meaning, and a particular emphasis was placed on the instantiation of models of knowledge acquisition in the form of computer programmes (e.g.: Newell, 1990). Knowledge acquisition was viewed as the outcome of an interaction between new experiences and the structures for understanding that have already been created. So building a framework for *understanding* becomes the learner's key cognitive challenge. This kind of thinking stood in sharp contrast to the model of learning as the strengthening of associations.

The cognitive account saw knowledge acquisition as proceeding from a declarative form to a procedural, compiled form. As performance becomes more expert-like and fluent so the component skills become automatised. Thus, conscious attention is no longer required to monitor the low-level aspects of performance and cognitive resources are available for more strategic levels of processing. Thus the computer tutors developed by Anderson and co-workers (Anderson et al, recent refs) are all based on this 'expertise' view of learning.

Increasingly, mainstream cognitive approaches to learning have emphasised the assumptions of *constructivism* that understanding is gained through an active process of creating hypotheses and building new forms of understanding through *activity*. In school-level educational research the influence of Piaget has been significant, in particular his assumption that conceptual development occurs through intellectual activity rather than by the absorption of information. Brown *et al* (1989) argued that we should consider concepts as tools, to be understood through use, rather than as self-contained entities to be delivered through instruction. This is the essence of the constructivist approach in which the learners' search for meaning through activity is central.

4.3 THE SITUATIVE PERSPECTIVE

The social perspective on learning has received a major boost from the reconceptualisation of all learning as 'situated'. A learner will always be subjected to influences from the social and cultural setting in which the learning occurs, which will also define at least partly the learning outcomes. This view of learning focuses on the way knowledge is distributed socially. When knowledge is seen as situated in the practices of communities then the outcomes of learning involve the abilities of individuals to participate in those practices successfully. The focus shifts right away from analyses of components of subtasks, and onto the patterns of successful practice. This can be seen as a necessary correction to theories of learning in which both the behavioural and cognitive levels of analysis had become disconnected from the social. Underlying both the situated learning and constructivist perspectives is the assumption that learning must be personally meaningful, and that this has very little to do with the informational characteristics of a learning environment. Activity, motivation and learning are all related to a need for a positive sense of identity (or positive self-esteem), shaped by social forces.

As Barab & Duffy (1999) point out, there are at least two 'flavours' to situated learning. One can be regarded as a socio-psychological view of situativity. This emphasises the importance of context-dependent learning in informal settings. This activity-based view of situated learning led to the design of what Barab & Duffy call '*practice fields*'. These represent constructivist tasks in which every effort is made to make the learning activity authentic to the social context in which the skills or knowledge are normally embedded. Examples of approaches to the design of practice fields are problem-based learning (Savery & Duffy, 1996), anchored instruction (CTGV, 1993) and cognitive apprenticeship (Collins et al, 1989). Here, the main design emphasis is on the relationship between the nature of the learning task in educational or training environments, and its characteristics when situated in real use.

The second idea is that with the concept of a community of practice comes an emphasis on the individual's relationship with a *group of people* rather than the relationship of an activity itself to the wider practice, even though it is the practice itself that identifies the community. This provides a different perspective on what is 'situated'. Lave and Wenger (1991) characterised learning of practices as processes of participation in which beginners are initially relatively peripheral in the activities of a community and as they learn the practices their participation becomes more central. For an environment of apprenticeship to be a productive environment of learning there need to be opportunities for learners to observe and then practice activities which move them into more 'legitimate' participation in the community. Lave and Wenger emphasised how a learner's identity derives from becoming part of a community of practice. Yet some apprenticeship relationships can be unproductive for learning – the apprentice needs opportunities to participate legitimately, albeit on low risk activities. For Wenger (1998), therefore, it is not just the meaning to be attached to an activity that is derived from a community of practice: the individual's identity as a learner is shaped by the relationship to the community itself.

4.4 ARE THESE PERSPECTIVES JUST DIFFERENT LEVELS OF ANALYSIS?

It is possible to view these differing perspectives as analysing learning at different levels of aggregation. A behaviourist analysis analyses the overt activities, and the outcomes of these activities, for individual learners. A cognitive analysis attempts a level of analysis which describes the detailed structures and processes that underlie individual performance. The situative perspective aggregates at the level of groups of learners, describing activity systems in which individuals participate as members of communities. There will be few current examples of approaches which derive from taking just one level of analysis, and neglecting the others. Most implementations of e-learning in modern HE/FE will include blended elements that emphasise all three levels: learning as behaviour, learning as the construction of knowledge and meaning, and learning as social practice. In any particular curriculum design it is very unlikely that there would be one-to-one mapping between a single theoretical analysis and a set of TLAs that are designed to achieve particular learning outcomes.

5 PEDAGOGIC DESIGN: DEFINING LEARNING OUTCOMES

In order to set our analysis of e-learning in HE/FE in the context of curriculum design it is first necessary to consider the nature of the learning outcomes that are sought through educational innovation, including e-learning methods.

Bloom's (1956) taxonomy was originally developed to classify the complexity of questions asked in assessment, but has become used as a general system for classifying learning outcomes. The basic cognitive competences to be demonstrated are: *knowledge, comprehension, application, analysis, synthesis* and *evaluation* (see Bloom 1956 for the full schema). There are also competences for psychomotor and affective learning. Practitioners are often encouraged to use verbs from Bloom's taxonomy to define the desired outcomes of a course or learning session. This is often carried out as a post-hoc justification for teaching decisions that have already been taken and is quite inadequate as a basis for thinking through fundamental pedagogic issues.

5.1 LEARNING OUTCOMES IN HE AND FE

Goodyear (2002) has identified three kinds of learning in HE as *academic*, *generic competence* and Barnett's conception of *individual reflexivity*. To fully encompass FE it is perhaps necessary to extend these conceptions to *skills*-based outcomes.

5.1.1 Academic understanding

Higher Education requires students to acquire competence in academic discourse. Biggs (1999) has attempted to clarify the nature of understanding in academic contexts by expressing different levels of understanding as learning outcomes. Biggs' SOLO *(Structure of the Observed Learning Outcome)* taxonomy describes how a learners' performance grows in complexity when mastering academic tasks. As students learn, the outcomes of their learning display increasing structural complexity, both quantitatively (the detail in their responses increases) and qualitatively (the detail becomes integrated into a more complex pattern). In ascending order of complexity, they are: *pre-structural, uni- structural, multi-structural, relational* and *extended abstract*. Biggs adopts the view that real understanding is *performative* – the constructivist challenge is to describe what the students can *do* differently as a result of their developing understanding, which then specifies the assessment and allows us to measure the alignment of learning objectives and learning outcomes.

Laurillard's (1993) influential *conversational model* of learning, which deals directly with the place of e-learning in HE, assumes that academic (mainly declarative) knowledge is the primary learning outcome for HE. Increasingly, though, as Goodyear points out, this is seen as a too-restricted view of what mass HE should be about. However, Beetham[4] has argued that Laurillard's model also deals with 'academic-procedural' knowledge, which corresponds to ways of conceptualising the world.

5.1.2 Generic Competence (transformative potential)

There is a growing agenda in HE and FE for a new approach to learning outcomes giving greater emphasis to what are becoming called *employability assets*. These outcomes are all generic – not dependent on declarative knowledge – and include analytical and flexible learning capabilities, but also emphasise qualities that are much harder to specify as part of a curriculum: confidence, self-discipline, communication, ability to collaborate, reflexivity, questioning attitudes. These outcomes start to suggest a crucial role for the community of practice approach, and turn our attention to learning environments that provide maximum opportunity for communication and collaboration, such as networked learning environments.

5.1.3 Reflection

A strong theme in recent writing about HE has been the crucial role of reflection (eg Cowan, 1998). This is not only a necessary pedagogical method[5], but also a learning outcome: students must learn to be reflective learners. The model of learning that has most directly placed the role of reflection in a central position pedagogically is the experiential learning cycle of Kolb (1984).

5.1.4 Skill

Many learning outcomes in HE and FE will refer to mastering a skill. As Biggs has pointed out with his term 'functional knowledge', and Goodyear with 'working knowledge', most competences that are relevant for the world of work comprise both conceptual understanding and procedural knowledge.

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[4] Helen Beetham: comments on an earlier draft.

[5] Reflection has been emphasised in HE at least since Dewey wrote about it in the very first issue of the Science Education Journal, 1916.

5.2 MAPPING LEARNING THEORY TO LEARNING OUTCOMES

The associative perspective emphasises task analysis, defining sequences of component-to-composite skills. It provides a highly focused set of objectives, described as learning competencies.

The cognitive perspective emphasises conceptual development, stressing the importance of achieving understanding of the broad unifying principles of a domain. This view also encourages us to frame learning outcomes in meta-cognitive terms, with the educational aim of achieving learning how to learn, and encouraging the development of autonomous learners.

The situative perspective encourages the definition of learning objectives in terms of the development of disciplinary practices of discourse and representation. It also focuses on learning outcomes that are dependent upon the establishment of collaborative learning outcomes, and on learning relationships with peers. This perspective also encourages us to formulate learning outcomes in terms of authentic practices of formulating and solving realistic problems.

6 PEDAGOGICAL DESIGN: DESIGNING THE LEARNING ENVIRONMENTS

6.1 FROM THEORY TO DESIGN PRINCIPLES

This section considers the way in which we can map from the underlying assumptions about the nature of learning to the design of learning environments. This is the crucial stage in the design process: where the learning theory is unpacked into a detailed pedagogical approach.

We can summarise the design implications of our three theoretical strands as follows:

The associative view emphasises

- Routines of organised activity
- Clear goals and feedback
- Individualised pathways and routines – matched to the individual's prior performance

The cognitive view emphasises

- Interactive environments for construction of understanding

- TLAs that encourage experimentation and the discovery of broad principles
- Support for reflection

The *situative view* emphasises
- Environments of participation in social practices of enquiry and learning
- Support for development of identities as capable and confident learners
- Dialogue that facilitates the development of learning relationships

6.2 THE PEDAGOGY DERIVED FROM THE ASSOCIATIVE PERSPECTIVE: INSTRUCTIONAL SYSTEMS DESIGN (ISD)

Much of what is termed e-learning is still based in the training departments of organisations within a training philosophy that is traditional instructional design. The intellectual base for instructional systems design (ISD) consists of principles that are widely accepted within the organisational training culture. This base derives from the behaviourist perspective, but focuses particularly on task analysis.

Robert Gagnė (1985) set out the psychological principles on which ISD is based and essentially developed an instructional approach based on recursive decomposition of knowledge and skill. The basic principle is that competence in advanced and complex tasks is built step by step from simpler units of knowledge or skill, finally adding coordination to the whole structure. Gagnė argued that successful instruction depends on placing constraints on the amount of new structure that must be added at any one stage. So ISD consists of several steps:
- Analyse the domain into a hierarchy of small units.
- Sequence the units so that a combination of units is not taught until its component units are grasped individually.
- Design an instructional approach for each unit in the sequence.

Gagnė and others demonstrated that successively higher-level skills were more readily learned when their subordinate skills – lower in the hierarchy- were mastered first. However, a growing body of empirical evidence favoured a top-down superordinate learning model over Gagnė's bottom-up cumulative model and this led Gagnė to conclude that learning hierarchies only fully applied to a particular class of learning outcome – intellectual skills. Gagnė eventually wrote about additional classes of learning outcomes to which cumulative learning did not apply: motor skills, attitudes, and higher order thinking skills.

ISD consisted of guidelines and procedures for the decomposition of complex tasks into learning hierarchies and detailed prescriptions for the design of instructional programs based on such hierarchies. A theme in this work was the use of taxonomies representing different levels of complexity in learning outcomes. Different levels of intellectual skill were identified: discriminations, concepts, rules and higher order rules.

6.3 THE PEDAGOGY DERIVED FROM THE COGNITIVE PERSPECTIVE: CONSTRUCTIVIST LEARNING ENVIROMENTS AND ACTIVITY SYSTEMS

6.3.1 Constructivist Learning Environments

It is rather too simplistic to argue that constructivism has emerged directly from a cognitive perspective. In fact, in its emphasis on learning-by-doing, and the importance of feedback, it leans partly towards the behaviourist tradition. In its emphasis on authentic tasks it takes much of the situativity position. The emergence of *situated cognition* was itself partly dependent on the influence on mainstream cognitive theory of Lave's socio-anthropological work. Duffy and Cunningham (1996) distinguish between cognitive constructivism (deriving from the Piagetian tradition), and socio-cultural constructivism (deriving from the Vygotskian approach). We will consider the latter strand of constructivism in the following section, in the context of activity theory.

Piaget's constructivist theory of knowledge (1970) was based on the assumption that learners do not copy or absorb ideas from the external world, but must construct their concepts through active and personal experimentation and observation. This led Piaget to oppose the direct teaching of disciplinary content – although he was arguing against the behaviourist bottom-up variety, rather than the kind of meaningful learning advocated by Bruner (1960).

In the constructivist view, which emphasises general conceptual understanding and thinking ability, the reasons for disillusionment with didactic teaching are mainly empirical. There is very strong evidence that didactic teaching simply does not produce generic understanding. Constructivism can be seen to have developed not so much in the Piagetian sense as a reaction against the small-components-first approach of ISD, but rather as a reaction to the persistence in practice of a transmission-based didactic mode of teaching, for which there is no real theoretical base, but rather a strong folk tradition that compelling explanations will lead to better learning. There is a crucial point here for e-learning: the presentation of subject matter using multimedia is based on a discredited idea – that more vivid and naturalistic representations of knowledge would lead to better learning. This misconception was responsible for much of the disillusionment that resulted from computer-based learning in the 1980s and 90s (Mayes, 1995).

A challenge for the design of curricula in HE and FE continues an unresolved theme in pedagogy – the fundamental tension between what Newell (1980) called *weak* methods, a focus on generic skills, and *strong* methods, domain-specific. Many studies have shown that students' abilities to understand something new depends on what they already know.

Educators cannot build expertise by having learners memorise experts' knowledge. New knowledge must be built on the foundations of already existing frameworks, through problem-solving activity and feedback.

The constructivist view of learning can be summarised by the following assertions:

The learner actively constructs knowledge, through achieving understanding
Learning depends on what we already know, or what we can already do
Learning is self-regulated
Learning is goal-oriented
Learning is cumulative

Activities of constructing understanding have two main aspects:
- Interactions with material systems and concepts in the domain.
- Interactions in which learners discuss their developing understanding and competence.

The design principles for constructivist TLAs can be listed as follows:
- Ownership of the task
- Coaching and modelling of thinking skills
- Scaffolding
- Guided discovery
- Opportunity for reflection
- Ill-structured problems

In the research literature we see an increasing focus on the design of student-centred methods and environments: research on problem-based, project-based, enquiry-oriented pedagogies producing constructivist tasks and environments, placing emphasis on reflection and feedback. The following methods have been extensively researched:
- Problem-based learning
- Anchored instruction
- Cognitive apprenticeships
- Reciprocal teaching
- Goal-based scenarios
- Project-based learning

Adopting a true learner-centred approach would imply treating each student as an individual case. In a sense this has always been the ultimate goal of educational technology: the achievement of individualised instruction. Taking this to its logical conclusion would imply that TLAs should be designed to match the profile of the individual learner. Beetham[6] has suggested that adaptivity to individual needs should follow from the constructivist notion that learners make sense of the world in their own way. This is undoubtedly correct, but the idea might be thought to provide a rationale for the popular idea of learning styles. There are two reasons why we would be cautious about that line of reasoning. First, despite a long empirical quest to pin these down, the identification of learning styles remains elusive. Secondly, and more fundamentally, the idea that each learner displays enduring preferences and patterns of learning in all situations contradicts the notion that learning is context-bound.

The emphasis on task-based learning and reflection can be seen as a reaction to the rapid development of multimedia and hypermedia in the 1980s and early 90s, in which a tendency for technology-based practice to resurrect traditional *instructionist* approaches was evident. Here the main focus was on the delivery of materials in which information can be more effectively transmitted by teachers and understood by learners. Indeed, for a while in the early 90s, these trends were working in opposite directions: the research community was uniting around some key ideas of learning which emphasised the importance of the task-based and social context, while the policy makers were seizing on the potential of e-learning to generate efficiencies through powerful methods of delivering information.

There are recent signs that, while still not perfectly congruent, these are no longer in opposition. Since the development of the web both have converged on communication as a key enabling construct.

6.3.2 Activity Systems

An important strand of new thinking about pedagogy has emerged over the last decade through the influence of *activity theory*. Researchers are beginning to identify how activity theory can inform the design of learning environments (Jonassen, 2000). This strand can be seen as a version of the communities of practice framework, although to some extent it integrates aspects of both the constructivist and situative themes.

Activity theory focuses not on the individual learner, but with the *activity system,* a larger and more social unit of analysis. An activity system consists of a group, of any size, pursuing a specific goal in a purposeful way. A well-known example (Cole & Engestrom, 1993) is of doctors practicing preventive medicine in a health-maintenance organization. Students on a networked learning course collaborating on a project would represent an activity system. Even seemingly isolated activities are usually embedded in a larger system, as in Peal & Wilson's (2001) example of collaborating researchers who must negotiate differing approaches, and coordinate their actions with colleagues.

[6] Comments on an earlier draft.

These activity systems can be analysed into the elements devised by Engestrom (1993). The fundamental connection is between the individual *participant* and the activity system's *purpose*; this relationship is not direct, but is mediated by *tools*. Participants are usually part of communities, a relationship mediated by *rules* for acceptable interactions. Activity systems are in constant development, always changing through the actions of new participants, purposes, and tools. Tools make activity possible in the first place. Tools can be both physical (networks, books, software) and cognitive (concepts, language, memory). Tools both enable and constrain activity through their *affordances*. To illustrate the elements in terms of teaching, pedagogical frameworks are tools that afford educators a way of approaching instructional design, thereby shaping associated ways of thinking (and not thinking) about learning. An *activity*, then, is when tools are used for a purpose within the activity system. So employing a pedagogical design tool to create an e-learning course would constitute an action within the teaching and learning activity system. Actions can be further decomposed into automatic *operations*. In the case of teaching, for example, there are moves performed through pre-planned curriculum procedures (actions) and moves carried out in response to students (operations). However, these three levels (activity, action, operation) are constantly subject to change, as the activity system develops into a community of practice.

Activity theory can inform the key aspects of e-learning design: the learning outcomes, the TLAs, and the assessments.

6.3.3 Constructivist learning outcomes: the zone of proximal development

The groundwork for activity theory was laid by Vygotsky, the Soviet psychologist who developed the concept of the *zone of proximal development* (ZPD) in 1934; the term has become part of mainstream thinking in pedagogy since the translation of his *Mind and Society* in 1978. Vygotsky defined the ZPD as the distance between a learner's current conceptual development (as measured by independent problem solving) and that learner's potential capability, as measured by what can be accomplished *"under..guidance or in collaboration with more capable peers"* (Vygotsky, 1978). With personal support, and with practice, novices *"gradually increase their relative responsibility until they can manage on their own"* (Cole, 1985). Skills, rules, and knowledge, are internalized, creating the cognitive tools used in self-directed learning.

Vygotsky's concept influenced Lave & Wenger (1991) whose socio-anthropological account of learning communities can be thought of as a situative description of the ZPD.

The constructivist theme is reflected in the way in which the ZPD idea has directly influenced the design of learning environments. Peal and Wilson (2001) summarise the design of web-based learning environments as ZPDs by employing the following features:

1. Learning activities that are part of real or simulated activity systems, with close attention to the tools and interactions characteristic of actual situations.
2. Structured interaction among participants.
3. Guidance by an expert.
4. The locus of control passes to the increasingly competent learners.

6.3.4 Constructivist LTAs: scaffolding

The concept of *scaffolding* describes the process of exploiting the *ZPD*. The learning and teaching activities will be designed to provide scaffolding –with the tutor having the main responsibility for providing the guidance, but the wider learning group itself also playing a role. To be effective scaffolders, tutors must be sufficiently expert in their domain to judge individual learning needs, and sufficiently skilled as teachers to adjust dynamically, continuously to switch between the novice's and expert's perspectives. In the ZPD learning is distributed: thought and intelligence being "stretched across" the larger structures of activity (Pea, 1993; Lave & Wenger, 1991; Salomon & Perkins, 1998).

Learning and teaching can be viewed at each level of an activity system--activity, action, or operation. The lower the level, the weaker the connection to a specific activity system and the more transferable the skill, since activities are unique to particular systems while operations can be generalised. E-learning itself can be seen as both a tool and as a simulated activity system within which participants are introduced to and learn to perform the actions and operations. Purposive, coordinated learning can be organized and led by a tutor, automated by a computer-based tutorial, or created by the learners themselves, depending on the design of the TLAs.

Tutors will themselves need guidance in the art of scaffolding as they learn to use and monitor e-mail, discussion fora, and synchronous communication tools, to engage students supportively. An effective e-learning environment will also include a variety of performance supports and other resources to help learners pick up community practices.

6.4 THE PEDAGOGY DERIVED FROM THE SITUATIVE PERSPECTIVE: COMMUNITIES OF PRACTICE

There are perhaps three levels at which it is useful to think of learning being situated. At the top level is the social-anthropological or cultural perspective, represented by the work of Lave and Wenger, which emphasises the need to learn to achieve a desired form of participation in a wider community. The essence of a community of practice is that, through joint engagement in some activity, an aggregation of people come to develop and share *practices*. This is usually interpreted as a stable and relatively enduring group, scientists for example, whose practices involve the development of a constellation of beliefs, attitudes, values and specific knowledge built up over many years. Yet a community of practice can be built around a common endeavour which has a much shorter timespan. Greeno et al (2000) give examples of communities of practice which more closely resemble the groups studied in the social identity literature (eg Ellemers et al, 1999). Some examples are a garage band, an engineering team, a day care cooperative, a research group or a kindergarten class. These are exactly the kind of groups described as activity systems. One characteristic of these groups is that they allow a greater scope for interplay between the psychological (or personal) and the social in determining practice than do the long-established communities. The influence of individuals, and of individual relationships, is likely to be greater.

For long-term stable communities there are two different ways in which the community will influence learning. First, there is the sense most directly addressed by Wenger – someone aspires to become a legitimate participant of a community defined by expertise or competence in some field of application. The learning in this case is the *learning of the practice that defines the community*. This is the learning involved in becoming an accredited member of a community by reaching a demonstrated level of expertise, and then the learning involved in continuous professional development. This may be formal, as in medicine, or informal, by being accepted as a wine buff or a political activist. The second sense is that of a community of learners, for whom the practice is *learning per se*. That is, a very broad community identified by a shared high value placed on the process of continuous intellectual development.

At the second level of situatedness is the *learning group*. Almost all learning is itself embedded in a social context – the classroom, or the tutorial group, or the virtual CMC-mediated discussion group or even the year group. The learner will usually have a strong sense of identifying with such groups, and a strong need to participate as a full member. Such groups can have the characteristics of a community of practice but here the practice is the learning itself, in a particular educational or training setting. Or rather it is *educational* practice, which may or may not be centred on learning. While there have been many studies of learning in informal settings (eg Resnick, 1987), there are comparatively few ethnographic studies of real groups in educational settings to compare with the many studies of group dynamics in work organisations (see Greeno et al, 2000)[7]. Yet every student and every teacher knows that there are characteristics of these groups or communities which are powerful determinants of the nature of the learning that actually occurs in educational institutions. Successful students are those who learn how to pass assessments, not necessarily those who have the deepest interest in the subject matter.

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[7] Martin Oliver (in correspondence) has pointed here to the sociological literature on the 'hidden curriculum'. (For an interesting account of how this idea impacts on internet learning environments, see Weiss J. & Nolan, J. (2000) 'Internet Literate: the hidden and null curricula of the internet'. Available at www.utoronto.ca/baitworm/).

There are, of course, many aspects of student behaviour which are determined by social goals which have little or nothing to do with the curriculum, but much to do with peer esteem.

The third level is the level of *individual relationships*. Most learning that is motivated by the above two levels will actually be mediated through relationships with individual members of the communities or groups in question. The social categorisation of these individuals will vary according to the context and nature of particular dialogues. Sometimes their membership of a group will be most salient, in other situations their personal characteristics will be perceived as more important. Such relationships will vary according to the characteristics of the groups involved, the context within which they operate, and the strength of the relationships (Fowler & Mayes, 2000)

6.4.1 Networked learning in communities of practice

Goodyear (2002) gives an account of networked learning as knowledge-sharing for continuous professional development. He describes a cycle of learning, moving through phases of externalisation (of tacit knowledge), sharing, discussion, refinement and then internalisation.

The design of online learning tasks is central here. *"Neglect of task design tends to have two consequences –either students flounder around unproductively and unhappily, not knowing what is expected of them, or tutors find themselves spending much more time than they can afford trying to animate online discussions"* (Goodyear, 2002).

Paulsen's (1995) taxonomy of online learning tasks:

Techniques	Example methods
One-alone	Online databases; online journals; online applications; interest groups; software libraries.
One-to-one	Learning contracts; apprenticeships; interviews, collaborative assignments, role plays
One-to-many	Symposiums; lectures. role plays, interviews
Many-to many	Discussion groups, debates, games, simulations, case studies, brainstorming, Delphi, project groups

Table 1: Paulsen's taxonomy of online learning tasks

Goodyear points out how little is yet understood about how to design online learning 'spaces and places' and how primitive is our understanding yet of how the affordances of all the web-based learning resources should shape the design characteristics of MLEs and VLEs. He points approvingly to the work of Kollock (1997) who derived design principles for the creation of online communities from an analysis of social dilemmas and research on communities that are successful in managing collective resources. These provide guidelines for the creation of organisational forms and protocols that will encourage the formation and sustaining of a learning community.

7 PEDAGOGIC DESIGN: ASSESSMENT

A full account of the pedagogy of assessment, and the implications for e-learning, might be considered as the subject of a separate report. There is clearly a strong relationship between perspectives on learning, the way in which learning outcomes are described, and both curriculum designers' and practitioners' thinking about how to assess.

Here we make simply make the point that the three pedagogical perspectives emphasise different aspects about what should be measured, and how.

The ISD approach emphasises
Assessment of knowledge or skill components

The constructivist view emphasises
Assessment of broad conceptual understanding
Assessments of extended performance
Crediting varieties of excellence

The communities of practice view emphasises
Assessing participation
Authenticity of practice
Peer assessment

8 PRAGMATIC ISSUES IN PEDAGOGIC DESIGN

Many of the decisions that are taken in the curriculum design process depend on pragmatic issues that will not be addressed directly in this document. It is worth acknowledging, however, that a principled approach to pedagogic design is necessary but not sufficient. The following are some of the other issues that bear directly on curriculum design:

Eight key issues for an e-learning implementation

Efficiency v effectiveness
Costs
Quality assurance
Tutor/student ratio
Staff development
Student support (face-to-face?)
Technical support
Management support

9 EXISTING E-LEARNING APPROACHES AND THEIR PEDAGOGICAL ORIGINS

We are now in a position to review the landscape of e-learning models against the pedagogical background described above. The 'modal pedagogy model' would describe how to engage the learners in meaningful tasks, give rapid feedback, encourage reflection through dialogue with tutors and peers, align assessment, and would encourage through discussion the creation of a community of learners. A modal *e-learning* model would describe how technology would achieve each of these functional stages.

This section will consider a range of e-learning approaches in relation to the three pedagogical perspectives: instructional systems design, constructivist and communities of practice. The e-learning list is by no means exhaustive and provides a starting point for deeper reflection of how pedagogy can be mapped to teaching and learning practice when using technology-enhanced tools and systems.

Few current e-learning examples are pure derivatives of the three pedagogical frameworks described above. Most exhibit features from more than one perspective. It is also unclear exactly what counts as an e-learning model. The candidates range from very broad teaching frameworks, within which e-learning is assigned functional roles, to technically-oriented accounts which focus primarily on tools. However, it is possible to consider e-learning models in broad classes, and to map these onto our pedagogical strands.

Although we have described the development of pedagogical thinking in three broad strands, when mapping onto e-learning models we have found it helpful to classify the cognitive/constructivist into a further subdivision. This distinction is between those approaches which focus on the individual dialogue between a teacher and a learner, and those that support group learning: distinguishing a focus on individual cognition from a socio-constructivist emphasis on the group.

Thus, for any particular e-learning approach we ask four broad questions:

1. Is the model characterised by an analysis of the learning outcomes into subject-matter units?
2. Is the model characterised by active ownership of the learning and teaching activities by the learners, producing task outcomes for feedback from tutors or peers?
3. Is the model characterised by active discussion across groups of learners?
4. Is the model characterised by a focus on the development of real-world practice?

If it is possible to judge that an approach is primarily focused on the first, then it would map onto the associationist/ISD strand. If the second is more characteristic then the individual cognitive/constructivist pedagogy is dominant, while the third indicates a major influence from the *socio-cognitive* tradition. Finally the fourth maps onto the communities of practice approach. Of course, these are very high-level categories and there will be several e-learning models that will be characterised by each of them. Nevertheless, the following four clusters of e-learning models can be regarded as evolving through the three lines of pedagogical thinking:

1. *Subject matter focus (Associationist/ISD):*

E-training, CBT, learning objects, some intelligent tutoring models.

2. *Focus on individual-tasks, formative assessment and dialogue (Cognitive/constructivist):*

Dialogue models, Laurillard's conversational model, most intelligent tutoring systems, IMS Learning Design.

3. *Focus on group tasks and discussion (Socially-mediated constructivist)*

CSILE, Salmon's e-tivities, DialogPlus

4. *Focus on building communities of practice*

The CSALT networked learning model

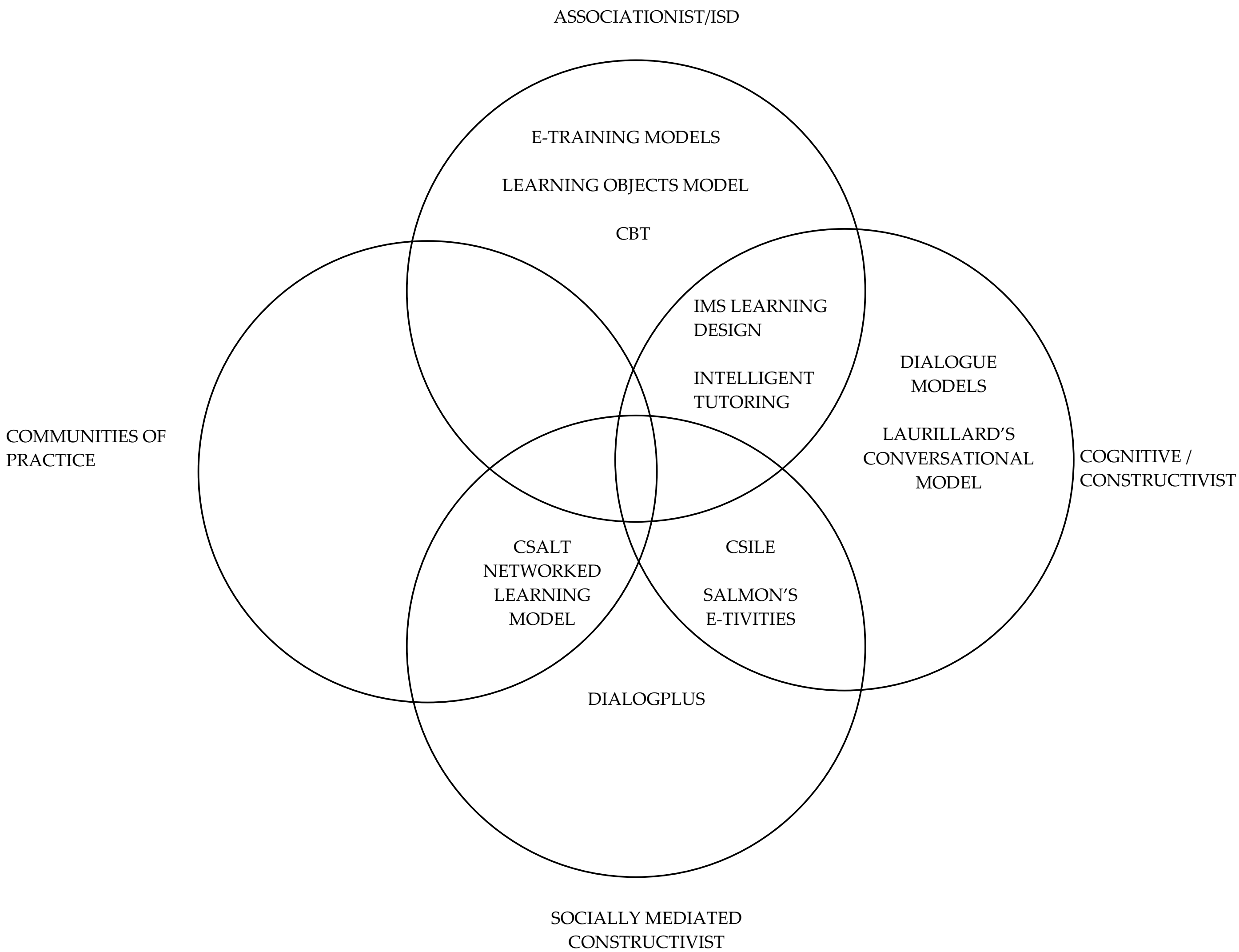

Figure 2: E-learning models within the wider learning theoretical perspectives

10. CONCLUSIONS

The main goal of this report was to describe the assumptions about learning that underpin current practice models of e-learning. Thus, we have offered a mapping of theoretical accounts of learning onto pedagogical frameworks for design. We have attempted to show how these design principles have been derived from the three broad theoretical perspectives: associationist, cognitive and situative. We have also attempted to frame this account within the familiar curriculum design model, with its stages of describing intended learning outcomes, designing TLAs to achieve them, assessments to measure how well they have been achieved, and an evaluation of whether the stages are properly aligned.

To apply this framework comprehensively to current e-learning models would require two steps:

a) To examine each against this explanatory background and position each in a pedagogical space represented by Figure 2.
b) To investigate how each model *in practice* encourages a systematic alignment of the design cycle.

Considering point a), Figure 2 represents the authors' best judgements about the positioning of each model in the pedagogical space. We would benefit greatly from a more developed methodology for achieving this positioning. Currently it is simply a representation that invites reflection and argument yet we can begin to see how influential such an analysis could become if the classification of each model was more formally derived.

On point b) the design cycle offers one systematic method for classifying case studies. However, further analytical work is needed to identify the pedagogical underpinning of assessment. Our current understanding of the design cycle is unbalanced: we have much stronger links between the principles of pedagogical design and the nature of TLAs than we do for the design of assessment techniques.

Figure 2 appears to lead us to a rather interesting conclusion. We are unable to identify e-learning models which fully emphasise a pedagogy based on the building of communities of practice. The authors would indeed argue for this conclusion: we see remarkable examples of peer-to-peer technologies emerging in other contexts, yet few signs that e-learning designers can yet see how exploit them in educational contexts. Nor are we yet able to see convincing examples of the exploitation of vicarious learning as a paradigm for situative pedagogy. Nevertheless, this conclusion is currently entirely open to argument and individual interpretation. A more evidence-based method for deriving the positioning would allow us to move from a framework to a genuine taxonomy.

APPENDIX

APPENDIX

Summary Descriptions of E-learning Models

A. E-training models

A whole class of e-learning applications has evolved from the ISD perspective, based on training needs analysis. The defining characteristics of the CBT tradition are:

- to identify clear learning outcomes in terms of the subject matter or skill to be mastered.
- the instructional method involves achieving the learning outcomes in a hierarchical 'bottom-up' analysis of the domain or skill.
- the role for technology will usually involve a simulation of a process and the automatic presentation of problems or routines that have been carefully graded in difficulty
- assessment may be automated: both for progress through the stages of the required mastery, and for summative performance measures.
-

B. Intelligent tutoring systems (ITS)

An ITS is essentially instructivist – identifying the learner's misconceptions or missing conceptions, based on a detailed subject matter model and an analysis of building mastery bottom-up. There may be some influence of contructivist thinking in the problem-solving tasks and the model of tutoring that underpins the particular example, but no influence from CoP assumptions.

An example ITS:

<u>LISP TUTOR</u> (Anderson & Reiser 1985)

LISP TUTOR (Anderson and Reiser 1985) is an ITS developed to teach the basic principles of programming in LISP. In the LISP TUTOR the expert model was created as a series of correct production rules for creating LISP programs and a learner model was built as a subset of these correct production rules along with common incorrect production rules.

LISP TUTOR is an application of Andersons ACT* theory (Anderson 1983). ACT* theory is one of the earliest attempts to establish a complete theory of human cognition. It combines declarative knowledge in the form of semantic nets with procedural knowledge in the form of production rules. In ACT* learning is accomplished by forming new procedures through the combination of existing production rules.

The main principles of the ACT theory are :

- Cognitive functions can be represented as a set of production rules. The use of a production depends on the state of the system and the current goals.

- Knowledge is learned declaratively through instructions. The learner must carry out the process of knowledge compilation if the productions are to be properly understood and integrated into their existing knowledge and later recalled and used.

Anderson and his team used GRAPES (Goal Restricted Production System Architecture) to represent the knowledge in LISP TUTOR as approximately 325 production rules. The system also embodies around 425 buggy production rules which represent misconceptions which any novice programmer can easily have.

LISP TUTOR employs model tracing to provide a learner with detailed feedback. The learner is given a problem and the tutor monitors the learners input character by character. The tutor generates all the possible next characters using both correct and buggy production rules.

- If the character is predicted by the correct rule the learner is allowed to continue.

- If the character is predicted by a buggy production rule remedial instructions is given.

- If the character is not predicted the tutor says that it cannot understand and asks the learner to try again. After several tries the tutor explains the next step.

This method has the advantages of early diagnosis of learner misconceptions and of giving immediate feedback to the learner. The learner never strays far from a correct solution. However, this can be viewed as unnecessarily restrictive and counter productive as the student is never allowed to explore incorrect behaviour.

C. Britain and Liber's Framework

This framework was developed by Sandy Britain and Oleg Liber in 1999 and was revised in 2004 (Britain and Liber 1999, 2004). Their framework is based upon the Laurillard conversational model (see below) and the Beer viable systems model (Beer 1979). It also borrows from the associationist systematic approach to training which frames the design and diagnosis of effective management of organisational structures within their framework.

The Britain and Liber framework was primarily developed in order to facilitate the take-up and use of virtual learning environments (VLEs) across further education. However the framework has found most favour amongst the higher education sector where primarily managers have used it as a planning tool for managing complexity at different levels within the learning organisation - particularly for the procurement and implementation of high-level systems.

Adapted from Beer's viable system model with its management function systems one through five, the Britain-Liber framework focuses upon five criteria: resource negotiation, adaptation, self-organisation, monitoring and individualisation. Through a consideration of these criteria an analysis of the functionality of the systems used in the organisation can be provided from three perspectives: the 'management of the teaching and learning on a module or course; student management of their own learning and management of modules within an overall programme at the institutional level' (Britain and Liber 2004, p. 69). The repetition of the same patterns and relationships on different levels is known as 'recursion' and enables the same function to be mapped and compared across the different levels according to criteria such as consistency. The model allows for complex networks including networks of people within an organisation to be mapped in this way.

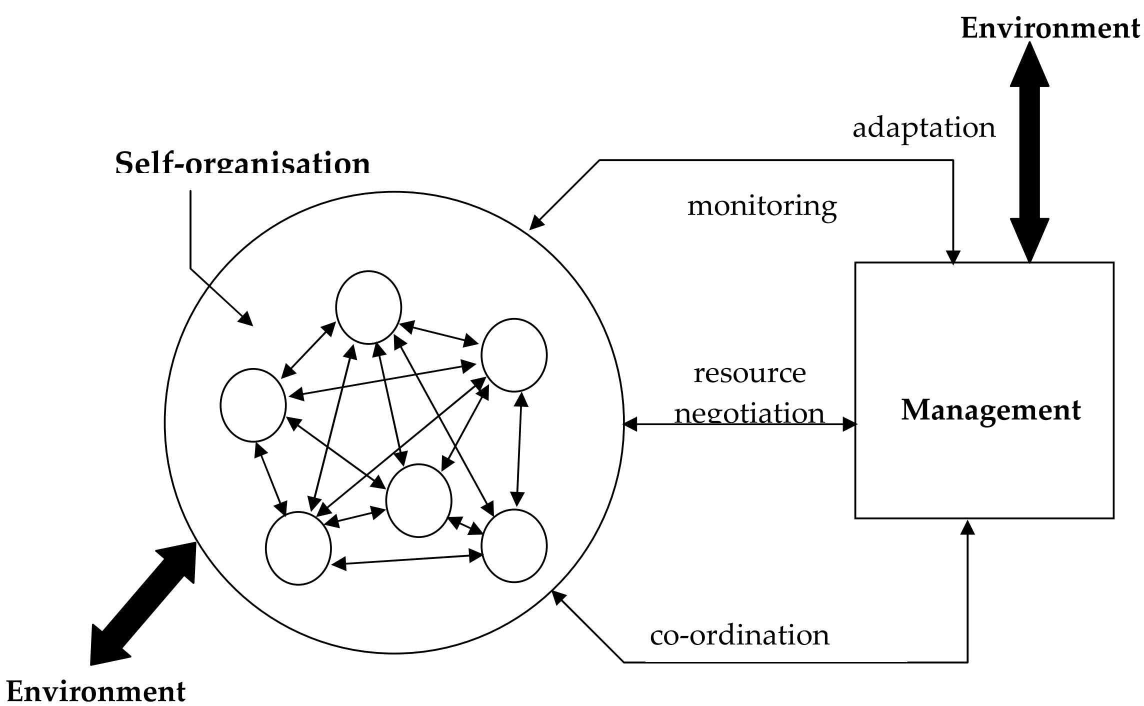

Figure 3: Britain & Liber simplified adaptation of Beer's viable systems model

Applying the Beer cybernetic model to education, to course or programme, module and individual levels allows for control over the level of granularity and allows for a better understanding of the *variety* and changing foci in the system.

Managing the variety that e-learning systems such as VLEs present is considered at the course/programme, module and individual level according to Beer's slightly simplified model (see: figure 3):

- Resource bargaining - where teachers make an agreement with students about what they need to provide for each other
- Coordination - where oscillation is restricted due to its destabilising effect upon a system
- Monitoring – where the health of the system particularly with regard to variety is monitored
- Self-organisation – where self-organisation of a system where individuals manage their own variety
- Adaptation – where the system is part of environmental changes and opportunities

When applying Laurillard's conversation model to VLEs Britain and Liber highlight the importance of activities and dialogue highlighting the need for discursive tools, adaptability, interactivity and reflection.

While the model has a potential usage for teaching and learning, it is notable that the framework has not been used in this way. A factor that is interestingly emphasised in the revised report (2004):

> …one major reason why the predominant use of VLEs is for basic course management tasks… and consequently why there has been little pedagogical innovation using these tools to date is that the first generation VLEs do not obviously support more radical or diverse learning activities (Britain and Liber 2004, p. 5).

Furthermore, as the authors' argue, it would seem as though one problem here could be that tutorial tasks and learner activities are designed separately and are not integrated - perhaps a consequence of the approach taken in designing the tool.

D. The Learning Objects model of learning

This model of learning is based upon the notion of the 'learning object' as 'any digital resource that can be reused for to support learning' (Wiley 2000). However learning objects have come to mean many things to many people (Polsani 2003). Essentially the model has emerged from the potential of reusing learning materials and has been adopted as part of the development of standards for learning technology. Consequently the model is rather more instructional and technological, to the extent that learning objects (LOs) have been described as 'an instructional technology' rather than a model or approach to learning *per se* (Wiley 2000). Furthermore the model is dependent upon the learning specifications and standards developed by the Learning Technology Standards Committee of the Institute of Electrical and Electronics Engineers set up in 1996. They define LOs as 'any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning' (IEEE LTSC definition cited in IMS Global Learning Consortium 2002, p. 7).

The use of the term object rather than materials or resources is problematic though borrowing from the computer science paradigm of object-orientation it does not sit well with the constructivist and often epistemological approaches of educationalists. However the fundamental idea behind object-orientation relates to small-sized pieces of learning materials that can be reused in a range of different contexts and a number of different times. This control over sequences of learning materials is fundamental to the learning design approach, and fits well with instructivist approaches where learning may become more elaborate through practice and time.

Another posited strength of the use of learning objects, is the broadened access that can be offered, as the object can be delivered digitally and over networks increasing the numbers and the limitless locations where objects can be reached. Extra functionality can be gained from recording the sequences of object use which may vary greatly according to context and place of use. Interoperability is another stated strength of the learning object model (LTSC 2000).

The reusability of the objects and the broadened access provide the most compelling uses of objects, however some weaknesses might include: changes to standards which might inhibit or restrict development, pedagogic neutrality of the objects, although this may not be a weakness but may allow tutors to develop their own pedagogic approaches to the material and the lack of contextual specificity, which in a context-specific learning environment may provide problems in terms of how the object is embedded. There is also an assumption that learning objects can be developed independently from tutors but can be generated by developers which would be problematic.

However the learning object debate has also foregrounded the differences between instructional design and constructivist approaches where the learner may be the producer of learning materials, this debate will it is envisaged continue to shape the debate that centres upon learning design and reusability of learning objects.

E. IMS Learning Design

Learning design according to Koper (2001) is modelling 'units of study' building upon this idea Koper developed educational modelling language (EML), at the Open University in the Netherlands. An educational modelling language, which describes a unit of study needs the following:

1. Formalisation
2. Pedagogical flexibility
3. Explicitly typed learning objects
4. Completeness
5. Reproducibility
6. Personalization
7. Medium neutrality
8. Interoperability and sustainability
9. Compatibility
10. Reusability
11. Life cycle

Koper also defined the key actors in the learning process as: learners, staff and developers of units of study. The containing framework for units of study that Koper describes in his work (2001) has been taken up and developed by the IMS Learning Design group (IMS Global Learning Consortium 2002), which aims to 'work towards establishing specifications for describing the elements and structure of any unit of learning' (IMS Global Learning Consortium 2002, p. 3). Units of learning here include: resources, instructions for learning activities, templates for structured interactions, conceptual models, learning goals, objectives and outcomes and assessment tools and strategies. IMS Learning Design is a notation system which specifies 'a time ordered series of *activities* to be performed by learners and teachers (*role*), within the context of an *environment* consisting of *learning objects* or *services*' (IMS Global Learning Consortium 2002, p. 50).

Learning Design in this way describes learning objects as units of study but Koper also developed a pedagogical meta-model which models pedagogic models and contains four packages:

1. the learning model, which describes how learners learn
2. the unit of study model, which describes how units of study are modelled
3. the domain model, which describes content and the organisation of that content
4. the theories of learning and instruction (see figure 4)

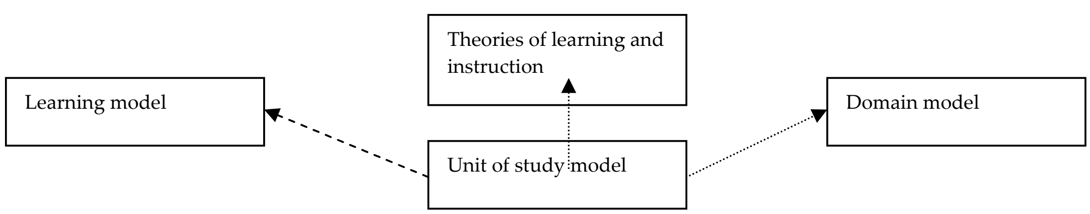

Figure 4: Packages in the pedagogical meta-model

This departs from the standard learning object model of e-learning design which centred rather upon the units of content and metadata rather than units of activity.

F. The DialogPlus project

The DialogPlus model places most emphasis on social processes, facilitated by the interactions of learners and tutors. The model has been developed by Grainne Conole and her group at the University of Southampton to underpin a learning activity toolkit which is being designed to help tutors in higher education to design learning activities more effectively. The design of the toolkit has been informed by learning objects, interoperability and metadata.

The approach and developed toolkit (Conole et al., 2004) developed by DialogPlus is adapted from work by Kari Kuutti (1995). Kuuti uses activity theory as a framework for research into human-computer interaction (HCI). Kuuti's approach, which borrows, from information systems (IS) research outlines three levels: a technical level, a conceptual level and a work process level (1996, p. 21). The model focuses upon seven elements of a learning scenario, four requisite elements, which include: learning outcomes, a set of attributes, tasks and roles; and three optional elements, which include: tools, resources and outputs. See figure 5.

The essence of a learning activity is that it must have one or more learning outcomes associated with it… In order to achieve the intended learning outcomes there are a 'sequence of tasks' which must be completed… Those involved in the learning activity are assigned different roles when undertaking these tasks. (Conole et al., 2004).

In addition the learning activity has a set of associated contextual attributes such as level or skills. The three optional elements include associated resources, tools and outputs. Conole et al have also developed a taxonomy of attributes which includes subject, level, environment, context, approach, skills, assessment, time and pre-requisites.

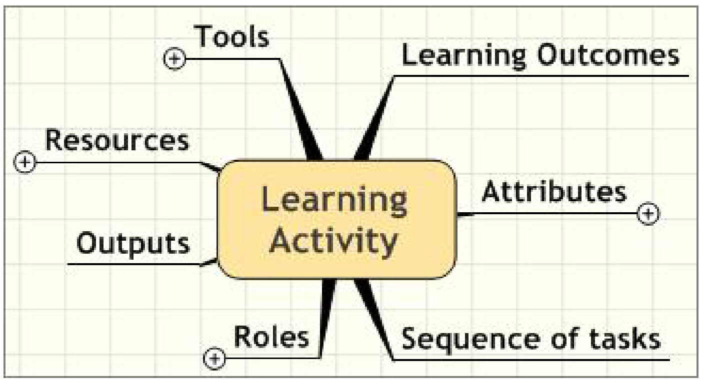

Figure 5: DialogPlus Toolkit

DialogPlus also adopts a dimensional approach to the definition of learning approaches, along the axes: reflection-non-reflection, experiential-informational, and individual-social. Of particular interest is the way that this classification of learning approaches has been developed into a toolkit for planning learning activities, organised around activity, context, actions and co-ordinating actions. The toolkit is in the process of being tested with practitioners and it is hoped will inform how learning activities will be designed in future higher learning contexts.

G. The JISC ReLoad project

The JISC funded Exchange for Learning (X4L) programme cluster supports the embedding and use of existing e-learning content, the programme has focused upon developing tools to support learning technology interoperability specifications such as IMS and SCORM. The projects focus both upon learning activity and intended learning outcomes and together include three tools-development projects and a pilot learning materials repository.

The Reload project has already produced a successful metadata and content-packaging editor tool (Britain 2004) and a learning design specification is in the process of being added to the tool. Research into the most appropriate user interface model will be needed however in order to facilitate learning design.

The cluster recently reviewed the state of learning design and concluded that learning should be modelled along the following five 'dimensions': teacher, learner, context, process and resources. The open source Reload editing tool will aim to include the main components of the IMS-LD specification, including learning objectives, activities, activity-structures, roles and resources. Through the extension of the editor it is envisaged that the creation and editing of learning designs in IMS-LD format will be possible facilitating support of a wide range of pedagogies in blended learning situations. Although Reload is a tool for learning design it is focused upon the same pedagogical principles as IMS Learning design and learning objects and is activity focused in its applications.

H. The European CANDLE project

The CANDLE consortium are a European IST funded group exploring collaborative and network distributed learning environments. Part of their deliverables has included a pedagogical framework that focuses upon the interactions that take place between tutors and learners. To provide practical guidelines for tutors the CANDLE consortium has devised a metadata framework – or wizard - which describes these sets of learning activities. The project is also concerned with learning objects

The CANDLE consortium has based their pedagogical framework upon activity theory (Leont'ev 1978) and rhetorical structure theory (Mann and Matthieson, 1989). Activity theory considers that:

> …the essential unity of systems, users and their goals, and contexts, including the community in which an activity occurs. The interrelationship between all the elements of an activity (described as the structure of an activity) are key to describing complex systems of behaviour such as pedagogy (CANDLE 2003, p. 3).
>
> Rhetorical structure theory is concerned with the choice of particular forms of expression to realise discursive goals… it is used to express the way in which pedagogical activity is both end-directed and structured by specific modes of interaction between teachers and learners (CANDLE 2003, p. 3).

Six dimensions are refined from these two theories:

- the purpose of an activity,
- the structure of an activity,
- the context of an activity,
- tools used in the activity,
- objects used in the activity and
- roles for the participants in the activity.

The CAT tool which has been based upon this approach is designed to support authoring of courseware into reusable learning objects providing semantic links. The tool supports different levels of granularity and metadata that depends upon pedagogical considerations.

I. The CSALT Networked Learning Model

The CSALT networked learning model (Goodyear 2001) developed by Peter Goodyear and his colleagues at Lancaster University is based firmly on both constructivist and CoP principles. The model is aimed particularly at tutors in higher education and includes a pedagogical framework as well as providing an overview of the broader issues surrounding networked learning.

The pedagogical framework defined here introduces four levels of pedagogy: philosophy, high-level pedagogy, strategy and tactics. The upper two levels are considered as declarative or conceptual and the lower two levels are regarded as procedural or operational. The model (see figure 6) suggests a distinction between the *tasks* designed by the tutor and the *activities* carried out by the learner. Interestingly, the networked learning model also integrates an element of the systems approach through a deeper analysis of the management by tutors of networked learning activities. The model is sensitive to organisational context and asserts its importance particularly in higher education settings.

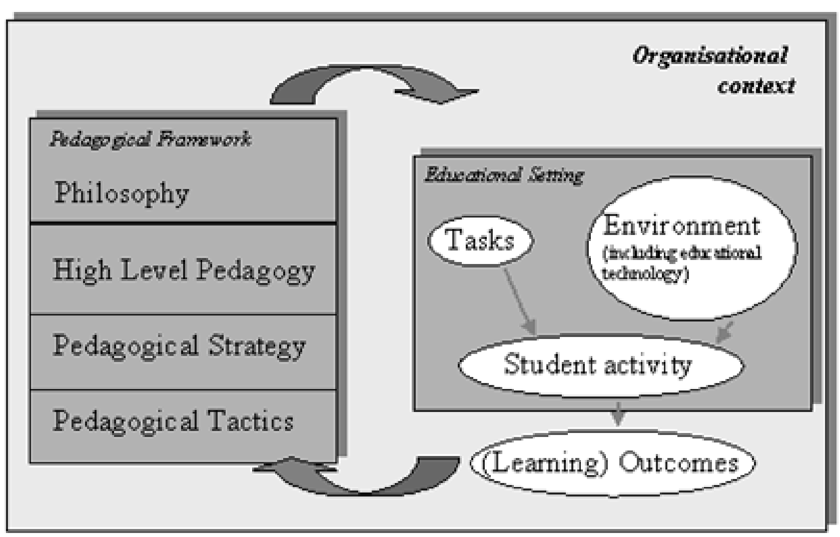

Figure 6: CSALT pedagogic framework diagram

This model provides a strong CoP perspective through the reification of knowledge about practice shared by the learners. The model is unusually strong in its focus on collaborative learning, taking the work of Dillenbourg (1999) as a basis for the analysis of online collaboration. Goodyear also emphasises the transformational and personal development aspects of networked learning. This model demonstrates how learning outcomes can be associated with specific supported learner groups and their activities need to be designed with these outcomes in mind.

J. The Laurillard Conversational Framework

Laurillard's conversational framework has been very influential in the development of UK e-learning, at least among educational developers in HE. Laurillard's analysis of academic learning as learning mediated through conversations between learners and teachers, rather than situated in direct experience, is the basis for describing five interdependent aspects of the academic learning process. These are:

- The need to understand the structure of the academic discourse – organise and structure the content, through some kind of narrative.
- Understand and practice the forms of representation.
- Learn to manipulate these (acting on descriptions).
- Use feedback actively.
- Learn to reflect on the goal-action-feedback cycle.

Laurillard adopts a phenomenographic perspective to link these learning requirements to a teaching strategy. She advocates *"a continuing iterative dialogue between teacher and student, which reveals the participants' conceptions, and the variations between them…. there is no escape from the need for dialogue…there is no room for mere telling, nor for practice without description, nor for experimentation without reflection, nor for student action without feedback"*.
Laurillard's prescription is constructivist, but places more emphasis on the *interaction* between teacher and individual student, and stresses the need for meaningful intrinsic feedback to be a central feature of e-learning. This sets out the requirements for academic learning, and Laurillard considers how far current learning technology can help to meet these by subjecting each 'media form' to an analysis in terms of the conversational framework. The following table summarises this analysis (Laurillard, 2002).

Learning experience	Methods/Technologies	Media forms
Attending, apprehending	Print, TV, video, DVD	Narrative
Investigating exploring	Library, CD, DVD, Web	Interactive
Discussing, debating	Seminar, online conference	Communicative
Experimenting, practising	Lab, field trip, simulation	Adaptive
Articulating, expressing	Essay, product, animation, model	Productive

Table 2: Mapping of learning experience onto method, technology and media form

The learning activities themselves are designed using the conversational framework, and a media prototype is specified using iterative design principles.

As Goodyear (2002) has noted, not enough emphasis in Laurillard's analysis seems to be given to the key challenges in mass HE, and by extension, to FE. That is, how far can the model of individual dialogue be sustained in a situation where the reality is a few words of feedback once or twice a year, and where the main educational challenge is to enhance generic skills? Here is a real challenge for e-learning: to offer a reasonable level of individual dialogue in a situation where there are too few tutors and too many learners. Can technology help to provide LTAs from which intended learning outcomes can be achieved, without an unattainable level of support from human tutors?

J. Mayes & Fowler's framework

This framework maps stages of learning onto categories of e-learning.
The learning cycle is described in three stages:
• Conceptualisation
- refers to the users' initial contact with *other peoples' concepts.* This involves an interaction between the learner's pre-existing framework of understanding and a new exposition.

• Construction
- refers to the process of building and combining concepts through their use in the performance of meaningful tasks. Traditionally these have been tasks like laboratory work, writing, preparing presentations etc. The results of such a process are products like essays, notes, handouts, laboratory reports and so on.

• Application
- the testing and tuning of conceptualisations through use in applied contexts. In education the goal is testing of understanding, often of abstract concepts. This stage is best characterised in education, then, as *dialogue*. The conceptualisations are tested and further developed during conversation with both tutors and fellow learners, and in the reflection on these.

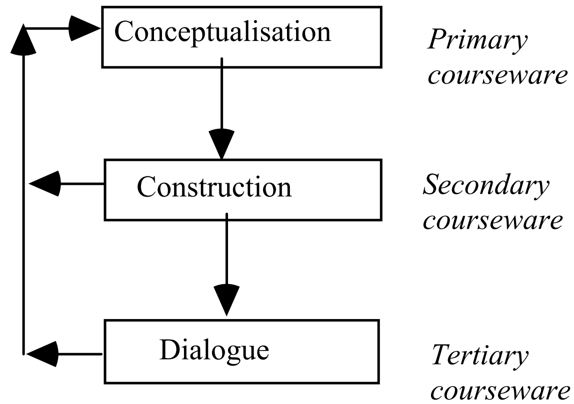

Figure 7: Mayes and Fowler framework mapping

Primary Courseware is courseware intended mainly to present subject matter. It would typically be authored by subject matter experts but is usually designed and programmed by courseware specialists. Increasingly, primary courseware will be seen as a publishing product, for wide distribution.
Secondary Courseware describes the environment and set of tools by which the learner performs learning tasks, and the tasks (and task materials) themselves. Here, the products are volatile and of varied quality.
Tertiary Courseware is material which has been produced by previous learners, in the course of discussing or assessing their learning tasks. It may consist of dialogues between learners and tutors, or peer discussions, or outputs from assessment. One kind of tertiary material will be compiled from the questions, answers and discussion that will typically be generated in networked learning. The potential for developing this kind of resource in HE/FE has generated a research programme on the concept of vicarious learning (refs).

K. Bereiter & Scardamalia (CSILE and Knowledge Forum)

Bereiter & Scardamalia's CSILE (Computer-supported intentional learning environments) (Bereiter, C., 2002; Bereiter and Scardamalia, 1989, 1993; Scardamalia et al, 1989; Scardamalia, 2002) pioneered the design of networked learning environments which focus on 'knowledge building' (the term originated with their work). CSILE was first prototyped in a university course in 1983. By 1986 a fully-functioning networked version was in daily use in an elementary school. CSILE was produced by Apple in 1993 as the "Collaborative Learning Product." In 1995 it was redesigned to exploit the possibilities of the web, and produced commercially as Knowledge Forum. http://www.knowledgeforum.com Current developments are exploring the potential of wireless technologies to allow the integration of online and offline knowledge building. Knowledge Forum is used in US education (grade 1 to graduate), health care, community, and business.

The core of CSILE/Knowledge Forum is a multimedia group knowledge space. Learners contribute theories, working models, plans, evidence, reference material etc to the shared space, in the form of notes. The software provides tools for scaffolding, both in the creation of notes and in the ways they are displayed, linked, and made objects of further work. Revisions, elaborations, and reorganizations over time provide a record of group advances and can be used for assessment.

L. Salmon's e-tivities approach

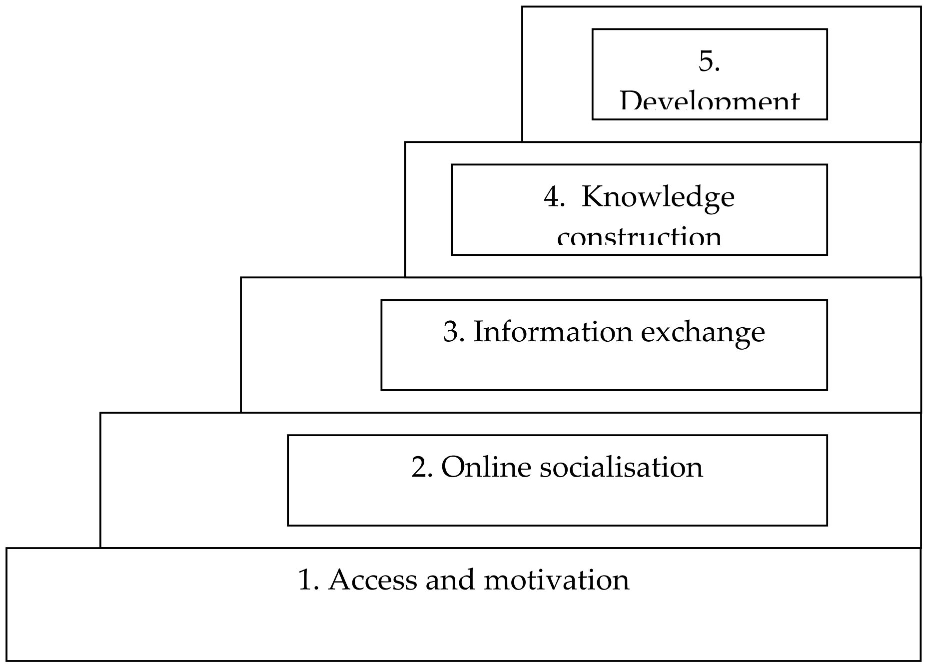

Figure 8: Salmon's e-tivities approach

Salmon's five-stage model of teaching and learning online describes the stages of progressing towards successful online learning both for participants (learners) and e-moderators. It describes how to motivate online participants, to build learning through online tasks (e-tivities), and to pace e-learners through stages of training and development. Stage 1 involves essential prerequisite individual access and the induction of participants into online learning. Stage 2 involves individuals establishing their online identities, and locating others with whom to interact. At stage 3 participants exchange information and start to support other participants' goals. Course-related discussions develop at stage 4 and the interactions become more collaborative. Finally, real reflection and personal development will occur in the achievement of goals at stage 5.

This model provides a framework for good practice in engaging learners in online discussion. In its stance on pedagogy it is a-theoretical, but it implies a commitment to constructivist tasks and the greatest possible degree of dialogue. It provides guidelines for e-moderating that take account of some of the realities of tutoring in UK HE/FE.

M. Collis & Moonen's flexible learning approach

Collis & Moonen (2001) have produced a comprehensive account of technology in the service of flexibility. Nineteen dimensions of learning flexibility are described. The model relates all aspects of flexibility to two simple pedagogical dimensions: *acquisition* and *contribution.* A flexibility-activity framework is then mapped onto types of technology, both core and complementary, current and future. The approach is unusual in its attempt to deal with all issues in terms of the '4 Es' of implementation:

- Environment: an institution's profile with respect to technology use.
- Educational effectiveness (both short and long-term payoff)
- Ease of use
- Engagement: individual self-confidence

This approach is also distinctive by dealing explicitly with costs.

N. The OU (IET) Extended Learning Objects approach

Mason, Pegler & Weller (2004) have described an approach to designing a course entirely in learning objects. The key design principle is the "integrity and internal contextualisation" of each object, where the object is a unit of study, representing a holistic learning experience. This extends the notion of a learning object well beyond the focus on a self-contained element of content, or even a discrete task. Here, an object is described in which the key issues about a topic are presented and the learner is offered a range of readings, followed by both individual and group learning activity, supported discussion and feedback from a tutor. The object therefore includes a discursive element, an interactive element, an experiential element and a reflective element. The object can represent from one to five plus hours of study. Thus a learning object can be regarded as a lesson, or perhaps as a mini-module. The glue connecting the objects is described as narrative learning objects, these are non-reusable, setting out the aims, highlights and recurring themes.

Mason et al also provide an account of another integrating principle: their learning objects approach to assessment. An e-portfolio is constructed by each student, as a kind of repository of their chosen learning objects, supported by an integrative commentary. Students choose eight from a pool of over 100 learning objects and submit only these activities for assessment. In the course described by Mason et al no two students submitted the same set of completed activities for assessment.

This approach to learning objects has been very successful in terms of reusability, with several new courses, and staff development applications, using the same objects with only minor changes to adjust the activities for a new audience. This is particularly interesting since one might have predicted that there is a trade-off between grain size of object and its reusability in new contexts. In fact this approach raises most of the key pedagogical issues about learning objects; their transferability, their student-centredness, their integrity for learning. It may be that the 'narrative learning' objects are the crucial added ingredient and if their design is too demanding on time and resources then most of the advantages of reusability will be lost.

O. Opencourseware@MIT

The Opencourseware initiative at the Massachusetts Institute for Technology in the US aims to put all its educational materials online by 2007. Hal Abelson directed the project and was supported by other MIT faculty as part of MITs general approach to e-learning and distance learning. The project which makes use of web-based access to learning and has led to 701 courses being offered online (by May 2004). These under- and post- graduate course materials include: course outlines, syllabi and activities, book lists and assessment exercises. Not only is this a valuable resource for students who cannot attend MIT, it is also a useful reference point for tutors developing courses.

The MIT model completely transforms the standard model where curricula details are normally held for the enrolled learners only and copyright held by the educational institution. The model offers an open access approach to learning materials inverting the traditional notion that educational materials should be paid for. While the model does provide the benefits of open access for all to education, there are extreme implications for what this might mean for education delivery in institutions around the world, leading many to question how they may deliver their own educational output. Notably one of the project goals The main problems encountered by the MIT group have included the issue of intellectual property rights and copyright legislation in particular managing issues over ownership of content, as well as the considerable work involved in converting face-to-face courses into an online format.

While there are no specific pedagogic models employed, the offerings include pedagogic approaches according to the individual course, therefore incorporating relevant subject specific pedagogic approaches and models.

REFERENCES:

Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. The Journal of the Learning Sciences, *4* ,167-207.

Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs. New Jersey: Prentice Hall.

Bandura, A. (1977). Social learning theory. Englewood Cliffs. New Jersey. Prentice Hall.

Bandura, A. (2001) Social cognitive theory: an agentic perspective. Annual Review of Psychology, 52, 1-26

Barab, S.A. & Duffy, T.M. (2000) From Practice Fields to Communities of Practice. In In D.H. Jonassen, & S.M.Land(eds), Theoretical Foundations of Learning Environments. NJ: Lawrence Erlbaum

Beer, S. (1979). Heart of enterprise. Chichester. John Wiley & sons.

Biggs, J. (1999). Teaching for Quality Learning at University. Buckingham. Society for research in Higher Education. Open University Press. See also http://www.dmu.ac.uk/~jamesa/learning/solo.htm. Last accessed 23rd March 2004.

Bloom, B. S. (ed.) (1956). Taxonomy of educational objectives: The classification of educational goals. New York. Longman.

Britain, S. (2004). 'A review of learning design. Concept, specifications and tools'. JISC report. See: , last accessed 20th June 2004.

Britain, S. and Liber, O. (2000). A Framework for Pedagogical Evaluation of Virtual Learning Environments. JISC Technology Applications Programme report 041.

Britain, S. and Liber, O. (2004). A Framework for Pedagogical Evaluation of Virtual Learning Environments (Revised). JISC report. See: http://www.jisc.ac.uk/uploaded_documents/VLEFull Report8.doc. Last accessed 23rd March 2004.

Brown, J.S., Collins, A., & Duguid, P. (1989) Situated cognition and the culture of learning. Educational Researcher, 18(1), 32-41.

Bruner, J. (1960). The process of education. Cambridge. Massachusetts. Harvard University Press.

CANDLE Consortium. (2003). 'Collaborative and network distributed learning environment'. See: http://www.candle.eu.org, last accessed 29th September 2003.

Cognition and Technology Group at Vanderbilt (1993) Anchored Instruction and Situated Cognition Revisited, Educational Technology, 33, 52-70.

Cole, M., & Engestrom, Y. (1993) A cultural-historical approach to distributed cognition. In G. Salomon (Ed.), Distributed cognitions: Psychological and educational considerations. New York: Cambridge University Press.

Collins, A., Brown, J.S. & Newman, S.E. (1989) Cognitive Apprenticeship: Teaching the crafts of reading, writing and mathematics. In R.B. Resnick (Ed.) Knowing, learning and instruction: Essays in honour of Robert Glaser, NJ: Lawrence Erlbaum

Collis, B. and Moonen, J. (2001). Flexible learning in a digital world. London. Kogan Page.

Collis. B., Peters, O. and Pals, N. (2000). 'A Model for Predicting the Educational Use of Information and Communication Technologies'. Instructional Science, vol. 29, pp. 95-125.

Cowan, J. (1998), On Becoming an Innovative University Teacher. Buckingham: SRHE and Open University Press.

Dillenbourg, P. (1999) What do you mean by "collaborative learning"? In P. Dillenbourg (Ed.) Collaborative learning: cognitive and computational approaches. Amsterdam: Pergamon.

Ellemers, N., Spears, R., & Doosje, B. (Eds.) (1999), Social identity: context, commitment, content. Malden, Mass.: Blackwell.

Fowler, C.J.H., & Mayes, J.T. Learning relationships: from theory to design. Association for Learning Technology Journal, 7, 3, 6-16 (1999)

Fowler, M. (2000). UML distilled. A brief guide to the standard object modelling language. Second Edition. Reading. Massachusetts. Harlow. Addison Wesley.

Gagne, R. (1985). The conditions of learning. New York. Holt, Rinehart and Winston.

Goodyear, P. (2001) Effective networked learning in higher education: notes and guidelines. See: http://www.csalt.lancs.ac.uk/jisc/guidelines_final.doc. Last accessed 23rd March 2004.

Goodyear, P. (2002), Psychological Foundations for Networked Learning, In C. Steeples & C. Jones (Eds), Networked Learning: Perspectives and Issues. London: Springer-Verlag.

Greeno, J.G., Collins, A.M. & Resnick, L. (1996) Cognition and Learning. In D.C. Berliner & R.C. Calfee (Eds) Handbook of Educational Psychology, NY: Simon & Schuster Macmillan.

Greeno, J.G., Eckert, P., Stucky, S.U., Sachs, P., Wenger, E. (1998) Learning in and for participation in work and society. International conference (US Dept. of Education and OECD) on 'How Adults Learn'. April, Washington DC.

History of the Cascade Project. (2004). Http://www.pitt.edu/~vanlehn/cascade-story.html. Last accessed 23rd March 2004.

Hogan, K. and Pressley, M. (eds) (1998). Scaffolding student learning: Instructional approaches and issues. New York. University of Albany. State University of New York.

IMS Global Learning Consortium. (2002). IMS learning design: best practice and implementation guide. See:

http://www.imsglobal.org/learningdesign/ldv1p0pd/imsld_bestv1p0pd.html. Last accessed 8th March 2004.

Jonassen, D.H. (2000) Revisiting Activity Theory as a Framework for Designing Student-Centred Learning Environments. In D.H. Jonassen, & S.M.Land(eds), Theoretical Foundations of Learning Environments. NJ: Lawrence Erlbaum

Jonassen, D.H., & Land, S.M. (2000) Theoretical Foundations of Learning Environments. NJ: Lawrence Erlbaum

Knowles, M. (1984). The adult learner. A neglected species. Houston. Texas. Gulf publishing company.

Kolb, D.A. (1984). Experiential Learning: experience as the source of learning and development. Englewood Cliffs. New Jersey. Prentice Hall.

Koper, R. (2001). Modelling units of study from a pedagogical perspective. The pedagogical meta-model behind EML. See: http://www.learningnetworks.org/downloads/ped-metamodel.pdf, last accessed 20th June 2004.

Kuutti, K. (1995). 'Activity theory as a potential framework for human-computer interaction research'. In B. Nardi (ed.) Context and consciousness: Activity theory and human-computer interaction. Cambridge. MIT Press, pp. 17-44. See also: http://www.dwr.bth.se/kari_kutti%20Nardi_book.pdf. Last accessed 23rd March 2004.

Laurillard, D. (1993). Rethinking university teaching. London. New York. Routledge.

Lave, J. and Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge: Cambridge University Press.

Learning Technology Standards Committee. (2000). Learning technology Standards committee web pages. See: http://www.ltsc.ieee.org/, last accessed 20th June 2004.

Lee, J., McKendree, J., Dineen, F. & Mayes, J.T. (1999). Learning vicariously in a distributed environment. Active Learning, 10 , pp.4-9, 1999.

Leont'ev, A. N. (1978). Activity, consciousness and personality. Englewood Cliffs. New Jersey. Prentice Hall.

Luria, A. (1976). Cognitive development: Its cultural and social foundations. Harvard. Harvard university press.

Mager, R. (1975). Preparing instructional objectives. Belmont. California. Lake publishing company.

Mann, W. C. & Matthieson, C. (1989). 'Rhetorical structure theory and text analysis'. ISI Technical report. Information Sciences Institute. California. United States.

Marquardt, M. J. (1999). Action learning in action. Consulting Psychologists Press.

Maslow, A. H. (1970). Motivation and personality. New York. Harper and Row.

Mason, R.D., Pegler, C., & Weller, M. (2004) A Learning Objects Success Story (submitted for publication).

Mayes, J.T. Learning Technology and Groundhog Day (1995), In W. Strang, V.B. Simpson & J. Slater (Eds.)Hypermedia at Work: Practice and Theory in Higher Education. University of Kent Press: Canterbury.

Mayes, J.T. & Fowler, C.J.H. 'Learning Technology and Usability: A Framework for Understanding Courseware'. Interacting With Computers 11, 485-497, 1999

Newell, A. (1980), One final word. In D.T. Tuma & F.Reif (Eds), Problem solving and education: issues in teaching and research. NJ: Lawrence Erlbaum

Newell, A. (1990), Unified Theories of Cognition, Cambridge, MA: Harvard University Press

Pask, G. (1975), Conversation, cognition and learning. New York. Elsevier.

Pea, R. (1993), Practices of distributed intelligence and designs for education. In G. Salomon (Ed) Distributed Cognition, NY: Cambridge University Press

Peal, D., & Wilson, B. (2001). Activity theory and web-based training. In B. H. Khan (Ed), Web-Based Training. New Jersey: Educational Technology Publications.

Piaget, J. (1970) Science of education and the psychology of the child. New York: Orion Press.

Pithers, R. & Mason, M. (1992). 'Learning style preferences: Vocational students and teachers'. Australian education researcher, vol. 19, no. 2, pp. 61-71.

Polsani, P. R. (2003). 'Use and abuse of reusable learning objects'. See: http://www.jodl.ecs.soton.ac.uk/Articles/v03/i04/Polsani/. Last accessed 20th June 2004.

Reigeluth, C. (ed.) (1983). Instructional design theories and models. Hillsdale. New Jersey. Lawrence Erlbaum Associates.

Resnick, L.B. (1987) Learning in school and out. Educational Researcher, 16, 13-20

Resnick, L.B. & Resnick, D.P. (1991) Assessing the thinking curriculum: New tools for education reform. In B.R. Gifford & M.C. O'Connor (Eds) Changing assessment: Alternative views of aptitude, achievement and instruction. Boston: Kluwer.

Salomon, G., Perkins, D. & Globerson, T. (1991) Partners in cognition: Extending human intelligence with intelligent technologies. Educational Researcher, 4, 2-8

Salmon, G. (2000). e-Moderating: The key to teaching and learning online. London. Kogan Page.

Salmon, G. (2002). e-Tivities: The key to active online learning. London. Kogan Page.

Savin-Baden, M. (2000). Problem-based learning in higher education. Buckingham: Open University Press.

Savery, J.R. & Duffy, T.M. (1996) Problem-based learning: An instructional model and its constructivist framework. In B.G.Wilson (Ed.) Constructivist Learning Environments: Case Studies in Instructional Design. NJ: Educational Technology Publications.

Scardamalia, M. & Bereiter, C. (1991), Higher level of agency for children in knowledge building: A challenge for the design of new knowledge media. Journal of the Learning Sciences, 1, 37-68.

Scardamalia, M., & Bereiter, C. (1993). Technologies for knowledge-building discourse. Communications of the ACM, 36, 37-41.

Steeples, C. and Jones, C. (2001). Networked learning: perspectives and issues. Springer Verlag.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard. Harvard university press.

Vygotsky, L. S. (1962). Thought and language. Cambridge. Massachusetts. MIT press.

Watson, J. (1983). Psychology from the standpoint of a behaviourist. London. Pinter.

Wenger, E. (1998). Communities of practice: learning, meaning, and identity. Cambridge: Cambridge University Press.

Wiley, D. A. (2000). 'Connecting learning objects to instructional design theory. A definition, a metaphor, and a taxonomy'. See: http://reusability.org/read/chapters/wiley.doc, last accessed 20th June 2004.

Wilson, B.G. & Myers, K.M. (2000) Situated Cognition in Theoretical and Practical Context. In In D.H. Jonassen, & S.M.Land(eds), Theoretical Foundations of Learning Environments. NJ: Lawrence Erlbaum