Multimedia Distance Education Interactions

Juhani E. Tuovinen, *Churchill, Victoria, Australia*

Abstracts

English: The nature of multimedia interactions in distance education discussions has been approached from many different perspectives. This article attempts to synthesize approaches based on distance education theory, cognition research and multimedia development. As a result a composite framework for discussion of multimedia and multimodal interactions in distance education context is proposed, which is based on interactions between the instructor, students and content. This framework should be useful for establishing clearer relationships among the existing interaction literature, for classifying interactions in distance education instructional design, and as a basis for further research.

Français: La nature des interactions multimédia dans les discussions en enseignement à distance ont éte abordées sous différents angles. Cet article cherche à faire une synthèse des approches basées sur la théorie de l'enseignement à distance, les recherches sur la connaissance et les developpements multimedia. On propose un cadre composite pour la discussion des interactions multimédia et multimodales dans un contexte d'enseignement à distance fondé sur les interactions entre l'instructeur, les étudiants et le contenu. Ce cadre serait plus utile pour établier des comparaisons plus claires entre les écrits sur l'interaction pour classer les interactions dans l'élaboration de l'enseignement à distance et pour jeter les bases de recherches futures.

Deutsch: Die form von multimedia interaktionen in diskussionen über DL ist von vielen verschiedenen seiten her angegangen worden. In diesem beitrag wird versucht, überlegungen aus der DL-erziehungstheorie, der lernforschung und der multimedia entwicklung zu vereinen. Als ergebnis wird eine vielfältige struktur zur diskussion von multimedia und multimodal interaktivitäten in der distance education vorgestellt, die auf interaktionen zwischen dem lehrenden und den studenten sowie den inhalten beruht. Diese struktur sollte bei der gewinnung klarerer einsichten aus der literatur, bei der einordnung von interaktionen in DL-unterrichtsdesign und als ausgangspunkt für weitere forschungen hilfreich sein können.

Introduction

The importance of multimedia and the value of interaction in distance education are commonly accepted. However, both of these concepts and the relationships between them are not always as clear, or as fully elaborated as we may assume. In this article these issues are examined on the basis of distance education theory and educational cognition theory. Four main interactions in distance education will be discussed, mainly based on Moore's conceptualization (Moore, 1989; Moore and Kearsley, 1996). Each of these interactions will then be elaborated in terms of the communications media involved and the educational implications of recent cognition research. The resulting interaction framework for distance education provides a useful basis for discussion of distance education technologies, techniques and instructional design. It helps to map out issues requiring further research, and should point out the relationships between existing research and its implications for distance education practice and theory.

The Moore distance education interaction model

We shall begin with the model of distance education interactions proposed by Moore (1989; with Kearsley, 1996). He distinguished three main types of interactions in distance education. They are *learner–content* interaction, *learner–instructor* interaction and *learner–learner* interaction. He argued that articulating and defining these interactions would help to dispel some of the misunderstandings that had arisen in the debates about educational media.

His three interactions model will be used in this paper, although Soo and Bonk (1998) added to this *learner–self* interaction, where they highlighted the importance of the learner's reflections on the content, the 'self-talk', in

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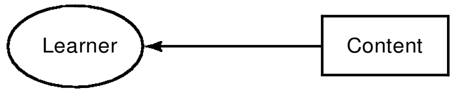

Figure 1 *Learner–content interaction*

distance learning. This was treated as an essential aspect of the learner–content interaction process by Moore (1989). In this discussion we will treat the learner–self interaction as part of the learner–content interaction as Moore did in the original formulation of these ideas.

Learner–content interaction

Learner–content interaction is without doubt one of the most fundamental interactions in any educational situations. The intellectual engagement of the learners with material which changes their understanding, attitudes, etc. is basic to all educational processes (Moore, 1989).

One-way presentation technologies

We could classify the content presentation distance education media and communications technologies available for this engagement using the media/technology categories developed in a discussion of online learning (Tuovinen, 1999). The nine categories are text-only, graphics, video, virtual reality, sound, and combinations of sound with the other elements, as shown in figure 2. Each of the categories in the sequence: 'text → graphics → video → virtual reality' can contain the previous means of communication in the sequence, e.g. in a picture (graphics) text may incorporated, and a video may convey still pictures and text. Thus as we progress to the media on the right we move to richer dimensions of educational communication and engagement.

The explicit separation of the sound category may appear trivial at first but recent cognitive research indicates it is very important to consider the added contribution sound makes to the educational engagement between a learner and the content. If we consider the structure of the human cognitive architecture it becomes clear that we have a very small capacity for conscious processing in our central thinking space, usually called the working memory (Baddeley, 1990; Logie, 1996; Miller, 1956). However, the working memory is thought to consist of separate processing spaces for visual and auditory information (Baddeley, 1992), which means we have a greater capacity for problem solving and learning if the information is presented in these two modes rather than in either mode alone (Mousavi, *et al.*, 1995; Tindall-Ford *et al.*, 1997). Thus we have evidence to support the use of multimedia, i.e. educational multimodal presentation.

The experiments on multimodal presentation of information indicate that the best benefit is gained when the information to be learned is complex, i.e. has high element interactivity (Sweller and Chandler, 1994), and when the two modalities present different aspects of the learning content. When material from different sources needs to be integrated mentally in a given cognitive task, such as from a picture and text or verbal explanation, the research indicates that a combined graphic-auditory presentation is better than the graphic-textual version (Mousavi *et al.*, 1995; Tindall-Ford *et al.*, 1997). This result is best understood in terms of the dual parallel processing capabilities of the human working memory, where the single modal graphics-text presentation overloads the single visual working memory loop. In contrast the graphic-verbal separate modal presentation engages both the visual and auditory processing components of the working memory and enables the learner to deal with more information.

Thus we have solid evidence to indicate importance of multimodal or multimedia presentations of learning–content to students in the distance education learner–content interactions if the material to be learned is complex. On the other hand, educational cognition research suggests that if the material is simple, i.e. has low element

	Text	Graphics	Video	VR
Sound	Text + Sound	Graphics + Sound	Video + Sound	VR + Sound

Figure 2 *Learner–content media interaction dimensions*

interactivity, then presenting it in multimedia form, especially if exactly the *same* information is presented both verbally and in text or graphics, may make learning more difficult due to the redundancy effect (Bobis *et al.*, 1993; Chandler and Sweller, 1991).

2-way learner-content interaction via interactive multimedia

In all of the above interactions between the learner and the content, the interaction is assumed to be one-way, i.e. the content is presented to the learners for their consumption, without the learners affecting the content as they internalize it (see figure 1). However, the promise of interactive multimedia has always been an active engagement of the learner with the learning environment, as shown in figure 3. We shall consider how this may be achieved from the perspective of an educational multimedia designer.

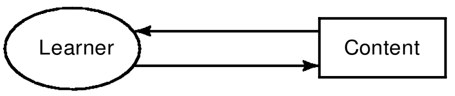

Figure 3 *Two-way learner–content interaction*

Seven (plus one) levels of multimedia interaction

Sims (1994) argued that a multimedia designer may structure educational software to provide the learner seven levels of interaction. The designer may confine the software user to passive interactivity where they can simply influence movement through a single sequence of presentations. At the second level the learner may work through a hierarchy of choices in navigating through presentation screens, and at the third level the operator can update information in the programme. The fourth level consists of construct interactivity where the user manipulates objects to achieve a goal. At the fifth level the learner participates in a simulated operation of an environment. At the sixth level of free interactivity, the operator is provided a hyperlinked source of information, which can be traversed at will. Finally at the seventh level, the learners are able to work in a meaningful, job-related context. They experience a microworld of the actual operational environment they seek to master.

A further level of interaction may be added to this list. In many educational situations the benefits of involving students in creating multimedia as part of their learning is recognized (Blumstengel and Kassanke, 1998; Dunlap, 1998). This constructive activity goes beyond the seven levels suggested by Sims, where the students act to design the multimedia. Thus eight levels of learner engagement with multimedia content are possible, these levels of are summarized in table 1.

Are there any empirical guidelines to help choose the level of interactivity desired for given content and students? Some initial pointers may be gleaned from research into discovery learning and the use of computers in schools. Research on discovery learning in a computer environment indicates that if the learning content is demanding, i.e. has high element interactivity, unless the students have good domain schema they will not benefit as much from free exploration as from more structured study, such as practice with worked examples (Tuovinen and Sweller, 1999). However, the same study also indicates that once the students have adequate schema in the domain, an exploration approach is at least as good, and may even be better, than a more structured approach,

Table 1 *Eight levels of 2-way interaction with multimedia*

Level	Learner–multimedia interaction
1	Passive, 2-way flow control
2	Choices from a hierarchy
3	Information update control
4	Construction with components
5	Participation in simulation
6	Navigation of hyperlinked information
7	Operation in a microworld
8	Multimedia creation

Table 2 *Social and instructional interactions in educational sessions (Gilbert and Moore, 1998)*

Social interactions	Instructional interactions
Body language	Communication of content
Greetings, socializing	Setting objectives
Exchanging personal information	Questioning
Scheduling	Answering
Logistics	Exchanging information
Class management	Pacing
	Sequencing
	Branching
	Adapting
	Evaluating
	Individualizing
	Handling responses
	Confirmation of learning
	Controlling navigation
	Elaboration

indicating the benefits of increasing student control of learning and 'fading' of tutorial support as they master particular content area (Cox and Cumming, 1990).

Another study found that the benefits gained from students constructing educational multimedia (level 8 activity) was related to their skills with the authoring environment (Wallace and Tuovinen, 1992). Thus if the students are expected to benefit from constructing educational multimedia, as suggested at the eighth level of interaction above, they will need to be familiar with the software authoring environment and processes (Blumstengel and Kassanke, 1998).

Schwier's (1993) taxonomy of multimedia interactions also recognizes the highly structured multimedia learning environments, like the worked examples practice discussed previously. He would call it a *prescriptive* environment. He also identifies a *democratic* learning environment, where the students are proactive, very similar to levels six and eight identified in table 2. Although he discusses the relative merits of these environments for different students and course aims, he does not appear to explicitly recognize the need for students to move from the prescriptive to the democratic environments as they progress. He also describes a third multimedia learning environment, a *cybernetic* environment, where mutual adaptive interactions occur between the learning system and the learner. This might be equivalent to the seventh level of interaction in table 1. However, an important feature of this environment is the availability of various forms of hints and assistance from the learning system. Such learning systems may use artificial intelligence to monitor and assist the students and perhaps interface with the students via virtual reality. Thus the key aspects of Schwier's taxonomy appear to be covered in table 1 and the discussion of the various media in figure 2 deals with some of his media dimensions.

Instructor–learner interaction

The second of Moore's interaction categories focuses on the instructor–learner interaction. Research indicates this dimension is vitally important for distance students without onsite teacher support (Braggett *et al.*, 1995; Brown, 1996; Stephenson, 1997–98). The communication between the instructor and the learner may employ any combination of the nine media/technology categories shown in figure 2 but is by definition two-way in nature, rather than one-way. Thus whether the student and the tutor exchange messages via mail, email, phone, voicemail, or participate in audiographic sessions, videoconferences, or even in real-time virtual reality activities, they are engaged in an interchange of information in two directions.

Some instructor–learner exchanges are *synchronous* and others *asynchronous* in nature. All the learner–content interactions are synchronous, but in many of the instructor–learner engagements time delays add a further complicating dimension. Usually the longer the time delay, the less effective the feedback, as shown in the exchange of distance education materials (Biner *et al.*, 1997) and feedback on assignments (Roberts, 1996). So it appears the asynchronous mode is less desirable, but the possible time delays in many types of tutor-student meeting systems

– even with the most modern technologies, such as email exchanges, online newsgroup discussions, etc. – may have some real advantages. When complex issues are discussed, for example, the participants need time to thoroughly digest new information and formulate considered replies. Thus both asynchronous and synchronous tutor-learner sessions need to be considered in planning total distance education programmes, as well as the characteristics of the media to be utilized.

In the choice of the instructor–learner interaction mechanisms the evidence from the multimodal research discussed in the first part of this paper needs to be considered. Katz (1999), for example, found that videoconferencing was a more effective and acceptable method of learning from an instructor at a distant site than interactive internet or audiographic communication. It appears that the combined visual and auditory aspects of the lecturer's performance, i.e. the social and the instructional interactions listed in table 2 (Gilbert and Moore, 1998), were conveyed most effectively by the videoconferencing system. The broad thrust of the Katz study may be predicted on the basis of Mousavi *et al.* (1995) and Tindall-Ford *et al.* (1997) results discussed earlier.

Learner–learner interaction

Moore's third interaction dimension, learner–learner communication, is recognized as an important factor for students' success in distance education (Benson and Rye, 1996; McGill *et al.*, 1997). There is a vast literature on group and collaborative learning outside the distance education context (Webb and Palinscar, 1996), which may be used as a basis for the development of learner–learner interactions, as well as the emerging literature on this issue in the distance education context (Chiappini *et al.*, 1999; Freeman and Capper, 1998; Milter and Stinson, 1999; Ribbons and Hornblower, 1998; Spector *et al.*, 1999). Essentially the importance of this mode of interaction needs to be acknowledged in educational planning for distance education to ensure appropriate learner–learner collaborative activities are explicitly organized for the situations where such learning is beneficial (Bourdeau and Bates, 1997; Burke *et al.*, 1997; Coombs and Smith, 1998; Luetkehans and Nailey, 1999; May, 1993; Webb and Palinscar, 1996).

All the media/technologies available for the learner–content and instructor–learner interaction may also be used for learner–learner interaction. These interaction systems would mostly be two-way in nature but may be either synchronous or asynchronous. The same considerations of immediacy benefits and the competing need for adequate time for deep consideration of complex issues apply as in the instructor–learner interaction. In fact, often the instructor–learner and the learner–learner interaction mechanisms are the same. At major Australian distance education universities (such as Charles Stuart University and Monash University) internet forums or discussion groups (newsgroups) are routinely available for use in all distance education subjects for combined instructor–learner and learner–learner communications.

Burke *et al.* argue that in learner–learner interaction both cognitive and social interaction aspects are important. Thus rather than simply focusing on the capability of the interaction facility to communicate cognitive content, its capacity to emotionally support students is also important. If we take this issue seriously, then we may begin to question the value of only providing shared staff–student discussion areas, such as web forums or staff-led videoconferences, because the students often feel inhibited from discussing real concerns and obtaining the affective support they need. Pearson (1999), for example, found that allowing students to participate anonymously in computer conferences increased their participation significantly and added value and quality to their communications. Similarly the students in Freeman and Capper (1998) study benefited from anonymous web-based role play.

The value of multimodal interaction, already noted in the above two interaction contexts, needs to be kept in mind for learner–learner communications. In fact, in the development of interactive multimedia for distance education, the need for learner–learner (and/or instructor–learner) interaction can be satisfied by incorporating distance collaborative communications learning activities among students into the content itself, as well as employing multiple modal communications. For example, it is quite feasible to develop interactive distance education software at any of the seven levels suggested by Sims (1994) and add to it links to text-only (Feldmann-Pempe *et al.*, 1999), sound-only (Kötter *et al.*, 1999), text and graphics, graphics and sound (Steeples and Goodyear, 1999), desktop videoconferencing (Trentin and Benigno, 1997), or virtual reality (Jackson *et al.*, 1999) collaborative online communication and online computer supported collaborative work (CSCW) environments. Such software could be supplied on CD-ROMs or on a Web server and would allow students to collaborate in learner–learner communications sessions, either in real time or asynchronously, via networked computers. An example of this approach is the 'DreamTeam' synchronous CSCW Web environment where the presentation and collaboration functions are closely integrated (Roth and Unger, 1998).

Instructor–content interaction

Moore's (1989; with Kearsley, 1996) model of three types of distance education interactions has provided a useful framework for the above discussion. However, from an instructor's point of view the conventional deadlines of distance education often bar the inclusion of relevant up to date time-changing information. If lecturers are used to being able to change the lecture content up to the last minute, they often feel constrained by the long lead times required for the preparation of printed, audio-visual or computer-based distance education materials. Some new technologies, such as the internet and voicemail, may be used to overcome these irritations. In fact these technologies provide a new dimension in distance education instructor–content interaction.

The first way that distance education content may be made more timely for the students is by careful separation of the web-content or voicemail presentations into two parts: invariant content; and changing content.

The content which does not vary during the course needs to be provided to the web-designer or prepared for voicemail delivery in good time, just as the printed distance education notes and readings must be provided for the distance education departments in adequate time for typing, printing, collation and timely dispatch to students. In contrast, the second type of content may be altered by the lecturer as new information becomes available. The possibility and shape of the varying content and the mechanisms for its inclusion need to be planned at the time of the invariant material preparation. Thus lecturers may have the chance of adding web hotlinks to new relevant material while the course is in progress, or provide voicemail comments on new developments in the course.

An even better method of allowing the lecturer to change the web content before and during the course is to present the instructional web materials via a web database (McNaught *et al.*, 1998), such as the TopClass Web classroom building system (McCormack and Jones, 1998). In this case there are also the stable and variable aspects of web learning content. When a database is used to contain the learning content to be delivered to the students via the web, then the shape and structure of the database must be carefully designed before the course begins. However, once the database structure – including the student and instructor interfaces – have been designed then the rest of the content control and maintenance may be handed to the instructors. They can add the content at the pace that best suits their students' learning needs and allows the staff to include up to date information.

If the staff can interact with the content during the course the learning material can be more timely or include motivating current information not available at the beginning of the course. The material may also be adapted to suit expressed student needs, perhaps indicated by feedback from the students via discussion forums, etc. (Pearson, 1999). As well as responding to the expressed student needs by changing the learning content dynamically, the instructor-learner interactions may be modified. So the students may be assisted in more than one way, thereby probably suiting a greater range of student learning styles and coping better with individual differences.

Total interaction model

Taking a holistic view of the distance education interactions we develop a single model which may be represented as shown in figure 4. This model suggests the following implications for instructional design in distance education:

1. In planning a distance education programme all the four interaction aspects must be addressed. This model may form the basis of an instructional design checklist.
2. The means for interaction may include nine forms of media/technologies, which may be synchronous or asynchronous and 1- or 2-way in nature.
3. The more demanding and complex the content, the more beneficial the multimodal interaction in content presentation, instructor–student interaction and learner–learner interaction.
4. The learner interaction with multimedia content may be at eight different levels.
5. Optimal learning activities depend on the students' prior knowledge. For students with minimal background more structured learning activities are required.
6. Multimedia may be designed to incorporate learner–learner and/or instructor–learner interactions via the internet using multiple modalities and either synchronous or asynchronous communications.

Many aspects raised in this paper have not yet been thoroughly researched, and so some of the conclusions and recommendations can only be tentative. For example, the educational benefits of the instructor–content interaction during the course have not been thoroughly researched. The implications of multimodal methods of instructor–learner and learner–learner interactions have not been comprehensively studied in realistic distance education contexts. What are the comparative benefits and disadvantages of synchronous and asynchronous

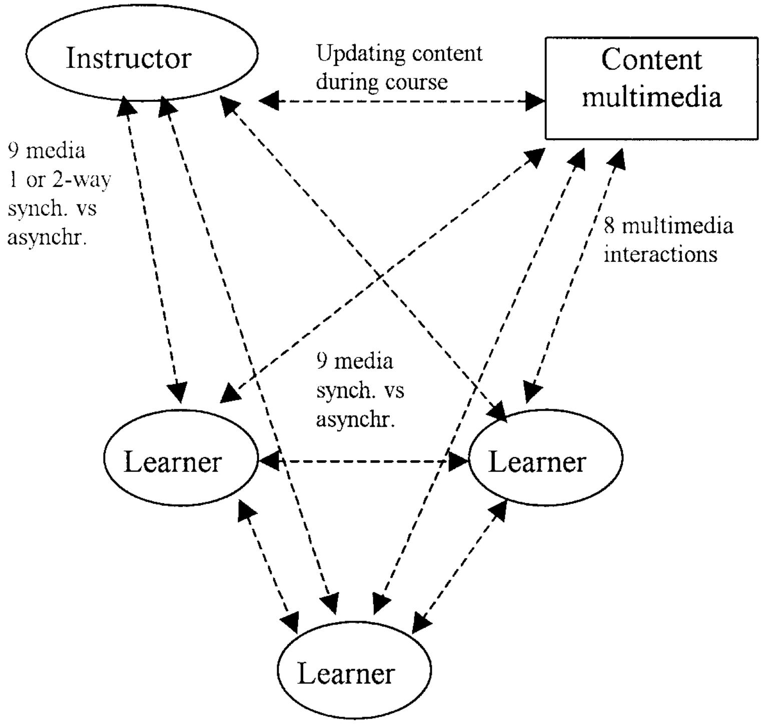

Figure 4 *Distance education four interaction models*

instructor–learner and learner–learner interactions? What are the optimal ways of including instructor–learner and learner–learner interactive activities in distance education multimedia? Questions such as these are demand answers. The intention of this paper is to provide ideas for action, both in distance course and multimedia development and for research into educational interactions.

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Biographical note

Juhani Tuovinen, is currently the Senior Research Fellow in Interactive Multimedia at Monash University's Centre for Learning and Teaching Support and the Director of the Centre for Multimedia and Hypermedia Research. Previously he was a secondary teacher, then lecturer in education at Charles Stuart University, working in both on campus and off campus modes. Research interests are in pedagogy and technology of distance and flexible learning.

Address for correspondence

Juhani E. Tuovinen, Centre for Learning and Teaching Support, Monash University, Churchill, Victoria, 3842 Australia; e-mail: juhani.tuovinen@celts.monash.edu.au