

Paper 5

# The interactive website as a medium for teaching and learning:

## A case study in presenting introductory science

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### Summary

- The distinctive differences between html and published hard copy have been used to introduce a distinct pedagogic style, exploiting the benefits inherent within the nature of the newer medium. Such benefits include the 'unordering' of the material and the potential to 'hide' information or ideas. This paper describes one method of using interactive web sites to overcome the problems faced by introducing a science subject to new adult learners. The design of the site is discussed in terms of the learning aims and the inbuilt strategy.

Also explored are areas of tension arising from this approach. Within an interactive website this results from a degree of openness within a bounded system, issues of the 'mindset' within the design, and within the latter, the use of narrative and induction to invoke deductive methods and the realisations of tacit knowledge.

The experiences of the learners, with varied geological pre-knowledge, are described and evaluated and further possible developments are suggested.

## Introduction to the case study

- This case study investigates a stage in the development of a telematics-based method of presenting introductory geology to adult learners. The website discussed was prepared during summer 1997 as support material to the 'Global Systems' module of the part-time Certificate in Environmental Science. Due to low recruitment on the course, the website address was also provided to adult students on related courses, and trial sessions were run within the Division of Adult Continuing Education for academic staff from different disciplines and for support staff.

The website consists of an imaginary narrative based on the 'detective novel' genre containing a series of exercises through which geology is learned. The reactions of nine of the volunteers were assessed through taped interview and full transcripts were produced. The interviews were deliberately conversational, but with a limited number of areas to which the conversation was either guided, or of which specific questions were asked. These were the:

- perception of the type of reading of text that was occurring.
- degree of engagement with the content.
- learning and recognition of learning.
- perception of ownership of learning.
- perceived degree of autonomy within the site.

Experience of the technology and of navigating websites varied widely, as did pre-knowledge of geology. Whereas the Environmental Science students had all attended several months geology tuition at a beginners level, others summed up their experience as varying from university degree level to "nil, absolutely."

In analysing the data care has been taken to avoid "using technical procedures of analysis (to) destroy the real information and recreate it according to (my) own mindset" (Scheurich, 1995) and losing

real meaning "through 'systematic' analysis" (Mishler, 1991). Therefore, where relevant, levels of experience will be quoted where learners reactions are described.

## A non-linear approach to teaching

- Geology suffers the perception of being an amalgam of difficult 'linear' sciences, while having the disadvantage of having no centre or starting point. This leads to a convention of topic by topic approach. The idea for a different way of presenting geology arose as an analogy. If, even at introductory levels, a foreign language is largely taught in that language, then the nature of geology - its structure and the ways in which geologists think within the subject - should influence how it is taught. This 'mind set' element will be discussed later. The approach employed here, and termed 'Geological Jigsaws' (Toynton, 1988), introduces learners to several topics at one time and gradually expands their knowledge to encompass intervening topics. This approach, which has proved successful in face-to-face teaching (Toynton, 1995 and 1996), encourages an appreciation of the interrelationships within the subject.

The structure of the Geological Jigsaw website (<http://www.dearnevalley.org.uk/he/courses/env>) was therefore influenced by three criteria: enabling the learner to collect information and ideas, placing the methods of this collection within processes commonly used by geologists, and ensuring some learner autonomy within the site. The introductory stage trialed here allows the learners to discover the nature of the task for themselves, which, overtly, is to collect letters towards a password, allowing access to the second stage. The narrative throughout the site is based around the exploration of an imaginary island.

## The website as a teaching and learning medium

- That “technology changes both what we can do and what we decide is best to do” (Berge and Collins, 1995) led to this investigation of the potential of a website version of Geological Jigsaws through which a specific pedagogic strategy could be implemented. Telematics can never be as interactive as the face to face experience, especially where the latter involves the handling geological specimens, but it does offer the ability to both obscure and reveal information in a way that cannot be done easily face to face.

Hypertext is too often used just to place text on a screen. Whereas Rouet and Levonen (1996) recognise that “there is neither a general theory of hypertext, nor a model of the cognitive processes involved in reading hypertext” the disadvantages of disorientation caused by readers of hypertext ‘looping’ and flipping through the pages, often inadvertently, was recognised by Foss (1989). Also, while Dillon (1996) suggests that “it is a myth that associative linking of information (in hypertext) is natural in that it mimics the workings of the human mind,” it certainly can be manipulated to more closely parallel these than can a book. In website material a distinction can be made between ‘usability’ and ‘learnability’ (Rouet et al., 1996). Beyond these learner-centred qualities however, it is also possible to employ the structure, the links and the nature of the material to produce a deliberate rather than incidental pedagogic style, enhancing ‘effectiveness’ from the tutors perspective. Just as it is possible to design a website with links forming a linear route, so it is possible for more complex patterns of links to highlight relationships between topics and also allow the learner to create their own route.

Computer games exploit the property of the hidden size and structure of the site, and this can be employed in discovery learning. There is a danger however of invoking feelings of manipulation which would be counter-productive (Harris, 1987) and therefore a much simpler version of such games may be appropriate.

The key distinctions between ‘texts’ and this website, recognised and raised by learners in the interviews, were informality and the personality or ‘voice’ of the author in both the written material and the activities. Just as in the face to face situation, teaching on the internet should ‘play to the strengths’ of the personality of the teacher. The ‘voice’, in the words and the structure, may be the factor which changes informative text on the screen into a quite distinct learning medium. In this sense the website can be located between the book and face to face teaching, drawing from the particular strengths of both environments.

## The exercises within the website

- Learner discovery can only occur where something is not immediately apparent, though it is important that some information is clear at an early stage. There is a need for the learner to appreciate the scale of the ‘core knowledge domain’ (Bednar et al., 1992) since uncertainty of this can make the task of learning appear impossible. To make the outline clear and yet to allow for later discoveries is the problem, while making the learner experience one which contains enough challenge to generate ‘achievement motivation’ but avoids the ‘incompetence demotivation’ (Marton et al., 1984) which can result from too great a complexity of style or task.

The exercises within the website are all based around “processes commonly used by geologists”, these being observation, collection of information, application of prior or tacit knowledge, deduction, correlation and elimination.

One exercise requires a description of the derivation of the name of each geological period to be matched with the appropriate name. This involves information presentation and familiarisation with the geological column. The given derivations vary from the obvious to the obscure. By ‘ticking off’ the more obvious ones, the learner narrows the options by elimination until fewer choices, and even fewer guesses have to be made.

Another exercise consists of damaged specimen labels, with letters missing. By using words within general knowledge, such as quartz and slate, the learner gains confidence from recognising their own knowledge. The labels also provide information about materials on the island. By completing the labels and clicking on the letter most commonly missing, a part of the password is revealed.

There is also an array of specimen drawers, the names on which must be remembered to answer a series of questions linked such that a correct answer to one leads straight to the posing of the next, and not back to the array. This provides further information about the island and promotes observation. The final question asks which label is spelt incorrectly, emphasising that the future information required may not always be that which is expected, and therefore observation of all that is presented is the best strategy.

Within a set of notes describing a walk across the island is a description of the strata crossed and the altitudes at which the boundaries are encountered, followed by two questions. To answer these questions the learner must make the realisation that the order in which the rocks occur will be constant and that the strata must be sloping. This requires careful reading, visualisation of the island, correlation of the strata and deduction of the geological situation.

## The use of narrative

- Within the fictional narrative of Geological Jigsaws, topics are previewed, later considered in more depth and frequently revisited so that knowledge of each topic and its relationship with others, develops throughout the course. By placing the learning in a fictional setting and allowing or guiding the learners to their own realisations, 'learning by discovery' and the creating of a 'reality' follows. In such a constructivist approach, there is normally an emphasis on situating the "cognitive experiences in authentic activities" (Duffy and Jonassen, 1992). In this method, by placing the experience within a fictional narrative, a mock-authenticity is achieved.

The narrative involves a person arriving on an island following the death of a relative and realising that only through learning the local geology can information be gathered allowing them to inherit. Information left by the deceased is used to guide learners towards the goal, through a series of self-ordered discoveries and the assembling of a password. The latter is a simple way to ensure that all pages are visited.

With learner freedom within the site comes the need for an incentive to explore and interact with the site. To have any degree of openness, the movement of the learner within and between sections must not be by direct teacher command. Einstein (1949) stated that "it is a grave mistake to think that the enjoyment of seeking something and searching can be promoted by coercion and a sense of duty." Embedding an imaginary narrative may address this problem.

The 'detective' narrative as well as lacking explicitness, seeks to harness curiosity, but in a way which does not become frustrating or patronising. The motivating force is the curiosity to find out just what the treasure on the island is: the "who done it". Within this, lies the challenge to find the code word within each section. Throughout the course, the aim is to provide a structure through which the learner will encounter enjoyment, engagement, challenge and learning. Through interview it was ascertained that none of the learners found the narrative trivialising or patronising. Also in the interviews the question of engagement with the material was addressed. The responses from all but one of the interviewees suggested real engagement and even the statement: "I could have done it for ever." The exception was a learner who had studied geology to degree level and felt "a little on the outside looking in."

## The recognition and use of tacit knowledge

- Tacit knowledge can be of two kinds: that which McConnell (1994, p16) defines as 'unconscious' and therefore not known to the self or others, and that which is known but not made explicit. For the new learner it is important to recognise and vali-

date their own tacit knowledge. All of the exercises include this as an aim, and in particular the one involving partially destroyed labels. The website also attempts to build further tacit knowledge which can be utilised later, through the inclusion of seemingly irrelevant information and ideas, prior to them being addressed explicitly.

There was a positive reaction to the recognition of tacit knowledge in this case study. The two learners with the greatest pre-knowledge of geology, found that at this level they made no new realisations, while the two ranked below them on this criteria reacted with: "I....surprised myself when I realised how much I could remember" and "I realised....that I knew a bit more than I thought I did. It suddenly came across 'Ooh, I've come across that word before!" One learner with no pre-knowledge of geology stated: "I ...thought 'Oh I do know something about this subject after all.' So there was that sort of 'Oh' type of feeling."

These reactions suggest true realisation.

## The issue of the 'mind set'

- In promoting learning through processes central to the way geologists think within their subject, the idea is not to instil intellectual uniformity, but rather to allow the beginner to think 'along the grain' of the subject rather than against it. There is however an undercurrent of imposed uniformity in the mind set approach; of the accepted and uncritical. It can appear closed to the 'strategic heresy' of Reinhartz (1992). Within introductory courses however, the responsibility to 'strategic heresy' may be outweighed by that to the conventions since for a heresy to develop validity it must be based on a knowledge of the conventions it challenges.

To define 'mind set' is important, since meanings vary with different usage. Marton et al. (1984) write of those involved in teaching economics, philosophy and science emphasising the need for the learner to come to think in the way characteristic of each subject. Previously Kuhn (1974) argued that a sameness develops within the language created by the use of common concepts. This is made more explicit as: "in cleaving to its own specific body of knowledge a community commits

itself to what is a system of conventions" (Barnes and Edge, 1982, p5). Lieberman (1987) describes how the learning of trainee programmers was enhanced by the use of example, since through this, the underlying concepts were learned through practical means. This parallels another aspect of the 'mind set' approach within Geological Jigsaws.

In employing the 'mind set' approach and resultant website structure as a means of inducing the learner into a pattern of learning, a tension must be recognised between the method and the anticipated results. Plummer (1983) describes the theory underlying the humanities as 'inductive and grounded', and that underlying the sciences as (deductive, abstract and based on the operationalist). The mind set approach requires the induction of deductive processes, even though, if learning and the exploration of tacit knowledge is best achieved through doing, then the most effective way to invoke a 'scientific' mind set must be through 'scientific' methods such as deduction, observation and the controlled experiment. Returning to a previous analogy, to teach a language in that language works because the method is based on a valid means of communication which can be 'translated' in a simple way from the experience of the learner. To attempt to teach beginners algebra by only employing symbols and equations lacks such a means of communication. The spoken language is required to explain the unfamiliar abstract, in the same way that induction can be used to invoke deduction. That part of the 'scientific' base used in the process is Plummer's 'operationalist' strand. The 'doing' involved in exploring and bringing tacit knowledge to bear belongs to this strand of the 'scientific' and encloses the 'humanities' methods enabling them to be applied without tension.

Within Geological Jigsaws it was intended to invoke eliminism in the exercise dealing with geological periods, by allocation of the known and the obvious, narrowing down possible answers for the remainder. Of the five learners with whom this issue was raised, only one had employed eliminism. The poor rate of success may have been due to the lack of difficulty in most of the questions asked.

The exercise based on the walk aimed to foster logical thinking, but also included the need to picture a simple three dimensional geological situa-

tion. The relative difficulty of this exercise was raised by most of the learners. For one it was “the least enjoyable part” though for a learner with no pre-knowledge of geology and an antipathy to the subject it provoked the response that she “read (it) several times to get the answer (and) ... hadn’t thought of things in quite that way before.” The quality of reading was a useful outcome of the exercises. One learner “was tending to read fairly slowly to be sure that I hadn’t missed anything” while another “was trying to skim-read .....to get through it quickly....(but) had to go back and read it in more detail”, supported by a third who “started skimming it and then I realised...I had to read it much more carefully.”

The learners realised that they were being asked to think about the geology in a particular way, though explicit evidence of deduction, eliminism, correlation and observation is not easily recorded. The number of learners who remembered the misspelling of quartz suggests that observation was recognised as important. Deduction and correlation were invoked largely through the exercise based on the walk, and all recognised that deduction was necessary, if not always successful first time.

It is the failure of eliminism which may illustrate a problem of using ‘learning through the mind set’ concept here. The website is the introductory section of a course which itself is introductory. Eliminism cannot be forced, and if the learners already know the answers, is obsolete. This does not make the exercise pointless, since in subsequent sections, as material becomes less familiar, so eliminism would become more relevant. Since adult learners come with a whole range of levels of pre-knowledge, all the ‘methods’ should be present in all stages, since different learners may need to start using them at different stages..

## The degree of openness within the learning strategy

- The internet is a very open or ‘unbounded’ learning resource within which discrimination is necessary. Where learners are guided to particular material, or sites constructed for specific groups,

the degree of openness is diminished, and the need for discrimination lessened. Where such specific material appears, the openness for the learner is in the order and amount of ‘knowledge’ consumed (Hodgson et al., 1987)

The attempt to design a learning resource with openness is doomed to failure if measured by certain criteria. In that the “teacher, task and learning environment are all under teacher control” (Boud, 1988), any openness or learner autonomy must be internal to that environment. Where ‘openness’ is proclaimed, it is that defined by the teacher, and is therefore based on the assumption of a position of dominance of the teacher, which the openness is trying to overcome (Giroux, 1985). The definition by which some openness can be achieved is that of Dick (1992) where the concept is extended to learners taking some control of the exercise and at times operating “beyond the information given”. An element of ‘learner control’ can be inbuilt by designing a website which is ‘unordered’ in a way that a book or list of material or tasks can never be. The ‘learning’ is within a bounded system but choosing order is for the learner.

In Geological Jigsaws the aim is to contain some reflection of reality, and to allow the learner to choose the order of task, discover material and come to realisations, and yet all of this must be contrived by the tutor/author. The most ‘comfortable’ approach is to have the structure, processes, aims and expected outcomes made explicit from the start. However, in terms of openness, if the tutors expectations of the learners behaviour within the system and the learning that should be achieved are made explicit, all openness has gone. The uttered expectations of the tutor will be a straightjacket upon the learner, and no realisations or discoveries will be real.

The paradox is the imposed structure to foster some openness: allowing discovery and realisations to be owned by the learner and yet attempting to make them inevitable. By dividing the web site activity into stages, a structure is imposed, but this itself is left to the learner to realise, thus sharing some of the power of the teacher with the learner. Within an unsupervised website the learner has the freedom to make mistakes, to come to the wrong

conclusions, but then to test them and discover the mistake in private and therefore without embarrassment.

Concerning openness within the site, one learner “felt guided,” another that “the order didn’t matter” while another felt it “structured ...such ...that you’ve got to go down the maze in a certain way.” One learner obviously detected manipulation, since his response included “being made to jump hurdles to find something out rather than being able to go to it direct”, though this was tempered by the insight that “overtly you’re trying to get to the answer to the quiz, but covertly...you’re learning new information.”

The very introductory nature of the site and the non-integration of the material at this stage may also explain the limited success of learner choice within the site. Many worked through the exercises in the order of the links on the pages. Since the exercises were all introductory, these learners were inadvertently obeying a further precept of geology - “where several interpretations are possible, and there is insufficient evidence to make a real choice between them, choose the simplest.” Had the exercises been more challenging, different learners may have chosen different orders. Again, to introduce the principle of choice at this level may be important, even though it may not be used until later.

## The issue of explicitness of purpose

- In order to reflect a reality in the narrative, uncertainty, choice and serendipity must play their part. An exercise where all is explicit would reflect a real world situation where all information is known and only deduction and analysis is required. The field-worker in geology parallels the detective in piecing together facts and circumstantial evidence to build an interpretation based on the balance of evidence far more often than on proof. Perhaps by invoking the ‘detective’ model, the learner will be more comfortable with the lack of explicitness at the start of the exercise. This issue was raised with the learners. Although two would like to have known the aims from the beginning, another stated:

“it would have changed my perception of what it was about, and then I wouldn’t have sat back and enjoyed it as a game or a quiz... my ‘mind set’ would have been different. It would have been a little bit more ‘sat up straight in the chair’.”

## Identifying learning

- There were three areas of geological knowledge within the exercises: general items of fact or theory, the processes of geological knowledge creation and the specific geology of the island. These were addressed within the interviews. The three learners with greatest pre-knowledge of geology felt initially that no new knowledge had been gained, though one qualified this with “I think it helped me in using what I did (know).” The others felt that knowledge had been gained, and in some cases this included the processes, as illustrated in the following quotes:

“I think I can even remember some of the names, and the awareness of the overall approach, and the techniques used by the geologist. ....that the geologist is a detective in a way.”

“By learning the methods of enquiry ....I would think ‘Ah, now I will go off and do it with the real rocks.’”

Of those interviewed, all had increased their knowledge of geology. For those with considerable pre-knowledge, there was reinforcement, but even though they at first did not all recognise any learning, when challenged they realised that they had constructed a base of geological facts about the imaginary island. All learners could remember some of the strata mentioned in the walk, the names on the drawers and the labels. That quartz, which was deliberately mis-spelt on a label, was remembered by all who took part, suggests that in this case pre-knowledge of geology seems far less important than the associations made within the narrative by the learner.

Asked whether they felt ‘taught’, all replied in the negative. Two learners took more personal responsibility for the learning, one stating “I was wanting

to learn more myself” and the other “ I did not feel taught in the conventional sense....It was a sense of discovery which was good”. All of the learners perceived a personality within the site, and regarded this as a positive attribute. Comments included “this (site) was friendlier, more approachable”, “there was a human voice there...it wasn't just a faceless thing” and “I felt that I was in touch with the person who had created the pages”.

### Potential for further development and conclusions

- This website constituted a resource for a group of learners, while testing the effectiveness of the method. The reactions to it will help shape the stages yet to be constructed. The second and third stages, as already presaged, are based on the contents of a trunk and a personal computer. The former will allow the introduction of text-based internet resources and images of specimens, while the latter will allow the learner to explore other world wide web sites. Once access to the personal computer is gained within the narrative, e-mail links to other learners and the tutor can be added. It may possible to incorporate Slavin's (1990) 'jigsaw' concept by imparting, over e-mail, later parts of the narrative from different perspectives to various learners, such that only through discussion can a full picture be constructed.

The limited openness within this website was appreciated, if not fully exploited. Learning certainly occurred: of geology, of some processes used in thinking within geology and of the particular 'location'. The learners felt engaged and enjoyed the experience. The application of some of the processes was very limited at this early stage, but despite this, the case study suggests that the method is worth pursuing further.



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