Learning style and learning strategies

in a multimedia environment

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There is a growing realization that it may be expeditious to combine elements from different theories of learning when trying to derive a coherent and usable policy towards computer-mediated learning. Consideration of the subtle distinction between Computer-Aided Learning (CAL) and Computer-Aided Instruction (CAI) can form the basis of a possible classification of computer-mediated learning, and hence of multimedia tools. This classification enables the development of a continuum upon which to place various strategies for computer-mediated learning, and hence a means of broadly classifying multimedia learning tools.

It is also important to consider the characteristics of the user when deciding whether to employ interactive multimedia as a tool for learning. Learning style is predisposition to behave in a particular way when engaged in the learning process. Learning strategies are the methods employed by the learner to achieve learning. Taking the work of Pask (serialist/holist) and Kolb (learning Style Inventory) as starting points, research is being done to investigate links between learning style and strategy and multimedia. Such knowledge could prove invaluable when attempting to design multimedia learning materials for the widest possible educational use.

Introduction

Two important factors need attention when contemplating how and where to use the new computer-based learning technologies. Firstly, in order to select the right kind of software, it is necessary to have a clear picture of the desired outcomes of a particular learning situation. There are many varieties of interactive multimedia available, and matching the tool to the job should be an early consideration. Of equal, if not greater importance, is the question of whether, for a particular learner, interactive multimedia is the most appropriate learning tool. If there is too great a mismatch between the learning styles and strategies of a particular learner and the given learning environment, learning may be inhibited rather than enhanced.

The right tool for the job?

Behaviourist theories of learning have been largely overshadowed since the 1960s, when modern cognitive psychology began to gain in importance. Generally, behaviourism relies on a definition of learning as an observable change in behaviour not caused by physical development of the subject, and as such disregards internal learning by a process of maturation. The rationalist/cognitive approach places the main emphasis on the acquisition, manipulation and recall of abstract symbols, implying a greater interest in the mental processes involved with learning. It would be simplistic to assume that theories of education rely exclusively upon either of these extremes. However, they do offer a convenient starting point upon which to build a framework wherein to establish the capabilities of interactive multimedia as a tool for learning.

Table 1 shows the evolution of the two main strands of computer-mediated learning. CAL implies an active role for the student, who is more in charge of the learning process, and hence has greater freedom in the management of this learning. CAI suggests that the student is the recipient and adopts a more passive role.

Table 1: Table to show the relationship between computer-mediated learning and learning theory

Theories of Education	
Instructional Approach	Learning Approach
Behaviourist	Cognitivist
Skinner, Pressey . . .	Piaget, Bruner, Gagne
Computer Aided Instruction	**Computer Aided Learning**

← classification by amount of learner freedom →

This framework enables the development of a continuum on which to place various strategies for computer-mediated learning, since as the use of computers as learning tools matured, it resulted in a wide diversity of applications. Some of these are shown in Table 2.

Table 2: Table to show relationship between strategies for computer-mediated learning

Computer Aided Instruction		**Computer Aided Learning**
← classification by amount of learner freedom →		
drill and practice	case studies	all open styles of learning
equipment simulations	experiment simulations	rule-based problem solving
some limited problem solving	business and strategy games	exploration of information bases
routine testing		creative composition

In general, CAI leads to a single learning outcome while CAL encourages a variety of learning outcomes. Intelligent tutoring systems, which have been produced as an application of artificial intelligence, develop elaborate models of the expert and the student but are focused on the support of a single learning outcome. Cognitive tools (Jonassen, 1992), on the other hand, are environments that support a wide range of learning tasks in almost any content domain. Between the two extremes, lie microworlds (Kommers, 1992), where a more closed environment offers apparently free exploration but limits the conceptual domain in order to focus the attention of the learner. The placing of learning outcomes and environments within the same framework as before is shown in Table 3.

Table 3: Table to show learning outcomes and environments

Computer Aided Instruction		**Computer Aided Learning**
← classification by amount of learner freedom →		
single learning outcome		multiple learning outcomes
intelligent tutoring systems	microworlds	cognitive tools

The steadily-increasing range of interactive multimedia applications and authoring environments can also be placed on the same continuum between CAI and CAL. It is cost-effective, both in money and time, to try and match a particular learning situation with a suitable multimedia environment, since much of the complexity of some of the more sophisticated CAL applications may be wasted on a simple CAI implementation.

Table 4: Table to show placing of some commercial IMM software

Computer Aided Instruction		**Computer Aided Learning**
← classification by amount of learner freedom →		
self-contained closed environments	self-contained but allowing limited links to restricted range of external sources	completely open environment supporting almost unrestricted links
eg Hypercard	Supercard, Toolbook, Authorware, Guide . . .	Microcosm . . .

Table 4 shows the placing of some of the many different interactive multimedia environments onto the same framework as earlier.

The right job for the tool?

Learning style can be considered as a predisposition to adopt a certain kind of behaviour

when engaged in the learning process. For example, Table 5 shows an overview of learning modes as suggested by Kolb (1984).

Table 5: Overview of Learning Modes (Kolb)]

mode	focus	emphasis
concrete experience	involvement in experiences	feeling as opposed to thinking
reflective observation	understanding the meaning of ideas and situations	understanding as opposed to practical applications
abstract conceptualization	using logic, ideas, concepts	thinking as opposed to feeling
active experimentation	actively influencing people and changing situations	practical application as opposed to reflective understanding

This behaviour is influenced by the ways that learners process information, and how they react to certain learning situations and environments. This will result in certain preferences and tendencies to adopt particular habits or patterns, known as learning strategies. These patterns or habits may be liberating or inhibiting, depending on the learning situation, and therefore an understanding of the learning style of the learner is desirable, both for the learner and for the author of learning materials. Once this information is gained, guidance and advice on the adoption of the most appropriate learning strategies may be formulated.

There are several components of learning style, usually categorized as cognitive, affective or environmental (e.g. Smith, 1983; Kolb, 1984; Coates, 1991). The cognitive component encompasses the internal processes of learning. The affective component pertains to the feelings of the learner, and as such includes aspects such as the measure of structure and authority within the learning situation, which affect the amount of autonomy the learner has, and the expectations and motivation of the learner. The environmental component ranges from physical considerations of comfort to more abstract influences resulting from emotional support. The adoption of a particular learning style may be influenced by the learning task in progress, or by psychological predisposition, or both. Where this produces a conflict, it may be reasonable to assume that the learning process is impaired.

Learning strategies are the particular habits or patterns espoused when engaged in the learning process. The proficiency of different learners in learning, reasoning and problem-solving varies widely, and so do the strategies they evolve to carry out these activities. Hayes (1985) raises the possibility that there may be several hundred plausible learning and thinking strategies, and identifies at least fifty different strategies that he himself presents in a basic learning-strategies course for students. Many researchers (e.g. Hartley & Davies, 1976; Rigney, 1978; Tessmer & Jonassen, 1988; Coates, 1991) have examined

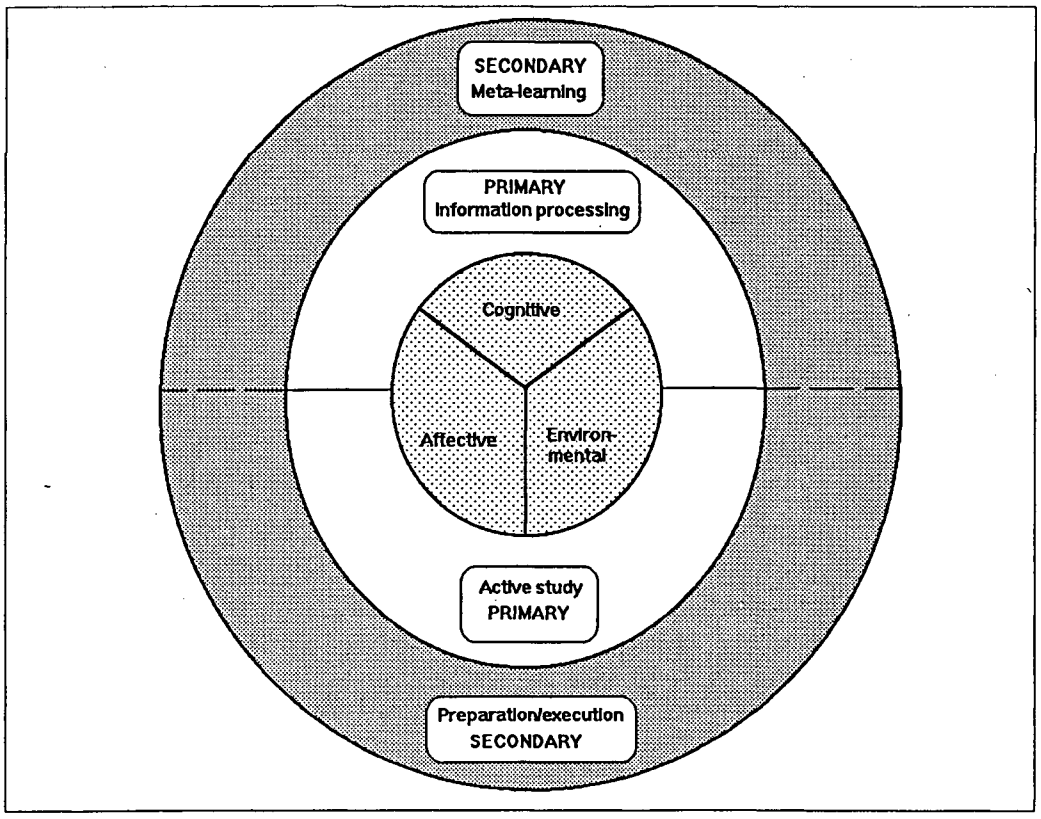

Figure 1: Relationship between components of learning style and primary and secondary learning strategies

the field of learning strategies, which has emerged as part of the cognitive science revolution in instructional technology.

Successful learning strategies enable learners to manage their own learning process and integrate new learning into their own existing cognitive structures. Unsuccessful or inappropriate learning strategies may inhibit learning (Pask, 1976; Ford, 1985).

Although there is general agreement on what learning strategies are (how one uses one's head when learning) and what they do when successful (help one to learn), the way they are viewed varies considerably. Nevertheless, despite the large number and wide variety of learning strategies, it is possible to group them according to how they affect the learning capacity of the learner. The major grouping is into primary strategies, which act on the information to be learned, and secondary strategies, which provide support for the learner. Primary strategies include information processing strategies, which have more influence on cognitive aspects of learning style, helping to enhance mental organization

and recall of material, and active study strategies, which often involve physical activities such as note-taking and seek to improve the affective and environmental components of learning style. Secondary strategies help the learner to establish a suitable mental and physical state for learning and to monitor progress as learning proceeds. These secondary strategies may be considered as meta-learning strategies and preparation/execution strategies (Tessmer & Jonassen, 1988). The relationship between the cognitive, affective and environmental components of learning style, and the broad groupings of learning strategies which may be favoured is shown in Figure 1.

Some experimental results

A preliminary study has been carried out in order to identify some of the links between learning style, learning strategy and the use of interactive multimedia as a tool for learning.

The experimental group consisted of course members for the MSc in Information Systems, which is a conversion course for students with little background in IT, but a wide range of non-IT experience. Kolb's Learning Style Inventory (Kolb, 1984) was used to investigate the learning style of each student. Learning strategy for each was broadly assessed by means of the single question identified by Clarke (1993) as a possible indicator of serialist/holist tendencies. The application used as a vehicle for the study was an interactive guide to the use of a complex telephone console (Paterson, 1990).

Four different navigational tools were available. These were:

- Representational: a graphic of the console and keyboard.
- Schematic: a hierarchical map showing the structure and subdivisions of the information available.
- Descriptive: a verbal list of information about keys offering more detail than the map but reflecting its structure.
- Menu: a pull-down menu listing the high level subdivisions of the information.

Students were allowed to browse the application freely until they were confident that they understood its structure. They were then given a question sheet which grouped questions under six named section headings and asked that these sections be searched to find a total of sixteen specific pieces of information. No time restrictions were applied, but all students completed the work to their own satisfaction within one hour.

An analysis of the total number of pages visited during the search for information was carried out so as to establish the potential validity of the data. For 28 subjects, the range was 70 pages (13 min, 83 max), the mean was 47.93, mode was 55.00 and median was 47.50. It was therefore decided to exclude the lower quartile (<33 pages) from analysis of preference for navigational tools on the grounds that the search for information was too cursory to produce a meaningful pattern.

Analysis of paths taken through the interactive-multimedia application shows distinct preferences by different users for different navigational tools. Representational (graphic/picture of telephone console), Schematic (map), Descriptive (verbal listing of keys on console) and Menu (pull-down list) tools were all freely available. In order to compare preferences, ratios of visits between pairs of tools were calculated from the original totals of visits. Boxplots were made of the ratios console/keylist, console/map and keylist/map (Figure 2).

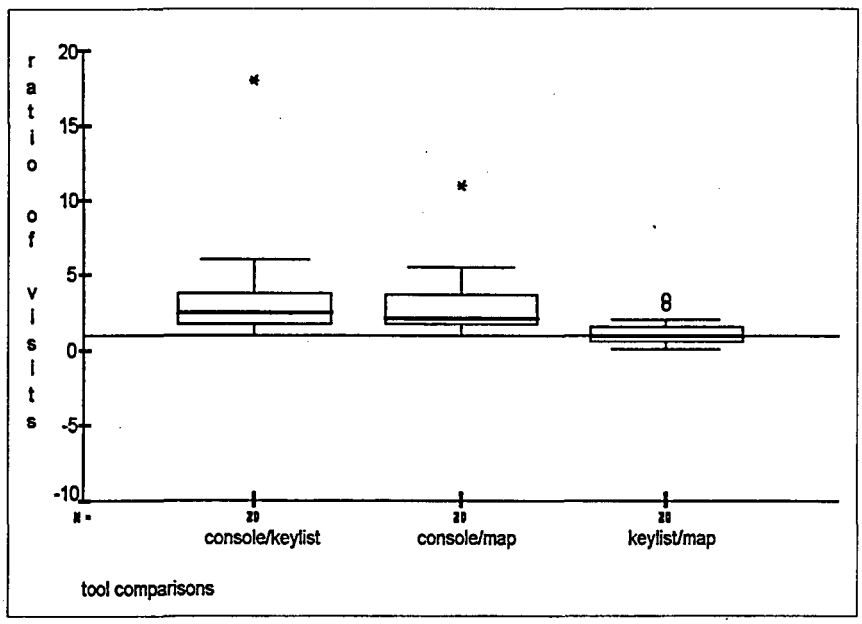

Figure 2: Boxplot to show comparisons between preferences for navigational tools

The horizontal line at ratio = 1 represents equal preference. It can be seen that the console was clearly preferred over both the keylist and the map, and that there was a slight preference for the keylist over the map. This result was unexpected, since the most commonly provided navigational tool is usually the map.

As described above, it was decided to exclude the lower quartile (<33 pages) from analysis of preference for navigational tools. This raised the question as to whether there was any discernible consistent reason for the cursory nature of the search as performed by these subjects.

Scatter plots of combined learning-style scores obtained form the Kolb analysis were plotted against number of pages searched, and the result of the active-reflective versus pages searched may be significant (Figure 3).

It can be seen that for all subjects whose searches were considered cursory, their

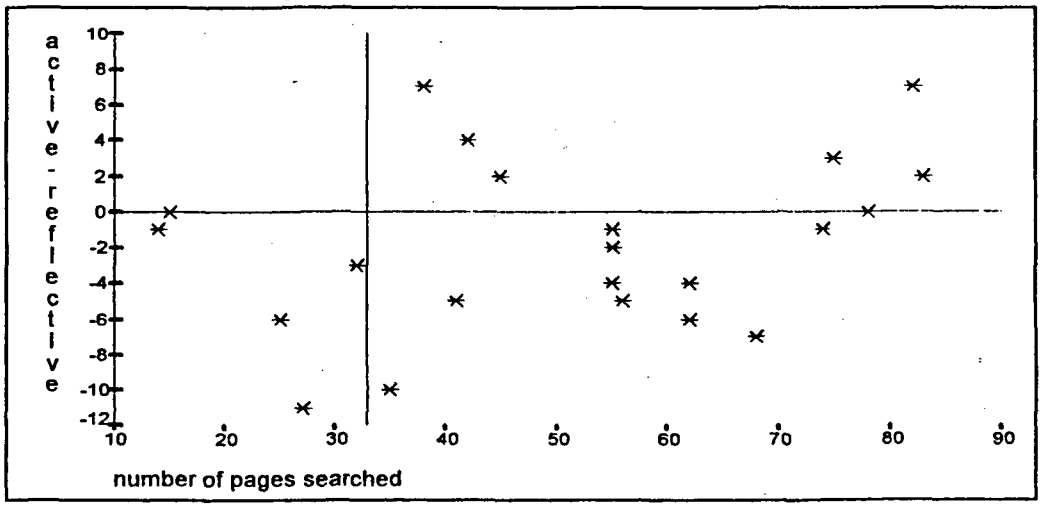

Figure 3: Scatterplot of combined active-reflective learning style (Kolb) and number of pages searched

orientation towards reflective observation, which emphasizes understanding as opposed to practical application, outweighs their orientation towards active experimentation (that is, their combination score on the active-reflective axis is <=0). The relevance of this is a matter for conjecture, and needs much more investigation, but it might correspond to a reluctance to delve too deeply into an unfamiliar computer environment such as interactive multimedia.

A further exploration of the data suggested an investigation of correlation of learning strategy with preferred navigational tool. A snapshot picture of serialist/holist tendency for each student was obtained using the following question (Clarke, 1993):

When I'm reading a book (or other information source) for my studies, I prefer to spend quite a long time skimming over and dipping into it to get a clear picture of what it's about and how it will be relevant	1 2 3 4 5	When I'm reading a book (or other information source) for my studies, I prefer to get quite soon into a fairly detailed reading of it once I know it's going to be useful, in the knowledge that its precise relevance and contribution will become clear from a detailed reading

While plots of console/keylist and console/map ratios showed an even spread across breadth-first depth-first strategies, the keylist/map ratio (which indicated no real preference for either tool – see Figure 2) was more interesting. Figure 4 shows the keylist/map ratio plotted against breadth-first/depth-first learning style preferences.

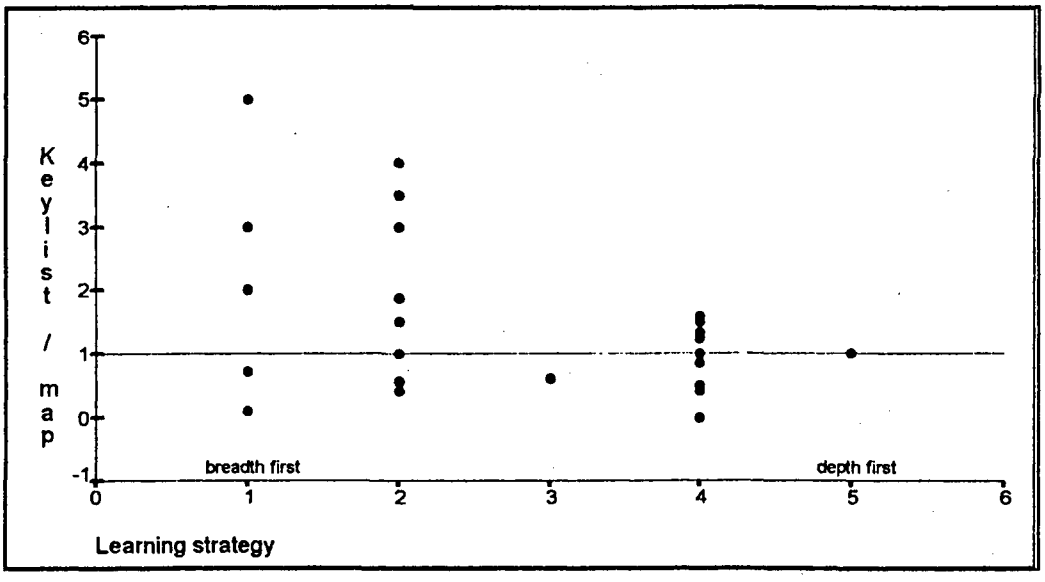

Figure 4: Plot to show relationship between keylist/map ratios and preferred learning strategies

The keylist is a descriptive tool which offers more detail than the map, and seems to be preferred by those who adopt a global approach to problem solving. Since a map is usually assumed to give the best overview, this result was somewhat unexpected. However, it may be that on this occasion the detail given in the keylist gave the better overview, and that the map encouraged a more linear approach.

Future work

Clearly, this preliminary exercise has produced more questions than it has answered. The study is being extended to include field dependence/independence tests (Witkin *et al.*, 1977) and further experiments are in progress. It is possible that for some students, the increased use of interactive multimedia as a learning tool may be a potential handicap instead of the expected advantage.

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