

# Interactions in multimedia learning materials: The things that matter

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## **Abstract**

Interactions and interactivity have become key elements characterising much of the teaching and learning associated with new technologies. In essence, the terms describe the means by which the user communicates with the technology and brings about a change or response as a consequence. An important aspect in the development of technology-based learning materials, is the consideration and choice of the interactions that are needed to support the required learning outcomes.

The presence of interactions and interactivity in technology-based instructional materials have become synonymous with enhanced learning. There are many forms that interactions can take in the development of instructional materials. There are also many purposes that the interactions can serve. The purpose of this paper is to examine the place of interactivity within the whole context of designing educational multimedia materials and to discuss the important attributes of interactions from a learning perspective.

## **Instructional Materials**

Instructional materials prepared in any medium consist of 3 discrete elements, content, organisation and interface. These elements define the essential characteristics of the package when they are combined to create the instructional sequence. The different media in which instructional materials can be developed all have unique and distinct attributes. Through these attributes, the content, organisation and interface can all be varied to provide the unique forms which we see in instructional packages across the different media forms. Before proceeding to discuss the factors that characterise instructional materials, it is useful to consider each of content, organisation and interface to distinguish between them and to establish the role of each in instructional materials design.

**Content:** This attribute describes the information that is contained within the product. Books and paper-based materials are limited in the content that they can carry. Typically this includes such elements as text, diagrams, graphics and photographs. Video materials are able to support temporal media forms such as sounds, animations and moving images as well as static graphics. Multimedia materials support many different media forms combined in instructional settings.

**Organisation:** The content within learning materials is delivered according to the manner in which it has been stored and represented. With books and paper-based materials, organisation tends to be sequential where one chapter leads to the next. Video materials also embrace sequential organisation and most materials designed with this medium are designed to flow from one point to the next in the order in

which they appear on a tape. Multimedia materials can support multiple organisational modes that extend beyond the sequential modes that constrain conventional forms.

**Interface:** The interface of learning materials describes the environment in which the information is presented. The computer interface describes the image that is displayed and the elements that form the operations of the display. Books for example can use a variety of interfaces, ranging from standard black and white pages as were the norm in the past, to colourful pages comprised of well designed text and imagery as we often see today. Video materials tend to be limited in the interface design, the medium requiring quite standard approaches. As with the previous attributes, multimedia materials support a range of interface designs and approaches.

While each of these elements can be considered as discrete and separate items in the design and development of multimedia materials, the design process often causes the distinctions to become blurred. Designers often blend and combine the elements in innovative ways to create and enhance learning opportunities. The attribute of educational multimedia that facilitates the linking of the content, organisation and interface elements is the interactivity which the product provides.

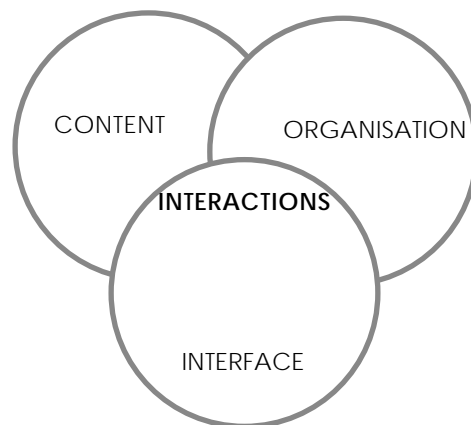
### **Interactivity**

Interactivity is a critical attribute of technology-supported educational environments. This term is used quite freely in current descriptions of learning materials but as Reeves (1995) points out, the term seems the unique domain of instructional technologists. The term, interactivity, describes the forms of communication that the medium supports enabling dialog between the learner and the instructor (Jonassen, 1988). With multimedia, interactivity is easily observed. As with human dialogue and communication, users are able to communicate with multimedia materials through established modes and the materials have the capacity to react to the communication. It is an interesting exercise to consider where interactivity sits in the above model describing the elements of instructional materials. Experience with the diverse forms of interactivity supported by multimedia cause many to consider interactivity as another discrete element of instructional materials.

What some fail to realise is that interactivity, as we have come to understand and define it, is not the sole domain of multimedia. Instructional designers have been creating interactive elements into conventional materials for many years. Many text books for example contain quizzes and questions that users are required to complete. The success of the activity can then be judged according to responses in the form of answers provided in some other location in the book. Well designed video materials can offer the same forms of interactivity. Problems and tasks can be posed for users to complete off-line. Once the tasks have been completed, the users can then restart the video and judge the quality of their responses by the solutions offered by the video materials (eg. Herrington, 1993). While such features are possible components of conventional instructional media, they are not always the

common attributes that they are in multimedia materials. Interactions and interactivity tend to be considered characteristic features of multimedia materials.

The forms of interactions that are supported by learning materials are many and varied and serve many different purposes. It is possible using the above model to consider interactions as discrete components of the existing attributes. Some interactions are designed as part of the learning materials and as such are best seen as elements of content. Other interactions are present to enable the user to control and manage the materials and are elements of the interface. Yet another form of interaction is used to locate and access the content. This form of interaction is tied directly to the organisational structure of the materials. When interactions are considered in this broad context, it is evident that rather than being discrete elements within instructional materials, they become characteristic of the complete package. Interactions and interactivity are evident in the content, the organisation and the interface (Figure 1).



**Figure 1**  
The principal components of educational multimedia materials

In multimedia learning materials, the nature and design of the computer-based instructional episodes, draw heavily on the need for human-computer interaction. Most programs are built with high levels of user involvement, but many of these interactions are really quite inconsequential in terms of the learning sought by use of the package. Each stage and step in the process of working with the computer demands communication between both. Thus to initiate the instructional program, the user must press certain keys or commence some action. In response to this action, the computer is programmed to react and as the sequence continues, the user is able to choose and run the particular learning package. These forms of interactivity are all related to managing and controlling the medium. The parallel activity with a book is opening it and turning the pages. This is not considered an interactive process though because the actions are not conducted in a way that suggests communication or stimulus and response. If an electronic device was used as a book opener and page turner, things might be different.

In a similar vein, users are often provided with many options for controlling the program interface. Such actions as scrolling text windows, moving, resizing and closing text windows are all interactions according to the true sense of the word but clearly have minimal impact themselves on learning outcomes. Although important from a usability perspective, such interactions are usually very simple forms of communication, usually selections from menus indicated by key presses and mouse clicks.

Multimedia materials support many different forms of content organisation when compared to conventional materials. The media elements and instructional episodes can be organised and stored in many different ways ranging from linear and hierarchical forms to the more flexible referential forms. To facilitate navigation and choice between the elements and forms, interactions are created. Once again, the forms of interaction used to facilitate navigation are usually quite simple. Common examples include selections from menus and tables using mouse clicks or keyword entries using the keyboard. In themselves the interactions are very efficient forms of communication, a little like answering yes or no to direct questions from a teacher.

While the interactions that are used to support the interface and navigational aspects of multimedia materials offer little chance for enhanced communication and dialogue, the interactions that form part of the package content differ considerably. When interactions are planned as part of the content, that is as part of the learning process, their value and place in the package takes on a higher domain. In these instances, the interactions can become true communication exercises where reflection and consideration on the part of the user becomes an integral component in the learning process.

### **Defining Interactions**

There have been many attempts to define and classify the different forms of interactivity that can be used in the development of multimedia materials. Sims (1994) describes interactions as a series of seven levels each distinguished by the form of communication between the user and computer represented. These descriptions are very broad in their scope and tend more to describe instructional design principles than interactive elements. The levels include navigational elements, feedback strategies and interface elements and in doing so provide a framework for comparing multimedia programs rather than the attributes of interactions. It is argued that by classifying the interactions in this way, designers are better able to integrate the various media elements based on instructional decisions rather than visual appeal. Other descriptions of interactivity are provided by authors who use context rather than purpose as their defining characteristics. Jonassen (1988) for example distinguishes between the different forms of interactivity by considering aspects of the instruction and learning that are supported. The levels include a range of supporting and overlapping elements that include learner characteristics, task specification, cognitive processing, program attributes including flexibility and intelligence. This form of description provides a means for comparing the learning potential and adds an important domain, that being consideration of the learners'

role including the manner of implementation. Both are factors with considerable potential to influence learning outcomes. Yet another form of classification is provided by Schwier and Misanchuk (1993) who distinguish between interactions according to three dimensions; *levels*, the nature of the thinking and engagement of the learner, *functions*, the purpose and context of the interactive communication and *transactions*, how the interaction is physically carried out. This description provides a very functional form for analysing the interactive elements in multimedia programs as it clearly distinguished between the forms, the purpose and the application of the interactions. It is clear in these descriptions of the different forms of interactivity supported by multimedia learning materials, that interactions play many roles in multimedia design with some able to contribute to learning outcomes more readily than others.

Laurillard (1988) describes learning as a conversational and communicative process. The interactions in the learning processes supported across the different media are essentially communicative episodes. In broad terms, we have always had interactions in teaching and learning but since they are part of a dialogue and a natural language process, they are rarely considered and described in such terms. While it is useful from an instructional design perspective to be able to define and distinguish between the many different forms of interaction and interactivity that can be used in multimedia programs, from the learner's perspective, the important consideration is not the type or form of the interaction that matters. Rather it is the instructional purpose served by the interaction and the contribution that it makes to the development of knowledge and understanding. This contention is derived from a constructivist epistemology which values learner-centred activities facilitating personal involvement in creating and framing knowledge construction. When constructivist principles are applied to teaching and learning environments, the key purpose is to enhance learning by supporting higher levels of cognitive activity among students. Activities such as decision making, reflective thinking problem solving and metacognition are key aspects of higher order cognition (cf. Lebow, 1993; Reeves, 1993; Rieber, 1992). In multimedia environments, interactivity is the key to creating these forms of activities.

Figure 2 shows a continuum along which the level of cognitive activity associated with multimedia interactions can be described. When interactions are considered in this fashion, their contribution to the learning process can more readily be judged. It is an interesting exercise to take multimedia packages and to use a description of the form shown below to gauge the extent and form of interactions that are present. Low and mid level interactions predominate in most instances. They are more easily created and implemented in the instructional design process and support a more bounded and defined finished product. But it is clear when students are observed working with such interactions that learning is not an automatic outcome of the process.



**Figure 2.**  
**Interactions in educational multimedia**

It is important to realise that while the development of appropriate forms of interaction in multimedia learning materials is a necessary condition for the development of higher order learning, this alone is not sufficient. The nature of learning achieved through interactions with multimedia learning material is defined by aspects beyond the software itself. There is a growing body of research that clearly demonstrates the strong influence of cultural and social factors associated with how the software is implemented (Mercer & Fisher, 1993). This adds yet another dimension to considerations of the learning potential of computer-based interactions, that of interactions with and beyond the computer-based environment.

### Research Findings

Our research at Edith Cowan University has been exploring students' use of educational multimedia and electronic information systems (Oliver, 1995; Perzylo & Oliver, 1994; Oliver & Perzylo, 1994, Oliver & Oliver, in press). A focus of this research has been the investigation of the students' ability to extract information from the multiple media sources that are contained within the packages they have been using. This research has revealed that the nature and form of the interactions employed in the design of multimedia materials has considerable bearing on students' learning and retention.

In a recent study, our research revealed that successful use of electronic information systems tended to depend on the development of discrete levels of knowledge pertaining to the multimedia program being used. These levels of knowledge were described as management, navigation and organisation. Management described the knowledge required by students to successfully operate and control the interface. Navigation represented the skills and knowledge required to move between the media elements and program sections to access particular information. We used the term organisation to describe the knowledge involved with actual program interactions and found that this level of knowledge was intrinsically of a higher level than the previous two.

Investigations of student behaviour were undertaken by observing the students' interactions and activities while completing set tasks. The study revealed that most of the activities involving interactions with the interface and navigation controls were carried out automatically and with low levels of cognitive activity and processing. On the other hand, the nature of student behaviours when interacting with the

content varied considerably depending on the context and purpose of the interaction. It was clear that in instances where the activity was planned and considered, students used higher levels of cognitive activity and achieved greater learning outcomes when compared to students who sought information through browsing or unstructured search strategies. While the students were using the same multimedia package and using the same interactive elements, it was the way in which the interactive elements were used that was the principal factor in determining outcomes, rather than the form or nature of the interactions themselves.

It is fascinating to watch the ease with which very young students learn to operate and control new multimedia packages. As students gain experience with different packages, there is a high degree of transfer of skills and knowledge from previous activities and experiences. Students have a sense of what forms of response to expect from different actions. Once students have had a degree of experience and in some cases a degree of training in specific functions of packages, we find little evidence of students experiencing any subsequent difficulties with interface control or operation. This leads us to assert that with time, use of the many of the interactive elements of multimedia programs will become automatic to users and of marginal bearing on what is learned.

Our most recent investigations have centred on the levels and forms of information that are retained through different interactive processes. We have compared users seeking information from text-based sources and from animations and interactive graphics. Preliminary analysis of the data suggests that the use of an interactive element of one form or another in working with a multimedia package does not guarantee knowledge acquisition or concept development. More important contributions to learning outcomes appear to be derived from the context and motivation accompanying the task. When students use the materials in a thinking and decisive way, they are better able to gain the forms of knowledge and understanding sought by the instruction.

In many of our studies we have observed students spending large amounts of time interacting with multimedia products, seeking and extracting information in response to set tasks. Our findings support those of others engaged in similar research that achievement is not necessarily greater than that achieved by students using conventional and non-interactive learning materials (eg. Large, Beheshti, Breuleux & Renaud, 1994). We know that if knowledge acquisition and concept development are to be achieved, the forms of interactions most likely to support this are those that more successfully engage the learner in higher order cognitive activity. The interactions that promote this are more open-ended and variable in their design. They are not necessarily software independent and can often be created through appropriate implementation strategies. What matters is not the method or form of the click or key press but the means by which the choice is made and the consequence of that choice in promoting thinking and reflection.

## **Conclusions**

Interactive multimedia materials by their very definition involve large amounts of learner initiated activity and action. While many consider that the interactions in programs make a significant contribution to achieving learning outcomes, most interactions play no such role. Interactions are present in all components of instructional materials, the content, its organisation and the interface through which it is presented. Interactions play a communicative role in the human-computer dialogue. Much of the communication is given to instructions and controls of an operational nature.

In considering the value of interactions from a learning perspective, the key attribute is not the function or form of the interaction but rather the nature of the thinking it encourages in the learner. Effective multimedia materials require interactions that do far more than manage and control the program and provide choices for the user. They require interactions that provide a context and setting in which students can explore and inquire. What matters is not whether it is a mouse that is clicked nor a key that is pressed, it is not important whether it is pull-down menu that is selected nor a button that is clicked, the things that matter are the decisions that are made, the processes employed in making the decision and the consequences that result.

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