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# Understanding learning: Applications to Information and Communication Technology (ICT) and to Environmental Governance & Learning Pathways and the Design of Integrated Tools

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Understanding learning: Applications to  
Information and Communication Technology (ICT)  
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&

Learning Pathways and the Design of Integrated  
Tools

*J. Ewing, J.-M. Douguet*



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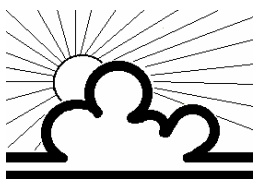
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## ***Introduction***

In addressing the application of learning in the specific contexts of ICT and Environmental Governance it is necessary initially to take a broader view. To achieve this we will look at learning from three viewpoints. These are;

- How learning takes place from a phenomenological view
- How some of the theoretical positions have attempted to explain the evidence and beliefs we have about learning
- How the principles of learning are translated into strategies for instruction in an ICT context.

Starting from this broad view of learning and general understanding of the processes and explanations of learning, the special circumstances relating to distance learning (through ICT) can be examined. Although our present understanding of learning tends to suggest that there may still be much in common across in different environments, there is nonetheless a widely held view that learning through traditional media is not the same as learning through electronic media, particularly if these involve learning online (Ewing, 2000). However, we must start somewhere and it seems reasonable that a basic grasp of what is known about the underlying concepts and beliefs of learning should provide an appropriate platform for exploring our understanding of the electronic learning environment.

Part I *Understanding Learning* will attempt to establish a basic framework which will permit an examination of the principles of learning where appear to be relevant to understanding learning and its practical application to ICT. The part finishes with the application of the basic framework to some newly created learning material in the context of environmental governance, the Virtualis material (O'Connor, 2004).

The learning pathway, as one example of the application of learning theory in practice, is described in Part II and an example of its application is given. The practical context of the application is an ICT based learning package of integrated learning tools (ViViANE) and examples of the three stages of a learning pathway are identified. Implications for a more general use of learning pathways as well as for the extension of existing packages are suggested.

# **PART I : UNDERSTANDING LEARNING: APPLICATIONS TO INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AND TO ENVIRONMENTAL GOVERNANCE**

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## ***How learning takes place***

Many notions have been advanced about how learning takes place and they probably all have some elements of truth or reality about them. In this examination of learning we will select just a few of these, but they are all fairly widely accepted in our general understanding of the phenomena associated with learning.

One of these beliefs is that learning is largely not instantaneous but is a process, possibly involving several elements or stages. For most of us, learning can be seen as occurring through a set of more specific events or over a period of time. Although there is much evidence for this in the experience of most individuals, there are instances where this belief might not appear to always be true. Two examples of this are the 'aha' experience and instances of a 'photographic memory'. The 'aha' experience is also known as the 'Eureka' phenomenon and occurs where a learner suddenly experiences what is often referred to as insight or the instantaneous realisation of the solution to an ongoing problem. A widespread finding with the 'aha experience' is that once the solution is obtained by this route, it is seldom forgotten and the learner does not have to go through a process of problem solving on future occasion to derive that answer again.

The place of a 'photographic memory' in learning may be experienced by a relatively small number of individuals and occurs where the learner literally remembers everything seen, though usually in relation to a short learning event or sometimes even through a single exposure. A celebrated such event involved a New Zealand soldier in the trenches during the First World War at Armentières. The 'photographic memory' event related to the platoon's records containing the men's names and service numbers and when the records were lost or destroyed during action, the soldier was able to provide his seniors with every detail from memory. This soldier,

Alexander C. Aitken, went on to become a professor of Mathematics at Edinburgh University and his powers of memory retention became legendary.

The more normal course of learning usually involves the 'flow' of information from outside the learner to inside the learner. There are a number of consequences to the notion of the learners receiving information in this manner. For instance, there exists far more information outside the learner than can ever be received by one individual, and therefore different learners will receive different information, even if they are in the same learning environment. Also, learners will receive information more readily when they are ready and able to do so, and for most learners, information is probably received in relatively small 'packages' rather than continuously and unending. Consequences such these suggest that for information flow to be more effective in learning, some degree of management or manipulation of the learning event is desirable, and the achievement of this management of learning is partly the function of the teacher, tutor or learning mediator. It is also in this context that the importance of information transformation compared with information transmission is recognised. If we assume (although in this instance there is some disagreement about the terminology) that information rests largely outside the learner and could become knowledge when retained meaningfully and useably within the learner, then the most obvious difference between information transmission and information transformation is taken as the former functioning in learner interaction with a knowledge base (such as in text books) whereas the latter will be more likely to function where a teacher is able to moderate and structure the flow of information to match the learner's needs.

Another widely accepted aspect of learning is that it largely involves internal processing. This was not always held to be true, as much of the belief associated with behaviourist learning during the first half of the 20<sup>th</sup> Century laid little store by any internalisation that was more than learning through the production of an instinctive response. This type of learning was characterised by the classical conditioning theories supported by Watson (1878 - 1958) and Guthrie (1886 - 1959), then by the later operant conditioning (or learning) philosophies espoused by Hull (1884 - 1952) and Skinner (1904 - 1995). Because of their focus on studying behaviour during learning, the contribution which the behaviourist psychologists have made to our understanding of learning has been profound and much of what we believe today about learning in a social context owes a lot to their ideas.

Although internal processing is now commonly held to be part of the learning process, there are different views about how this might function. There are also significant differences in the focus or emphasis which alternative views will promote. A fairly basic view is that internalisation is achieved by a form of information processing which is often described as having stages which, although not linearly arranged, do tend to indicate that there is an order in which the various elements will function. One such common view is that in the process of learning, the learner will receive all the information which the bodily sensors can detect, but that this will quickly be subjected to a 'attentional funnel' whereby only a proportion of what has been received will be attended to. Thereafter, the information received will be processed in short term memory and linked or categorised in some fashion for storing in long term memory.

Within the cognitive processing approach to learning, there are many features which have become fields of study in their own right. For example, self regulated learning is the cornerstone of much of the modern thinking about a metacognitive approach to learning and independent or autonomous learning. The key beliefs relating to self

regulation include the integration of the cognitive activities associated with monitoring and control into a set of procedures which enable learners to make judgements about the progress of their learning. These judgements might take account of how well the learning is proceeding according to some previously aware standards or expectations and, in the independent learning environment, permit learners to initiate control strategies to ensure a more successful achievement of the expected learning outcomes.

Another substantial feature of cognitive learning is how new material is associated with existing knowledge or the learner's past experience. Learning involves making links with existing events (or awareness) and the manner in which this might take place has been the subject of a very substantial field of research. A great deal of this research has centred on how learners conceptualise learning events and new experiences. The work of Bruner (1991, 1996) is typical of the development of some of the best known theoretical models of categorising and conceptualising. The basic tenet of his argument is that learners will remember things in order to develop a meaning and an understanding and not merely to retain facts *per se*. Liked with this approach, is the need for learners to categorise learning experiences for reasons such as; simplifying the complexity of the environment, being able to recognise objects, and reducing the need for constantly relearning with every new experience. Central to categorising, therefore, is the phenomenon of making links between what is new and what is known.

Additionally, learning has many social dimensions where the development of new knowledge, insights and awareness is associated with personal interactions with others in the learning environment. The views of Vygotsky (1896 - 1934) have dominated much of the development of the central ideas of social learning and there is now substantial acceptance that much learning (and arguably all learning) starts at the interpersonal level before developing into a more intrapersonal learning. The approach of Vygotsky has also led to the importance often attributed to the force of a culture, a society or a community in determining what is learned. The influence of such groups is that the learning material used with children is open to being socially determined and there are many examples of this occurring in almost every learning society worldwide. A key element of social learning is the interdependence of the learners on each other in discussing, examining, interpreting and organising information and experiences, as they are transferred into personal knowledge. Interdependence is closely associated with collaboration and the sharing of common beliefs and common values.

It should be easy to see that collaborative learning is one form of social learning, though it is frequently dealt with in the literature as a separate approach. There are some slight differences in the terms used and there are those who suggest that learning together on a task set by a teacher and having a specified outcome is co-operative learning (Johnson and Johnson, 1994). Others describe learners working together on different sub tasks to achieve a joint piece of learning as co-operative learning but if working synchronously for a single outcome it is collaborative learning, and there is also the view that co-operative learning is more as a corporate feeling of belonging within a classroom, whatever form the task completion takes. A further term, "collective learning", is also used because learning together is not always collaborative.

Much has been written about the underlying theory of a collaborative approach to learning and many have argued that collaborative learning combats failure to learn



through other more traditional, methods and that learning in groups provides the support which many learners lack in individual learning or teacher led learning environments. Collaborative learning undoubtedly helps to promote communication and the sharing of ideas which in turn lead to more effective 'sense making' by the individual.

### ***Some of the theoretical descriptions of the nature of learning***

There are possibly four major schools of thought in psychology which have addressed how to define and describe learning. They are the schools of 'behaviourism', 'cognitivism', 'humanism' and 'constructivism'. It is arguable if these are separate schools of thought or if they are different trends within a developing understanding of the learning process, and certainly they are not the only theoretical approaches. There have been other important approaches in trying to describe the phenomena and procedures of learning (such as 'rote learning'). However, for the purposes of this short description the four approaches have sufficiently different histories and elaborations to permit a meaningful examination of them separately.

#### *Behaviourism.*

In the behaviourist approach, first popular around the beginning of the 20<sup>th</sup> Century, learning involves a relatively permanent change in behaviour that would not have occurred by natural development or growth. Learning is therefore the result of changes in the behaviour of the learner through a process of reinforcing learned behaviour through the use of reward and encouragement. The process is normally a gradual one of 'shaping' the learner's behaviour towards a predetermined outcome through relatively small steps, each of which involves learning elements of the final behaviour. A particular feature of behaviourist learning is that the learner is motivated by his success in the smaller steps of the learning process, often achieved through the provision of positive feedback from the teacher or the teaching material used.

There are many features of behaviourist learning which have been researched and reported over a period of several decades, the most usual of which are the nature of the feedback or 'reward' given to the learner, the difference between intrinsic and extrinsic rewards and the subsequent role of personal motivation for learning, and the application of the behaviourist learning approach to distance and online learning.

The current concerns of applying behaviourist learning in modern online learning environments centre on the design of the learning material and on the engagement of the learner. Of particular importance in the design of the learning material are the relevance, the visibility, and the appropriateness of the intended learning outcomes. The statement of learning outcomes (or goals) should be immediately apparent and obvious, and located in the early stages of the learning material. The relevance of the goals can be an indication of the interest that the learning material engenders in the user and the resultant motivation for continued engagement and learning. The appropriateness of the learning outcomes relates to the extent to which the learning material has been designed with the needs of the intended learners in mind. The greater attention which has been given to the learners' needs, expectations and previous related experience, the more likely is there to be a high level of appropriate learning outcomes.

The engagement of the learner in online learning material can also be influenced by the differentiation of the content to be relevant to a range of potential users. The achievement of this in the online environment is now being addressed and the opportunities to motivate and challenge a range of learners using the same material are now an attainable target.

### *Cognitivism*

In the cognitivist approach, first popular around the middle of the 20<sup>th</sup> Century, learning involves the process of internalising information by the internal mental processes of selective attention, retention in memory, linking newly learned material with what is already known, and being able to respond. Learning is therefore associated with the information processing procedures which the learner will engage in during a learning activity. The mental processes which are typically described as part of cognitivist learning include the restructuring of experiences within the existing set of experiences already held by the learner. This typically involves the interpretation of a new learning event to make it meaningful to the learner and as such, learning is often seen as involving the making and testing of rules, defining and expanding concepts, and generalising from specific events or experiences.

The specific examples of cognitivist learning which have been widely researched and reported include discovery learning, holistic learning, process-oriented learning and insightful learning. The importance of learning having meaning for the learner and of the learner being engaged in making personal sense of the learning event is of particular relevance in the design of the cognitivist learning environment. Part of the process of internalising new information has been described by some of the more specific cognitivist learning theories in terms of the perceptual processes which are believed to be inherent in human thinking capabilities. Examples of such theories include those of the Gestalt psychologists, who examined the organisational processes of perception which included connections, associations, and the organisation of material during the perceptual process. One of the more important influences of Gestaltism has been the recognition of 'cognitive dissonance' which may occur when a learner is unable to integrate new learning experiences into an existing cognitive framework.

The application of a cognitivist learning approach to the design of learning material typically includes taking account of the needs of the learner in terms of his cognitive strengths (and occasionally his weaknesses). Learning, therefore, must be meaningful for the learner and, in particular, the purpose of the learning event should be emphasised, not only for the immediacy of the learning task but also for the longer term retention and use of the learned material. Another influence on the design of appropriate learning environments has been the widespread belief in 'systems'. Within the current understanding of systems as a part of human learning, is the interpretation that a learner has a structure of concepts, beliefs and understandings which collectively function as a framework to permit the exploration of new ideas and challenging or difficult concepts. Various terms have been suggested to help the visualisation and organisation of these systems, such as 'concept maps', 'mental maps', and 'conceptual neighbourhoods'.

## *Humanism*

In the humanist approach, which also became popular in the second half of the 20<sup>th</sup> Century, learning involves personal engagement in experiences to promote self-esteem and personal worth. Central to the humanist approach to learning is that the person is the most important aspect of a learning event and the consequence of this has frequently been interpreted as placing a large degree of the responsibility for learning on the learner himself. The frequently quoted strengths of humanist theory lie in the twin focuses of learners taking an active part in effecting change in their learned behaviour, and of the learning outcome being a positive reflection of the learner in his social group in order to make a contribution to the wider community.

Applications of, and derivations from, a humanist approach to learning have included the promotion of the belief that individuals have a natural desire to learn and a curiosity to know more about their environment. Making use of this natural curiosity is therefore a key element in the design of new and exciting learning events or tasks. Learning which is meaningful to the individual learner is also related to humanist learning in that learning is more likely to take place when it is perceived as relevant to personal needs and purposes. This is particularly true in attempting to engage learners in learning material which they might not have immediately chosen as being relevant to their current interests or responsibilities.

Perhaps the most significant contribution from the humanist approach to learning has been the widening of perspectives of learning to include the affective domain in the design of learning experiences. The feelings of the learner as well as his cognitions have been brought into focus and the intrinsic motivation of the learner becomes a dominant force in promoting effective learning. It has also been argued that because humanist learning is largely concerned with human growth and self worth, the associated learning is less constrained within the more normal curriculum or domain boundaries. The result is that learners will participate in more worthwhile and enriching learning experiences.

## *Constructivism*

This is the most recent trend in considering what learning is, but finds its roots in much the earlier seminal work of Vygotsky and Piaget in the early decades of the 20<sup>th</sup> Century. The basic element of the constructivist approach is that learners will construct knowledge and meaning throughout the process of learning and there are generally argued that two basic forms exist, cognitive constructivism and social constructivism. One of the central beliefs of the constructivist approach is that knowledge only becomes knowledge when it has been collected and construed by the learner as a part of his mental model of the relevant learning experiences. Constructing knowledge in learning is a personal mental activity and the learning outcomes, though not necessarily the processes, will be unique to each learner.

Constructivist learning is cognitive in that the knowledge acquisition involves cognitive or thinking activities and it is social because a great deal of learning derives from the learner interacting with other people. Covering both forms of constructivist learning, there are several primary principles which are now widely recognised as being indicative of this approach. For example, it is held that constructivist learning is not passive learning but rather it is interactive with the learning environment, at a cognitive level rather than at a practical or 'hands-on' level, although the latter is not specifically excluded. Also, learning is intimately related with the development of

interpersonal communication into intrapersonal comprehension, both of which are heavily dependent on language and the use of language to express thoughts. Another strong influence on constructivist learning is the belief that learning should be contextualised, usually in a real life environment where there will already exist links with the learner's past experience in a manner that permits new knowledge to be assimilated within a structure provided by existing knowledge.

There have been many attempts to integrate a constructivist approach to learning into the design of learning environments, and most have taken specific account of features such as: the importance of learner interaction and collaboration; providing for learner autonomy in deciding learning pathways; and contextualising and personalising the learning environment. Providing for personal growth as an outcome of learning has generally been one of the more demanding aspects of the design of constructivist learning experiences and has involved the re-examination of learning goals or intended outcomes to better reflect that learning is more than knowledge transmission, but rather is knowledge transformation. This approach has brought into focus the need for shared understanding between teachers and learners, and has consequently highlighted the role of the teacher as a facilitator and collaborator rather than as a provider.

### ***Some principles for learning in an ICT context.***

To apply an understanding of learning to the practice of teaching or instruction can involve a reflection on what the different theories and explanations might mean in the task of making learning happen. To achieve this it sometimes helps to adopt a perspective which tries to tease out the common threads which underlie the more formal descriptions or postulates. For the purpose of this paper, the common threads of learning which relate most fundamentally to a constructivist approach to learning and the procedures which support making collaborative learning happen, have been identified as 4 key principles.

*Principle 1. Peer interaction and collaboration* is one of the principles because of its undoubted value in learning environments in the classroom, workplace or home. Group learning in its various formats has now been around for so long that not much needs to be said in its defence and the literature is generally supportive of some aspect of its application, such as its reflection of social learning and the co-construction of knowledge (Dillenbourg, 1999).

However, the view that collaborative learning and peer interaction might be inconsistent with learning using a computer is not a difficult one to believe. Most individuals work at a computer on their own and if they have a learning task to address, there is no obvious or tangible evidence of being able to work with others, with the result that there is a strong expectation of having to work alone. The creating of shared learning environments is therefore an additional aspect of ICT based learning which has to be specifically addressed and the experience of some research (such as Fuks, Gerosa and Lucena, 2002) indicates that learners progress through stages of not believing in computer supported collaborative learning, not wanting to be part of it, 'paying lip service' to engaging in it, yet finally saying that more of their courses should be structured round it. Sharing as a part of learning does not come naturally to everybody and integrating it into electronic and online

learning is certainly one of the more worthwhile ICT challenges for both teachers and learners.

*Principle 2. Autonomy for the learner* is part of giving to the learner a large measure of control over the learning experience. In modern society such individual control is now expected and the right of the individual is paramount in so much of our lives. But rights have to be accompanied by a realisation and an acceptance of associated responsibilities.

Students have the right to choose in all sorts of ways and in the online learning environment this is enhanced by the inclusion of choosing the time and location of their interaction with the learning material. The responsibility to engage with the learning material is not diminished, however, and where this has been designed to include learning within a group, neither is the responsibility to the others in that group.

As always, there are some who abdicate their responsibility, often because of poor time management, restricted self confidence, limited ability and (sometimes) because they want to keep their 'good ideas' for themselves. In circumstances where there is an expectation for the learners to engage in collaborative group work (Ewing, 2000) it is sometimes easier to this to happen without reducing the learners' feelings of autonomy. By designing ICT based learning to create learning autonomy, effective use of the supporting technology is both possible and can be seen by the learners as successful.

*Principle 3. Personalisation of learning* is an (almost) undeniable aspect of successful individual interaction with a learning event. Motivation, whether intrinsic or extrinsic, has its roots in the 'feel good factor' of involvement and endeavour, and when the learning environment is online, students often feel isolated and as a result, unmotivated. Part of the task of the designer of online learning material is to ensure that the learner does not experience such isolation. Achieving this involves meaningful (and possibly substantial) involvement of the tutor. The contribution of the tutor is not diminished by making the learner distant; it might even be more important. However, online learning makes this easier than with the non-electronic media of distance learning. There are few learners who would not want to know from a tutor, that they were 'on the right lines' and if this can be an ongoing part of the learning instead of left to end-of-course submissions, then the learner is likely to have more positive feelings about his learning. Such aspects of personal worth and self-esteem are (or ought to be) a *sine qua non* of education and the affective aspects of successful learning are too important to be ignored.

For learners, the promotion of self esteem can often be linked with the alleviation of stress and the beneficial outcomes for students who might have been unwilling to admit negative self evaluation are often obvious and highly appreciated (Miller and Ewing, 2000). Therefore the challenge is to put personalisation back in and to make it a requirement in the design of all online learning environments. There are doubtless many ways of achieving this and successful examples are beginning to appear in the literature.

*Principle 4. The enhancement of learning outcome* as a principle of electronic learning is to ensure that electronic and online media are not used just because they are available. Most teachers would accept that the motivating effect of new and 'wizard-like' media has begun to wane (though new 'inventions' will doubtless prove this to be untrue). However, today's learners are often more familiar with, and more skilled in using, the medium to high level technology than many of their teachers.

By much the same argument, it is not good enough to transfer successful learning from a traditional environment to an ICT based one. This was part of an early contention that the use of ICT was to reduce costs by reducing staff contact with their learners, but there is a significantly increasing realisation that it actually takes more staff time not less, to teach electronically to the same standard as had been achieved by traditional, non-electronic means. To justify using ICT as the medium for learning, it ought to be demonstrable that the learning outcomes would be enhanced compared with what might have been achieved by other means.

Undoubtedly there are new personal learning skills which are achievable through the medium of online learning and the identification of such skills ought to be one of the first considerations in the design of online learning material. An example might be the opportunity for learners to create their own learning material using the resources available on the world wide web. Such creation of a unique 'learning folio' or 'personal learning plan' could usefully be a target for all online learning environments which expect learners to make extensive use of the available material in this way. There is increasing evidence from many new courses that the use of electronic folios and personal learning plans can be a highly valuable learning experience.

### ***A sample application to Environmental Governance***

The sample application considered is the learning material produced within the Virtualis Project (O'Connor, 2004; Douguet et al., 2004).

There are four different sets of programmes of learning material produced within the Virtualis project, relating to four domains; Climate Change, Sustainable Agriculture, Freshwater Resources and Marine Capture Fisheries. Each of these is a suite of programmes using interactive multimedia technologies to introduce interested users to environmental risks and governance challenges. There are four platforms of engagement in each of the domains and they are: a *personal barometer* where the individual users can enter information relating to the current lifestyles or to their beliefs; a *scenario generator* which permits users to explore their individual actions and to investigate the selected consequences in relation to environmental risks; a *virtual visit* which allows users to adopt one of a selection of roles to explore the domain to develop greater awareness of the 'reality' of living in that domain; and a *multi-player game* which permits several users to interact electronically and to adjust their lifestyles or beliefs to take better account of environmental sustainability.

An analysis of the Virtualis learning material under the headings of the four principles described above indicates the following examples of the application of these principles.

### *Principle 1. Peer interaction and collaboration*

In the Freshwater Resources domain an interactive environment has been established where players can interact using mobile phone technology and they do so by playing a maze-type game based on giving the correct answers to questions about water (as a resource, its use and its management). In the other domains a corresponding level of interaction is provided through the respective multiplayer computer based games. In the Marine Fisheries, domain fishermen and citizens must balance the amount of fish caught in order to stay in business and to ensure an appropriate supply to the market, while in the Climate Change domain the players have to learn to reflect on and adjust their lifestyles according to (sometimes unexpected) major influences on potential climate change. In the Sustainable Agriculture domain there is a multi-stakeholder and multi-criteria scenario where players must also take decisions collaboratively to encourage the most sustainable agricultural practices.

### *Principle 2. Autonomy for the learner*

The design of each of the four domains is such that the users have choices as they move through the related material and they must exercise decisions about these choices in order to progress through the learning material. Examples of these choices are as follows.

- Decisions about their own lifestyles or beliefs when creating their personal barometer in each of the four domains (see also principle 3 below).
- Selection of relevant material relating to the construction of personal knowledge about the context of each domain, during the virtual visit. This is achieved differently in each domain: in the Climate Change domain it is through accessing material from a wide ranging text based and multimedia-based library; in the Freshwater Resources domain it is by selecting from optional “storylines” relating to different aspects of water resource management in a catchment area; in the Marine Fisheries domain the user can select to learn about the underwater environment from different perspective (such as of a fisherman or of a migratory fish); and in the Sustainable Agriculture domain the user may chose to be taken on a guided visit, on a free visit or on a participative visit of a farming district.

### *Principle 3. Personalisation of learning*

In the personal barometer of Climate Change domain (‘V Gas Build Profile’) the user creates an account of the likely emissions of greenhouse gases according to his or her personal patterns of behaviour. The calculations take account of the regional and national energy supplies in the locality of the user. In this way, users have been allowed to personalise their learning by making the context of their involvement realistically embedded within their normal personal behaviour. Similar conditions apply to the personal barometers in the other domains. In the Freshwater Resources domain, a ‘water shadow’ concept permits users to visualise how much ground is required to sustain their annual water usage, and again this takes into account the region or nation of individual users. In the Marine Fisheries domain, from users’ indications of how much fish they normally consume, information is supplied indicating how users’ consumption relates to the available fish stocks and in the

Sustainable Agriculture domain users can select to simulate the profile of a farmer or of a consumer to provide information about their personal lifestyle and this is compared with food production and water use.

#### *Principle 4. The enhancement of learning*

The material which has been prepared for the Virtualis project was designed to be new, challenging and presented through electronic media. It generally uses material which could not be distributed through non-electronic media and therefore sets itself apart from other specific learning resources in the four domains. Enhancement of learning is significantly supported by easy access to the relevant information for personal learning by each user, due to the availability of such information having been partially structured and transformed to fit the learning environments created by the Virtualis material. The users are helped to focus on the learning material and the intended learning outcomes through the consistent overall structure across the four domains. Users may therefore be encouraged to move from one domain to another in the knowledge that there is a common structure to the learning environments and that it is a structure which is supportive and designed to meet the learning needs of the targeted users. Further support for learning is through the multiplayer games which provide and reinforce opportunities for working and learning collaboratively. The interaction of different perspectives of learning is particularly well demonstrated in the "Deliberation Matrix" in the Sustainable Agriculture domain.

### **Conclusion**

Applications of learning to environments involving ICT are now the focus of very many studies and the approach adopted in this paper is only one of several attempts to identify and implement a view of learning which seems to be relevant to the engagement of learning through electronic media. Through identifying a small set of key principles it should be helpful to establish some structures for the design and preparation of appropriate learning material for use in an ICT medium. The principles identified in this paper are relatively fundamental to learning as we presently understand it and they attempt to recognise that learning using information technology is not identical to learning in the non-technologically oriented media. They have been shown to be applicable and relevant to the production of new learning material (the Virtualis suite of learning material) and from that it might be suggested that they could be applied more widely. Their description in the paper is purposely at a more general level so that there might be opportunities to relate them to a range of material and thereby to define more accurately what might be the most useful principles for the design and preparation of ICT based learning material.



# PART II : LEARNING PATHWAYS AND THE DESIGN OF INTEGRATED TOOLS

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## *Integrated Learning tools and ICT*

The design of integrated learning tools occupies a prominent position in the study of knowledge management, which itself is seen by many organisations as a means of identifying and distributing knowledge for a wider awareness and user responsibility (for example, Wilson, 2002). Knowledge management is often described as an essential aspect of the successful functioning of groups, organisations and communities through their being able to bring together, deal with, and effectively control the knowledge shared by many individuals. Understanding and using knowledge management has placed significant emphasis on knowledge transfer and the creation of relevant learning tools (for example, Argote, Ingram, Levine and Moreland, 2000; Bontis, Dragonetti, Jacobsen and Roos, 1999).

The relationship between information, knowledge and understanding has long been an interest of psychology and the relevant literature has many examples of different attempts to explain the connection (for a summary, see Bates, 2005). Also associated with the increase in an interest in knowledge management has been a more open concern for the place of learning within organisations and communities, rather than exclusively in schools and universities. Relatively modern writing now refers frequently to terms such as 'learning organisations', 'learning communities', 'knowledge economy' and 'intellectual capital'. The application of information and communications technology (ICT) has introduced further terminology such as 'knowledge repositories', 'data mining' and 'expert systems'.

With an increase in taking account of, or at least having an awareness of, the learning process, more obvious moves have been initiated within learning communities to examine the links between theory and practice. Additionally, an enhanced approach to considering the importance of understanding learning in the application of knowledge management has gained from the rapid burgeoning of e-learning. Computer enhanced learning has brought about a substantial number of web-based teaching materials and the development of multimedia tools. Initially, the links between these tools and an application of learning theory in practice were not well developed. More recently, however, the role of learning and in particular of an understanding of the theory of learning has begun to play a much more prominent role in the promotion of practical learning applications. The previously perceived divide between theory and practice is becoming less with a greater willingness to explore what learning means to help promote its application in practice.

This paper examines how one aspect of a practical example of the theory of learning (learning pathways) might be helpful in the design of learning packages and it attempts to show how this illustrates the integration of an understanding of learning theory into the practice of promoting learning.

### ***What is a learning pathway?***

The fundamental meaning of a learning pathway is the creation or provision of the opportunity to progress from one state of learning to another. This progression or movement is always in one direction and always moves from a lower state of learning to a higher state of learning. It is generally accepted that the direction of a learning pathway is seen as always progressive, although there might be a very few instances where it is deemed relevant to 'unlearn'. Such circumstances are probably rare and might be more usefully interpreted as replacing earlier and less complete learning with a later and more comprehensive awareness and understanding.

A learning pathway can be considered at different levels, from highly specific learning for an individual or an event, or it can be looked at more generally for wider range of learners or learning expectations. At the specific level, a learning pathway might be planned, designed and created for each learner to achieve a set of learning outcomes which are closely directed to meet the requirements of an individual and should take account of the highly specific needs of one person (for example, individual tutoring for a student to assist in the passing of an exam at school). Alternatively, it may target precise learning outcomes related to prescriptive learned skills (for example, a training event for instruction relevant to carrying out safety checks before using specific machinery).

A learning pathway can also be at a more general level where a whole course of learning is made available to a large number of subscribers or interested participants. In such circumstances, the procedures must cover a more general statement of learning procedures and consequently address the needs of a wider range of learning products. There are many examples of this type of learning pathway in the courses offered at all levels of education and training.

There are also some instances of more formal learning pathways, where there is the expectation of a contract between the teacher or instructor and a learner, and in certain circumstances between a trainer and an employee. Under such conditions, the needs of the employer may figure prominently in the planning of the learning content – what the employer wants could take precedence over what the learner's need might be.

The more general case of a learning pathway is examined in this paper where the principles which underpin learning pathways are examined and then their application to the planning and preparation of a learning package are identified. The example, a learning package relating to sustainable agriculture, also has more general applicability as it demonstrates the wider aim of increasing the knowledge and understanding of potentially a large number of users.

There are generally accepted to be three key fundamental stages of a learning pathway and they are described as follows,

1. the beginning state of learning
2. the end state of learning

3. the elements of interaction which lead the learner from the beginning state of learning to the end state of learning.

### *1. The beginning state of learning*

For appropriately designed learning material, there should normally be a clear indication of the position of the learners for whom the learning is intended. This position should relate to such features of the learners as their knowledge, motivation, interest, as well as their beliefs and expectations about what they should learn. Where the learning material is intended for multiple users, the beginning state should include an awareness of the inter-relationships which exist between the various intended learners and their perspectives of each other within the planned learning scenario.

The relevance of knowing in advance the prior knowledge and previous experiences of the intended learners lies in the essential nature of learning in linking these with the new information to be presented. As learning becomes internalised, the process of creating meaning involves making cognitive links with what already exists within the understanding of each learner. Successful design of learning material must therefore know and take account of what is already known and experienced by the learners. Learning material which does not progress from the learners' current state will be substantially more difficult for the learner and may result in failure. In instances of multiple users of learning material, it may be necessary to create multiple starting or entry points to suit the varying levels of different learners. It may also be necessary to allow learners to refresh their awareness of their personal understanding and knowledge and thereby bring into their conscious awareness the relevant known information which will be required for linking with the new learning.

In addition to taking account of the learners' knowledge and experience, it is particularly valuable to know the level of interest and motivation of the intending users. Where the users are known to have a higher level of interest, it is often possible to propose a rate of progress through the learning material which will be appropriate for their enthusiasm and to provide alternative pathways which might be followed to better meet the higher interest levels. On the other hand, where interest levels are lower, the design might have to present the learning material in more attractive and motivating scenarios and to focus more closely on achieving the intended learning goals without too much in the form of additional alternatives. That is, more motivated learners might be more easily led to reflecting on alternative solutions to a learning event (for example, in the promotion of healthy eating habits) rather than focussing solely on the establishment of the basic knowledge required to implement good practice.

Where the inter-relationships between the users are known, there may be the opportunity in the design of the learning material to capitalise on shared views or knowledge to support the attainment of the desired learning outcome. It is often in this way that users can gain greater insights of their own learning if they can visualise how they are similar and different from other learners. For example, students addressing the concept of a personal barometer of greenhouse gases within the home environment might more realistically visualise their own measures when they make comparisons with those of others within a learning group. When learners approach a concept such as a personal barometer for the first time, they often have considerable uncertainty about what might be the norm and how far from that they

feel they are or should be. Sharing information with others from different personal backgrounds is particularly valuable (and reassuring) in being able to establish personal perspectives in such instances of relevant and important measures of personal performance, such as personal barometers.

Perhaps one of the more useful aspects of determining the beginning state of learning is the opportunity which this presents to include the learners in the decision making process about the design of new learning material. This involvement of the learners could substantially influence how much of the material to be used, might be designed to fit the users most appropriately and therefore lead to more efficient learning.

## *2. The end state of learning*

All learning requires a clear statement of the intended learning outcomes. These are variously referred to as objectives, aims, or goals and they have the responsibility of defining with sufficient accuracy what the planned learning event hopes to achieve.

The determination of the end state of learning will normally be undertaken by the group or body of teachers or instructors who engage in the preparation of the learning pathway. It will be their beliefs about the desirable learning outcomes that will give the structure of the expected targets of knowledge, understanding and skills to be achieved. However, there are some additional aspects of the learning outcomes which also need to be considered. These might include whether the outcomes are reasonably achievable or if they may require being limited for some users, and this might be interpreted as the description of a minimum level of achievement, with the opportunity for this level to be exceeded by some participants (that is, differentiated achievement). Further, some attention should be given to the negotiation of the end state of learning with the learners, to ensure that the learned outcome is the most useful and appropriate for these users. It has been argued, for example, that where learning institutions may have changed their focus from teaching to learning, they have yet to encompass a corresponding change in the measurement of the achievement of learning outcomes (Rust, 2002). A corollary of this is espoused by Higgins, Hartley and Skelton (2002) who support the use of feedback from learning in the promotion of higher order learning. The relevance of these ideas for the end state of learning of a learning pathway is that engagement of the learners in some of the decision taking relating to the end state is particularly beneficial in promoting more meaningful learning, possibly at higher and more rewarding achievement levels.

In some instances, the end state will seem to have been 'predetermined' to reflect a body of knowledge, understanding and skills which are widely held to be valuable, worthwhile or important. An end state of learning may therefore be stipulated by a curriculum (such as a school curriculum) or as a state of knowledge which is socially accepted (such as environmental governance) or as an essential professional skill (such as in many commercial or industrial contexts). In most of these events, the predetermined end states of learning may seem to be particularly influential.

## *3. The elements of learning interaction*

Within a learning pathway, there are many aspects of the learning experience which impinge on the successful progress of the learner between the beginning and end states. These can be referred to as the elements of a learning pathway and their identification and selection for inclusion in a particular learning pathway will depend on the circumstances of each learning experience.

Some of the more general elements of a learning pathway which will relate to the central features of any learning event will include;

i) the demands of the learning task. There is a widely varying set of circumstances which might relate to the demands of the learning task and most often they will include such features as: new knowledge and understanding; appropriate skills; the complexity of the learning; the standards or levels of learning outcome required; the balance between cognitive and affective aspects of the learned outcome; and how much effort is required from the learners.

ii) the needs of the intended learners. The needs of the learner will have been explored when establishing the beginning state of learning and will be closely related to the views which users have of their current knowledge and experience. The importance of promoting and maintaining an appropriate level of interest and motivation will relate to factors such as: the length of the task; its perceived importance; the level of interest currently held by the learners; the skills which the learners have in being able to learn cooperatively or individually; and whether the learners have chosen or have been instructed to be included in the learning pathway.

iii) the circumstances of the learning environment. There is potentially wide variation in the learning environment circumstances and those which must be considered might include: where the learning will take place (home or work or school); how much time is available due to other demands (overloaded curriculum and over worked staff); facilities for learning together in groups or alone; and the atmosphere which the learning environment will create (freedom or constraint).

iv) the resources to be used to promote learning. The resources will include the teachers or instructors who promote and mediate the learning event as well as the material which is used in the teaching or instruction. Resources might also reflect predetermined features of the learned outcome such as the integration of information and communications technology (ICT), or co-operative learning where corporate responsibility is required. Resources can undoubtedly influence learning significantly and material (and teachers) may need to be selected specifically fulfil the demands of the anticipated learning outcomes. For example, school principals or headteachers involved in 'training for the job' do not respond as well to input from instructors who have never themselves held the position of a school principal or headteacher.

In addition to the more general elements which might be applicable to most learning pathways there are several which will be more specific to learning pathways designed for identified learning tasks and these would have to be identified and elaborated according to the demands of each specific learning event.

It is usually accepted that each element, whether general or specific, would normally relate closely to the expected learning outcomes as indicated in the end state of learning and therefore it is necessary to have the overall view of the learning pathway from start to finish while determining the elements of interaction for any specific learning event.

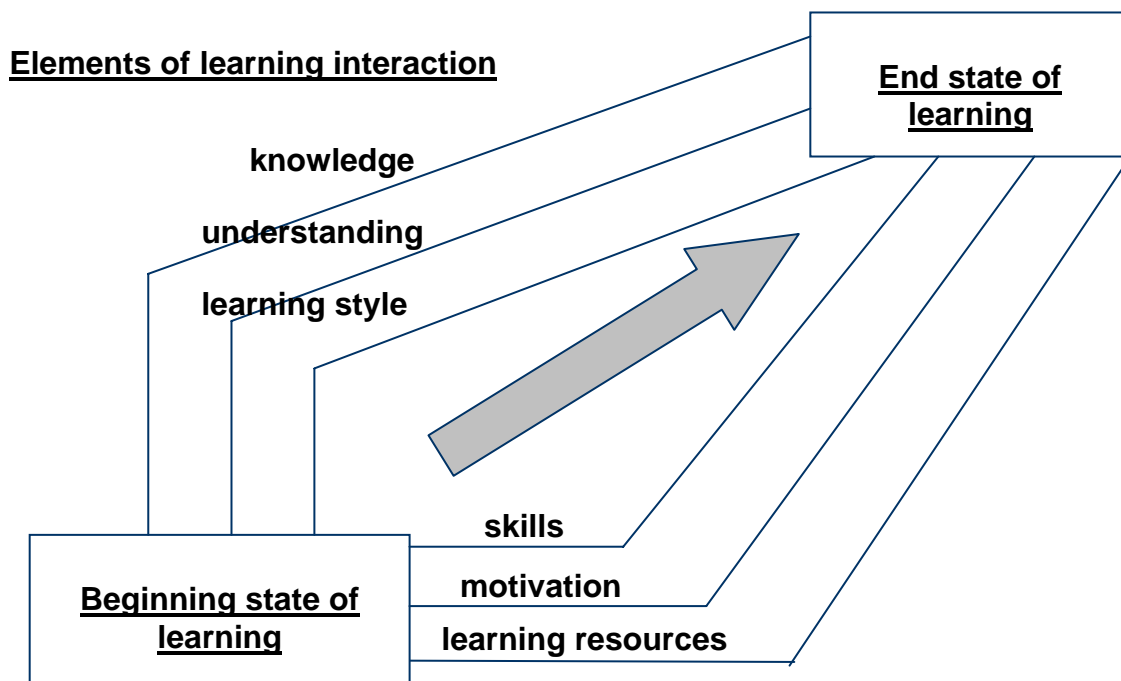
The prime function of determining the elements of a learning pathway is to decide what must be the focus (or focuses) of the design of the associated learning package. Once the elements of a learning pathway have been decided, they are taken account of in all the subsequent activities which are undertaken to produce the final learning environment. For instance, when considering the motivation of learners, if it is decided that promoting the engagement of unwilling learners is a specific focus, extra attention will be given to providing encouragement in every aspect to the learning task, to include personal support, use of positive feedback, taking account of length, diversity and difficulty of learning tasks, motivating resources and conditions for learning, and the perceived value of the learning outcomes by the learners. Under such circumstances, ideally no planning decision would be taken without addressing the issues of motivating unwilling learners.

### *The relationship between the three elements of a learning pathway*

One possible way of representing the relationship between the three elements of a learning pathway is given in Figure 1.

The beginning state and the end state of learning obviously lie at opposite ends of a progression which is represented by the unidirectional arrow to signify that learning will normally move from a lower level of less learning to a higher level or more learning. Some very general examples of the pathway elements which represent learning interaction are given and can be taken to 'contribute' to the arrow which progresses the learner from the beginning state of learning to the end state of learning. There will be more than six elements in any learning pathway and those given in Figure 1 are merely indicative.

Figure 1. Diagrammatic representation of a learning pathway



The three fundamental stages of a learning pathway (underlined in Figure 1) are essentially interactive, but the order in addressing them might be more efficient if the beginning and end states of learning are clarified in advance of an examination of the elements of interaction. It is therefore essential to have a clear view of the beginning state of the learners and to be certain that the entry level of the learners is both known and shared with all participants. In a similar fashion, it is important that the end state, or learning outcomes or expectations are sufficiently clear to permit the elaboration of the interaction elements to be closely and appropriately directed to an identifiable target.

The elaboration of the elements of learning interaction should be directed at making appropriate provision for their best achievement under the prevailing conditions of the learning pathway and this will involve taking decisions about the factors which have been suggested above (such as, the most relevant resources to use, the best

conditions to promote a stimulating and motivating learning experience, the provision of appropriate circumstances to encourage a specific learning style, etc.). In designing and creating a learning pathway, the focus of the implementation the elements of the learning interaction should be to make each element function at an optimal level for the successful operation of the overall learning event.

### ***A practical example – the knowledge background to ViViANE***

The evolution of sustainability policies – in agriculture and water management as well as other domains – requires a process of arbitration between different interests, conflict management, and if possible, the reconciliation of multiple water usage criteria, territorial and landscape management, the quality of edible produce, ecosystem integrity, the financial viability of agricultural activities, the interests of local associations, regional development, etc. This indicates that we must pay attention to the tensions between the preoccupations of present and future generations, different economic sectors, and human and non-human communities.

The virtual world ViViANE (Virtual Visit to my Environment) is one example of the new generation of interactive on-line deliberation support tools (DST) for discovery and analysis of the sustainability challenges facing public policy makers, the business world, scientists and civil society (Douguet et al., 2004). ViViANE specifically aims to improve the awareness of citizens regarding management and environmental risks in agriculture and water domains. It has been developed in the ViRTU@LiS project funded by the European Commission during 2001–2004. This project set out to develop computer-based learning tools exploiting state-of-the-art ICT that would test new opportunities for organising and communicating scientific knowledge about risks and challenges in the field of environmental management for non-scientific audiences. It brought together a consortium of specialists in information technology, sustainable development, environmental modelling, public policy and governance, learning psychology and open learning, to develop computer-based learning tools on ecosystems and natural resources.

By using this prototype, the aim is to facilitate the learning by non-specialist members of society through the “translation” of technical and scientific expertise into formats accessible to and pertinent to interested non-specialists. The underlying design concept is of learning as an inter-subjective “voyage of discovery”, taking place partly in a virtual space (that nonetheless evokes and portrays real spaces and places) in this case a voyage of the individual in society “towards sustainability” (Guimarães Pereira & O’Connor, 1999). We thereby postulate for a ‘model’ and practice of the knowledge and learning perspectives that can arise as within a deliberative process of multi-criteria multi-stakeholder evaluation of “policy alternatives”.

The problem situation presented in the ViViANE virtual world is based on a real-life case of the commune of Montreuil-sur-Epte, in north-western France. A crisis had emerged, due to the cumulative contamination of local groundwater by chemicals deriving from agricultural fertiliser and pesticide applications, meaning that this water source could no longer be used for municipal supply. The chemical pollution of soil and water interferes with the *functioning* of the local environmental systems in themselves and, more particularly, interferes with the services or *functions provided* for economic activity and human well-being by the natural systems (in this case, available of high quality drinking water for municipal supply). Resolving the question



of goals and strategies for water use and water quality emerges here as a key challenge for sustainability policy.

Within the DST system, users can provide suggestions for information categories that might be used for description or evaluation of scenarios and policy measures, and can also provide opinions about the pertinence (or not) of indicators and information categories already suggested. Seven major components or Discovery Space are developed in ViViANE DST are given in Table 1.

Table 1. Summary description of the components of ViViANE

<b>ACRONYM</b>	<b>SHORT DESCRIPTION OF THE DISCOVERY SPACE</b>
<b>§1 HOME</b>	The point of arrival from the 'outside', introducing the purposes, structure and navigation possibilities of the KerViViANE system.
<b>§2 KERVIVIANE</b>	The KerViViANE 3-D Virtual World = the composite space that, as a landscape with active objects, allows navigation to and from the various functionalities and that, as a function of choices made by users, manifests a range of scenario features.
<b>§3 PHYT'AMIBE</b>	The principal 'Personal Barometer' of the KerViViANE system, which establishes a personalised profile of farming activity on the basis of data inputs to a questionnaire.
<b>§4 FUTURES</b>	The 'Scenario Generator', which organises the presentation and exploration of a spectrum of possibilities for the evolution of farming practices, land use and water quality at the scales of the commune (county) and wider territory;
<b>§5 CUBE</b>	DELIBERATION MATRIX = the KerViViANE 'Multi-Actor Game' offering the opportunity to engage in a multi-stakeholder multi-criteria evaluation of scenarios, introducing the user (or users) to the challenges of governance and conflict resolution;
<b>§6 IDBox</b>	The prototype (Version 2.0) KerBabel Indicator Dialogue Box for the KerViViANE system that establish a deliberation on indicator and their pertinence;
<b>§7 DOCU</b>	The 'Virtual Library' components (in the C3ED's KerBabel Gardens) that present documentation of the virtual and real worlds (including pedagogic materials).

In all these ways, ICT users are invited to travel in, and interact through virtual worlds, in order to gain new insights that may help to inform actions and bring about change in the real one. The raising of awareness passes through a discovery of the problematic at hand, the understanding of certain relationships which might cause conflicts, the deepening of knowledge, the representation of evolutions relative to individual behaviours and/or collective choice, and by an ensemble of interactions with other social groups and/or users. ViViANE sought to demonstrate ways of creating learning opportunities through a user's (or users') interactions within the virtual world. However, in the context of governance and scientific analyses and stakeholder dialogues, it is fundamental to highlight not just the learning opportunity but also the wide scope for users' inputs or contributions to the knowledge mediation system.

Users can define their own pathways in VIVIANE DST as the set of sequences of passages between these seven components referred to as "discovery spaces". By this way, they navigate – following the guided visit or as free visit or participating visit – and demonstrate ways of creating learning opportunities through or users' interactions within the virtual world. In all these ways, ICT users choose to travel in, and interact through virtual worlds, in order to gain new insights that may help to inform actions and bring about change in the real one

## ***Using learning pathways in a practical examples (ViViANE)***

### ***1. The beginning state of learning***

The purpose of the work associated with ViViANE was to address a recognised need for the improvement of knowledge and understanding of the issues associated with environmental governance as it related to sustainable agriculture. To address the beginning state of knowledge relevant to prospective users (stakeholders) of the ViViANE material, some key aspects were identified at a very early stage in the design of the material. First, the existing knowledge held by most of the relevant stakeholders. This was taken to be varied and perhaps unfocussed. In addition, it was believed that the opportunities for many stakeholders to consider and deliberate the underlying issues and concerns of environmental governance were poorly supported through the knowledge acquisition facilities commonly available to them. The significance of these two concerns, limited knowledge and the lack of opportunities for discussion and deliberation, was therefore important within the decision making processes for the determination of elements of the learning pathway around which the whole package was to be based.

Other information about the motivation for learning, experience of e-learning and awareness of the benefits of co-operative learning, were also examined in ascertaining the beginning state of learning of the potential users. Due their engagement in agriculture (at a practical level as well as at a decision making level) it was felt that many of the stakeholders would be reasonably motivated to learn further about the field of agricultural sustainability. It was felt, however, that many may not have engaged in e-learning using ICT or that many may not have had much awareness of, or experience in, co-operative learning. It was therefore planned that these features would be also be given prominence in the decisions to be taken about the design of the content of the ViViANE learning package.

### ***2. The end state of learning***

The end state goal of the learning package was to raise awareness of sustainable agriculture from a perspective of several different stakeholders. It was intended that this might be achieved through the creation of a combination of individual behaviour profiles to examine the issues which face inhabitants and which are associated with collective choice and life in rural communities. The material created was therefore planned to be applicable to individuals from different backgrounds where each had a stakeholding in the development of sustainable agriculture (for example, farmers, consumers, institutions, scientists, associations and industries). The expectation was that users would become informed about agricultural governance and would understand the explanations and justifications for changing behaviour relevant to the promotion of sustainable agriculture.

An early decision of the planning process was that users of the ViViANE material should be given the chance to develop their knowledge through examination and deliberation using available technologies. In this way, the skills associated with e-learning using information and communications technology (ICT) and with learning collaboratively, would figure prominently and consistently throughout the learning package.

The knowledge to be addressed was seen as professionally competent by experts in the field of sustainable agriculture and the sources used in the promotion of this knowledge were taken from the current appropriate professional literature.

### *3. The elements of the learning pathway*

On the basis of the awareness gained from examining the beginning state of learning and the expectations determined for the end state of learning, some key elements of the learning pathway were identified. They were,

#### i. To make the learning interactive

This was achieved through the design of the learning experiences around five core learning tools;

- a virtual world which provided an electronic landscape or gateway to the information to be made available to individuals or groups of users. Choices were given to participants to enable them to navigate within a relevant virtual world of an agricultural environment and to explore the problems of chemical pollution of water and soil associated with intensive farming procedures. It also allowed users to identify opportunities for personalisation of their relevant learning through the identification of perspectives of different stakeholders.
- a personal barometer which established a personal profile of farming related activities where each user can identify his or her own food consumption and water use as these relate to agricultural production. It permitted an exploration of the links between different lifestyles and land use within alternative land-use and water scenarios.
- a scenario generator to allow a realistic representation of different farming practices across time and at different scales of geographical size. It allowed users to see the effects of water and arable farming management on future projections of community lifestyle.
- a multi-actor game to allow the user (and several users simultaneously) to engage in the evaluation of different scenarios relating to decisions about types of crops, the use of chemicals and the financial implications of agricultural management. Included was the opportunity to address the challenges of governance related to economic, social and environmental conflicts which challenge the goals of the agricultural sector.
- a virtual library to bring users into contact with appropriate pedagogical material relevant to a consideration of the governance of sustainable agriculture. This material was arranged according to different specialists within agriculture to allow all users to identify reading material relevant to their own interests.

#### ii. To make appropriate use of Information and Communication Technologies (ICT)

The thrust of the whole learning package was to exploit ICT in creative as well as conventional ways. Accordingly, the provision of access to information which was relevant to the learning scenario was presented electronically to permit learning anywhere, at any time.

The use of e-learning was enhanced through the use of digital models and representations, based on up to date scientific and technical information. These included both 2-dimensional and 3-dimensional models and the use of high quality graphics which allowed dynamic perspectives to be selected by the users.

#### iii. To meet the needs of users through a progressive development of knowledge

This aspect of the learning pathway was achieved by a consistent approach of starting with concepts which were believed to be largely known and understood by users and progressing to some of the less well known, understood or even accessible forms of information. This approach was extended to include the progressive development of methods of data analysis and representation which were novel to the majority of users (such as the Deliberation Matrix, see Reichel et al., 2007a, b, c, d).

The progressive approach was also applied to the principle used throughout the learning material of presenting useable knowledge to the users before attempting to discuss the underlying hypotheses and controversies associated with scientific knowledge in the area of sustainable agriculture.

A specific example of progressive development of knowledge was the use of the scenario generator where learning was focused more clearly on extending and applying existing (and sometimes expert) knowledge to the selected environments of the learning scenario. The success of this learning development was supported by a conscious decision to pre-determine the issues to be addressed rather than attempt to adopt a limitless exploration of all possible features of the management of sustainable agriculture.

iv. To permit multiple perspectives to be adopted by individual users.

The integration of this element of the learning pathway was undertaken by including at all levels of participation in the learning package, an appropriate level of choice for the user. Therefore six different but relevant perspectives were provided for the user (they were described as actors within the ViViANE world and were scientists, farmers, manufacturers, consumers, associations and institutions) through much of the interaction within the learning material.

Similarly, the Personal Barometer for each user offered options in six different areas (agricultural practices; basic information informing the purchasing of pesticides; agronomic practices in relation to fertilisers and pesticides; equipment use and maintenance; awareness of risks of using chemicals; and overall perspectives of agricultural development). The choices made were displayed through a graphical representation (the 'amoeba' graph) which responded immediately when users made changes to their selections in each of the six areas.

### ***Implications for further or extended use of learning pathways in online integrated learning support tools***

The work described in this paper has attempted to demonstrate that the preparation of some specific learning material can usefully integrate selected aspects of learning theory (relating to the design and planning of a learning pathway) at the design stage. The implications of early planning decisions based on an awareness of a learning pathways approach are not hard to find.

In the establishment of the beginning state of learning with the ViViANE material it was necessary to ascertain some key features of the intended users (stakeholders) and this included their current knowledge, motivation, concerns, willingness to learn, awareness of e-learning, etc. In the process of ascertaining this information, some crucial insights were gained about the predilections and expectations of the potential users and this was used to substantially inform the design of the final material. The

contribution of users to the design of learning material is substantially ignored and deserves to be given greater attention and prominence. There is seldom much to be lost but a substantial gain to be achieved, by interacting and consulting with users long before the final version of new learning material is produced.

It seems hardly worth restating the importance of having a clear picture of the end state of learning when designing and planning new material, but sometimes the obvious is not so obvious. The clearer the goal is when producing material, the more likely the material is to be appropriately targeted. But there are circumstances when the outcome will be unclear (such as in the resolution of complex philosophical, social or political issues) and it may be sufficient to aim to get *some* conclusion rather than a prescribed one.

In the context of the elements of the learning interaction, one of the more straightforward decisions in the design of the ViViANE material was to make appropriate use of ICT. This is probably a common decision in the design of much current learning material, but it is worth reporting that when the ViViANE material was commissioned in 2004, the target audience for its use was wholesome in its support of the efforts made by the material producers for making substantial use of available modern technology. No novelty is claimed about using ICT as a medium for promoting learning in the ViViANE material, rather in taking the key decision to make all the work relate to ICT applications. Therefore making appropriate use of ICT was a central element of the learning interaction in the learning pathway. Learners clearly appreciated being given material which was well presented, stimulating, interesting and 'fashionable'. The use of computer graphics to present high quality three dimensional models (sometimes with a bird's eye perspective) might be seen as more relevant to users who have experience of 3-D computer images (such as in many modern computer games), but having taken the decision to use this format, the outcome was generally seen as moving learners forward in a manner which they otherwise may have avoided. The message from this experience was probably that learners can gain from using learning environments which are on the periphery of their current everyday experiences and that learning through new technology is likely to be worthwhile for most.

The decision about making interactive learning a central aspect of the learning pathway approach to designing a learning package was also deemed worthwhile. With a consistent emphasis on interaction in the design and preparation of the ViViANE material there were both expected and unexpected positive outcomes. The expected benefits derived from the engagement of the users in activities such as the multiplayer game (the Deliberation Matrix) where dialogue and debate between users certainly led to enhanced knowledge and improved perspectives. Among the unexpected outcomes was the development from using the personal barometer where learning progressed beyond the user's first attempt at identifying personal levels of the relevant variables, to seeking ways of getting a 'better' profile as a result of having learned from the information and discussion promoted in the package. It was clear that through having established a core emphasis on interactive learning, there were probably some learning benefits in areas where none had been anticipated.

The place of knowledge management was central to the planning and design of the ViViANE material and the particular focus was on the transformation of information into knowledge. For all those involved in the preparation of the learning material, the decision was taken at the design stage to make clear the distinction between

information transmission and information transformation. Whereas the transmission of information is relatively widespread in a very large range of information providing environments (such as the public information presented in large quantities by many official sources), the transformation of information is much more limited. One recognised means of identifying information transformation is to examine how (if at all) the individual uses the information which has been received and internalised (that is, if it has been meaningfully transformed). In learning material such as that in the ViViANE programme, it might be that users indicate current involvement with no additional participation and this could be associated with the receipt of *transmitted* information. Others, however, might feel more empowered and inspired as a result of having made a personal interpretation of the information available and thereby had *transformed* it into personal knowledge. It is the responsibility of effective learning material to promote such knowledge transformation and this is frequently not assumed to be a key task within the design of many learning packages. The evidence of the ViViANE material is that decisions about knowledge transformation should be taken at an early stage and maintained throughout the whole of the material preparation.

These few implications of the work associated with the ViViANE material may serve to indicate some value in adopting a learning pathways approach at an early stage in the design and planning of new learning material. The approach helps to establish a relatively clear perception of learning, notwithstanding the substantially more complex nature of the process of learning. Addressing the elements of learning may not produce for all the most insightful understanding of the learning process but it is very likely to focus attention on some of the key areas for taking decisions during the production of learning material. When considering all three stages of the learning pathway as described in the paper, it seems most likely that attention will be given to the important features of learning; learner needs, communication, negotiation, the difference between information and knowledge, the raising of awareness, and resources. Learning is all about making links and the more links which are identified during the planning and production stages, the more effective the learning material is likely to be.

It seems likely that the application of the approach advocated here could be used in the preparation of a wide range of learning material and consequently that there is room for substantially greater emphasis to be given to thinking about a learning pathway approach from early in the design stage. To aid that process, the following short checklist is offered as a template for potential users who might be able to attempt a learning pathways approach.

A checklist for following a learning pathway approach to designing learning materials;

1. Establish a comprehensive list of potential users
2. Determine what is already known and what is not known about the users
3. Engage with potential users (or a sample of them) to ascertain relevant information about them which has been judged to be unknown or not completely known
4. Reaffirm that information about the users is substantially complete
5. Establish the end state of learning, consulting with experts (and users) as appropriate
6. In consultation with relevant colleagues, decide on the key focuses of the elements of the learning pathway for the creation of the most appropriate learning event (this could be a complex process which may need frequent revision)

7. Write a design plan for the preparation of the learning material to include all the relevant information from the previous stages (this could be complex process which may require conferring and confirmation)
8. Identify appropriate evaluation procedures
9. Establish a timeframe for the material preparation
10. Prepare learning tasks and associated learning material according to the design plan
11. Pilot the prepared material and make necessary adjustments
12. Implement learning events and evaluations

The material which has been used in this paper as an example of using a learning pathway in practice is based on integrated learning tools for use in a multimedia environment, the ViViANE package, which itself was a part of the larger ViRTU@LiS multi-domain learning material. Adopting a learning pathway approach to the ViViANE package has shown some specific areas where the method may be extended, such as: the variable use of sources of (expert) knowledge provided in an accompanying virtual library; how knowledge acquisition aids informed deliberation and collaborative learning; the need for supported learning activities to address conceptual confusions; the quest for creative solutions in addition to current solutions for existing conflicts; feedback to learners on how their learning is progressing. Each of these aspects of learning could readily be taken as an element of learning interaction (area three in the learning pathway description given above) and each could therefore serve as a specific focus for the design of future or amended learning material.

Similar analyses of other applications of the learning pathway would equally lead to improved versions or to new examples of relevant learning packages.

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ViViANE is free access software available at: <http://Viviane.c3ed.uvsq.fr>

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See also: VGAS prototype (<http://alba.jrc.it/vgas/>)