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Synthesising technology and context for instructional multimedia information systems within the primary classroom

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Abstract

Instructional multimedia often fails to realise its full potential, particularly with young children. This paper contends that the pedagogy of the primary classroom may gain from careful consideration of technology and context. It is argued that technological shortcomings stem from a lack of interactivity and structure, while contextual inadequacies emanate from the unsuccessful integration of the three 'C's: CAL, classroom curricula, and children. These issues are addressed in Mu.P.P.E.T., a system modelled on the UK National Curriculum.

Keywords

Computer assisted learning, instructional multimedia information systems

1 THE POTENTIAL OF MULTIMEDIA FOR EDUCATION

Studies and reports are beginning to suggest measurable improvements from the use of multimedia technologies at a time when their use within software and schools is increasing. Three main arguments tend to be used when advocating multimedia for educational purposes. Perhaps the most widely exercised is multimedia's potential for high retention rates and improved understanding. Research (e.g. Christel, 1994) frequently indicates a positive correlation between retention rates and the number of senses used to acquire information. Second, a system is only useful if the learner is active and motivated throughout the teaching-learning interaction (Woolf and Hall, 1995), with a student's overall satisfaction also making a significant contribution to learning success. Multimedia has the potential to motivate a student to use an instructional system and explore it more fully than he otherwise would, thus allowing more learning to take place (Angelides and Dustdar, 1996). While the computer is a

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novel system for the child in itself, multimedia technology is seen as still more exciting, intriguing and new. A third often advanced argument is the reduced space necessary and speed of referential access that multimedia peripherals provide. The storage of huge quantities of information allows both teachers and students to use information resources that have hitherto been physically and conceptually inaccessible.

2 THE REALITY OF MULTIMEDIA FOR EDUCATION

While the arguments above are convincing and to a certain extent valid, they tend to overlook the fact that multimedia is part of a complete system that is used within a specific context. These shortcomings are now discussed.

Existing instructional multimedia systems may be classified along a continuum according to whether they are (1) linear or interactive; and (2) structured or unstructured. Linear systems are those with a pre-defined sequence of events that the student-user cannot, or rarely can, alter; whereas interactive systems provide the student-user with some degree of control so that he can interact with the program in some way. In contrast, structured systems are those where progress through the system is clear to some degree and the student-user may learn within a framework of more or less explicit goals; while unstructured systems provide little indication of the way a student-user may progress through the system, thus learning generally takes place within a framework of investigation and simulation. Combining the two classifications provides us with four distinct categories:

- **Linear-unstructured systems.** These systems provide little in the way of structure or interactivity and as such are typically videodisks or CD-ROMs that have a minimal, or no, computer interface, e.g. The Adventures of Jasper Woodbury (Barron and Kantor, 1993).
- **Linear-structured systems.** Such systems provide minimal, or no, interactivity although they do provide a structure to the learning process, e.g. The Five Points: A Multimedia Experience in Social History (Picciano, 1993).
- **Interactive-unstructured systems.** These systems provide much in the way of student involvement in the program, but have an informal structure to them. Consequently, they are typically simulations, e.g. The Cardiac Tutor (Woolf and Hall, 1995), or highly interactive 'digital encyclopaedias' with advanced search and select capabilities, e.g. The Multimedia Encyclopaedia of Mammalian Biology (Rada, 1993).
- **Interactive-structured systems.** These are the least common. Typically highly interactive and goal-directed, they afford a formal structure to the learning process even if this is within a simulation, e.g. The Pupil Examination System (Lee and Kaufman, 1994).

Page turning or browsing is now commonly accepted as not ensuring effective learning (Woolf and Hall, 1995). Instructional systems with a 'page-turning architecture' (Schank, 1994) go back to the behavioural psychologist B.F. Skinner whose 'teaching machines' of the 1950s embodied the belief that the goal of learning is for the student to exhibit certain behaviours, thus they attempted to 'condition' the student-user by immediate presentation of correct answers on error. All users were treated the same by the program. Skinner's theories have since been refuted yet similar systems still prevail with typically linear movement and no more interaction than the occasional pressing of a few buttons (see above).

Linear-unstructured systems essentially amount to no more than a sequence of standard video footage, while linear-structured systems are essentially electronic books. Inasmuch as the latter offer a limited form of goal orientation, i.e. reaching the end of the book signifies completion, they can be considered to have a slight educational advantage over the former, but this is not significant enough to warrant their independent use in the classroom. This is why they are supplemented by active teacher involvement. This paper, however, adopts the standpoint of making multimedia instructional systems as independently instructional as possible. This does not mean that the concept of teacher involvement must be rejected completely, but that teacher activity should not exist as a 'cover up' because of a pedagogically poor system. There should be no weak links in the learning process. Thus passive systems must be dismissed as not indicative of truly instructional multimedia systems. Passive systems frequently fail to motivate the user because 'they merely add video and graphics to page-turning programs. ... Good educational software is active, not passive, and ensures that users are doing, not simply watching.' (Schank, 1994). The situation is analogous to the early days of television where announcers would read the advertisement off camera while signs containing the message were held in front of a television camera.

Many authors (e.g. Schank, 1994; Feifer, 1994; Woolf and Hall, 1995) have strongly advocated simulations as an alternative and this seems to be the currently prevalent paradigm. While simulations can provide an environment for tasks that might otherwise be too costly or dangerous, it should be remembered that simulations are only models, models which may be detrimental when interacted with. Roszak (1994) argues that children may believe that controlling the simulation is controlling reality. With the ever-increasing quality of multimedia the, especially younger, learner may begin to see the simulation as reality itself. Pre-multimedia instructional systems that used graphics and animation posed less of a problem for they were less 'lifelike'. The whole essence of multimedia is lifelikeness. One need only read how one proud author described a simulation he had developed that used multimedia technology because it 'strengthens the connection between reality and what is being taught' (Feifer, 1994). The difference is akin to that between cartoons and films: children have less trouble distinguishing the former from reality. Moreover, simulations typically exist in unstructured systems with little coaching and guidance for the student-user. Tutorial guidance is necessary so that flaws in the student's decisions may be recognised and explained and apparent impasses overcome. From this line of argument one must favour, when designed suitably, interactive and structured instructional multimedia systems.

It is also necessary to consider the context of use. In this respect there is a marked lack of educational software that reflects existing classroom curricula (Roszak, 1994) or is geared toward the very young, and fewer that facilitate both. I term this problem of incorporating classroom curricula into CAL software that is used with young children **the three 'C's** and believe it to be an important issue for two main reasons.

First, systems that do not represent, or misrepresent, what is actually being taught in the classroom are rarely used or, worse, cause the classroom to change in order to suit the system. Land and Somogyi (1984) term this case 'system dominance' where feedback from the system is high, but that of the environment (in this case, classroom curricula) is low, thus change is induced in the environment and not the system.

Second, many cognitive psychologists, most notably Piaget, have differentiated between the mental states of various age groups. Children between the ages of two and seven (approximately) cannot yet, according to Piaget, deal with thinking in any formal or abstract way, requiring instead to be able to think about real or concrete objects, e.g. using an abacus for simple addition. He coined this group 'pre-operational thinkers'. Instructional software targeted at such an age group should address this issue, disregarding more abstract, invisible concepts and providing for more concrete ones which are visible and embedded in the real world. Using multiple media should be beneficial here. By compelling the young to use software designed for older children we may not be achieving the levels of tutoring competence that a properly targeted system could provide.

3 THE MU.P.P.E.T. SYSTEM

To examine how the above concepts may be embodied in a complete instructional system, development was undertaken on Mu.P.P.E.T. (Multimedia Pedagogue for Primary Education and Tuition), an intelligent instructional multimedia information system developed using Asymetrix Multimedia Toolbook for Windows. Mu.P.P.E.T. is intended to tutor a knowledge of animals to primary school children aged between five and eight (Piagetian pre-operational thinkers). The system has been designed to fit within the framework of the National Curriculum for England and Wales (DFE, 1995), thus the target child would be approaching the end of Key Stage 1 (ages 5-7) or just beginning Key Stage 2 (ages 7-11). In particular, the system supports the following areas of what pupils should be taught of the Science Curriculum, sub-section 'Life processes and living things': from Key Stage 1, Section 1 (Life processes): '(a) that animals, including humans, move, feed, grow, use their senses and reproduce', and Section 2 (Variation and classification): '(b) that living things can be grouped according to observable similarities and differences'; and from Key Stage 2, Section 1 (Life processes): '(a) that there are life processes, including nutrition, movement, growth and reproduction, common to animals, including humans', and Section 5 (Living things in their environment): '(a) that different plants and animals are found in different habitats'.

Structure and objectives are provided by Mu.P.P.E.T.'s knowledge base, which represents the animal domain through a hierarchy of frames. The system's main goal is to communicate the knowledge of the hierarchy to the student by navigating through it, whereas sub-goals are realised by asking questions about the various elements and relationships therein. Multimedia is used whenever appropriate. Being an entirely factual domain, the tutoring of animals is an inherently concrete process. It is enhanced by the use of full-motion video in addition to text and sound.

The questions increase in difficulty as the student becomes more knowledgeable (consistently answers questions correctly) and are made easier as the student becomes less so (consistently answers questions incorrectly), although the answers remain the same. For instance, an easier question may be, 'Is an elephant a reptile?' where the student replies 'Yes' or 'No'. The more difficult version may then be, 'What kind of animal is an elephant?' where the student types the answer 'Mammal'. It is this questioning which provides the interactivity, particularly the system's reluctance in bombarding the child-user with factual information until an error is made. Even in this situation, remediation is given with information presented gradually so that the child may discover the correct answer himself. The more mistakes the child makes, the closer he becomes to being told the actual answer or the question being skipped entirely. In this way, the 'page-turning' architecture is avoided.

Mu.P.P.E.T.'s underlying aim is not for the student to answer all of the questions correctly, but to realise his errors. In particular, concern is not with successfully communicating **all** of the domain knowledge about a particular animal or class, but to be sure that the child has **some** knowledge of all the animals in the system. This is because the results of the child's session with Mu.P.P.E.T. are intended to provide feedback to the teacher so that they may tutor the student further. The system may even be used as a precursor to normal lessons, providing children with valuable background knowledge that should encourage them to be more active academically during the lesson. To this end teachers are provided with access to details of students' progress so far so that they may intervene and supplement the tuition as necessary. The teacher is thus supported as an active component within the learning process. This assists in balancing the varied requirements of the three 'C's.

4 CONCLUSION

This paper began with a discussion and critique of the potential of multimedia within education. In particular, it was argued that, particularly when used with the very young, multimedia should be integrated into a complete instructional system and contextual dimensions considered as well. An example of how this may be carried out was given through a discussion of the Mu.P.P.E.T. system. In the light of initially encouraging results from multimedia use, the need has now arisen to step back and assess progress so far. What is suggested is the contingent nature of multimedia. If multimedia is to be used for educational purposes then it warrants further investigation. Nowhere more so is this true than with the very young for here is a group that has often been inadequately considered. Suitably fusing the technological and contextual concepts presented in this paper assists in providing a valid pedagogical environment that supports the unique nature of early learning. It is then that the true potential of multimedia is harnessed.

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6 BIOGRAPHY

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