3. MULTIMEDIA LEARNING IN THE DIGITAL WORLD

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This chapter will review the current situation of what is commonly called 'multimedia learning'. This type of teaching-learning, which uses computer applications that offer different coding systems and forms of representation such as text, sound, images and animation, has become commonplace in the last few years, even though there is not much research available on the subject. In the first part of the chapter, current practice in multimedia learning is reviewed, the difficulties in finding a unified descriptive language are considered and the main developments in research discussed. In the second part, some of the diverse fields that have started to incorporate the potential offered by multimedia learning are discussed, and the necessity of developing a unified approach proposed.

MULTIMEDIA LEARNING

Multimedia learning and its associated problems

Over the last few years, the development and use of multimedia applications for education has been undergoing a shift in two contrary directions. On the one hand, the use of multimedia in education has become less and less visible, in the sense that many applications have been incorporated into normal everyday use, from word processors or presentations to interactive multimedia applications themselves. In this respect, the idea of 'multimediality', which arose at the end of the 1980s for the then new capabilities of

computers (Ambron and Hooper, 1988, 1989), has been gradually disappearing. People no longer talk about 'multimedia computers' because they all are now. Multimedia has become a given, and now it is unusual to see applications that do not incorporate a variety of different media. From the descriptive point of view, multimediality has lost its discriminating value.

On the other hand, many applications have been transferred from CD ROM to the Internet. The difference in architecture, the reduction in costs, the progressive increase in bandwidth and constantly improving access to telecommunications are the main reasons for this shift. As well as being technological, this has been fundamentally social. This second shift, however, has brought with it a decrease in the degree and complexity of interaction, as well as a much lower integration of the different media than prevalent at the start of the last decade.

This double tension has had various consequences. Firstly, it postpones the promise that many authors saw in CD ROM as a vehicle capable of offering complex interactivity (Smith, 1999). In reality the vehicle is not the key factor for interactivity, although in the case of CD ROMs sufficient read speed was reached to enable media to be loaded almost instantaneously, giving the sensation of responsiveness and interactivity. The technological problem has now become one of reducing the forms of interaction and the forms of composition to those permitted by the standard Internet application: the Web browser. The language browsers use for multimedia composition (limited by HTML and JavaScript) and for navigation, in which the semantic value of the link is the same as the navigational jump (Burbules, 2002), have considerably reduced the potential for interaction, because some standardized actions included, whilst important, are limited. Fortunately, other programming languages, such as Flash, allow

more complex forms of interaction, although almost always within the interface imposed by the browsers.

It should not be forgotten that the Internet is not only a protocol and a type of application based on browsers, even though these are specialized in displaying information. Gaskin (2003) shows this on trying to distinguish between uses:

'Tasks like word processing, graphics production, and other media-creation tasks provide a useful distinction for the domain of dedicated applications: they involve *creating* data. In contrast, successful Browser applications are more commonly oriented toward the *viewing* of data.'

Secondly, the double tension postpones the production of a new unified language. As Plowman (1994) states, following Burch's concept, we are in a phase similar to the 'primitive representation mode' of cinema, in which the search is still on for a unification of the multimedia elements, as well as 'institutional' forms of its syntax and meaning. In contrast to cinema, multimedia applications are interactive, so that their meaning does not depend solely on the structure of the message and on the interpretative activity of the receiver; the very actions of the receiver change the content of the message. On the other hand, multimedia applications always carry a significant multimodality (Kress & van Leeuwen, 1996), in such a way that it is difficult to construct a unique and standard interpretative language.

On the contrary, educational applications have opted, in many cases, to simplify both the multimedial diversity as well as the compositional forms of the different media, in such a way that the richness of the media has declined in favour of messages that are more easily interpreted. This has been the route chosen for various applications produced in different universities in Spain and other countries (see Hepp, 2003, for a general Latin American overview). In the TEAM Project (Rodríguez Illera and Suau,

2003) more then 50 teams of teachers from the Universitat de Barcelona have participated in developing multimedia materials in many different disciplines. In some cases these materials are very complex with thousands of different screens with hypertext and links. What stands out is that multimedia and interactive complexity has given way to simpler interfaces and environments, in many cases based on web sites or on the use of standardized virtual campuses (such as WebCT).

This simplified multimedia language has not been well researched either. Perhaps the most important problem with multimedia applications will continue to be understanding why a multimedia message is better, from an instructional point of view, than a 'monomedia' message. The question is broad and complex. It relates in the first place to the idea that if it is possible to consider that the media are 'in themselves' educational. This is a question that is considered difficult or impossible to answer adequately as it is impossible to separate the effects of the different media from the effects of the different structuring of the instructional messages, which are not directly comparable due to the inherent specificity of the media.

However, pedagogical reflection is lacking on this idea of specificity of the media, which so evidently results from looking at the media from a non-specialized perspective. Although the media cannot be said to be intrinsically educational, nor the technology, it is also difficult to assert that it is possible to consider them mere 'media', neutral vehicles for a pre-existing educational message. If we take the distinction of learning with/from, the media and the technologies in general appear as an environment through which we communicate and express ourselves, but with which we also act. The distinction between the technological environment and the system or agent that is 'located' within that technological environment is not clear in many cases. That is to say that this is an analysis that entails the integration of the technological environment as

part of the message produced in a specific situation. For this reason the question does not seem to be so much whether the media are educational, which effectively they are not because they are only media, but the to see how they condition the characteristics of the educationally structured message.

Although the question of the advantage of multimediality has been displaced, there are basic aspects of this that remain unclear from the point of view of the processing of the information involved. Why are two media, or three or four, better than one? Is it always this way? Are some media better than others? And, if it is this way, why are they better? Or, on the contrary, does every medium impose a significant communicative specificity that makes it different to the other media? In short, the questions can multiply and each one leads to more questions.

Basic research on multimedia learning

One approach that tries to answer these questions about multimediality stems from the bringing together of cognitive psychology and information processing. Although the type and scale of analysis is very different to other theoretical frameworks, it is important as an approach because it aims to understand why the different media generate different representations and so influence the receiver. Furthermore, when the question is posed as to whether multimedial messages are more effective, which hardly happens at all in scientific literature, often the sole, and often vague, reference is to Paivio's Dual Coding Hypothesis. Paivio (1986) states that there are two specialized perceptive-cognitive subsystems in the processing of different stimuli: one for audio stimuli, especially spoken language, and the other one for visual stimuli. Both systems complement each other, but the processes that they carry out are differentiated,

especially in short-term memory and in the verbal or image models that they use. Paivio's idea may appear simple, but in the cognitive psychology tradition both systems have been treated separately. Many studies concentrate on one or the other, but rarely on both at the same time. Double codification states that our perceptive processes almost always use both subsystems simultaneously.

This theoretical background provides the basis for the experimental approach developed by Mayer (2001) and is used, to a lesser extent, by others such as Rouet *et al* (2001) and Dijkstra *et al* (2001). Mayer has carried out a systematic analysis that has enabled him to construct a theory of multimedia learning in which very idea of 'multimedia' is thought of classically as a mode of presentation (textual and visual representations), or as a form of sensory modality emphasising more the role of the receiver and the necessary codifications. What is important is how these ways of thinking of multimedia are related to models of what multimedia learning is. Mayer uses the distinction, also classical, of conceiving of learning as an acquisition of information or as a construction of knowledge, making him fall back onto conceiving of multimedia learning as a technological issue (that is to say, how technology enables a better structuring of a presentation of information), or else as a cognitive issue, which sees the student as an active subject, implicated in the construction of knowledge from the data and information that the student processes. Both approaches would also be involved when establishing the role of the teachers. In the first case the teacher is a source of information, who structures and improves the access to it, while in the second case the teacher is more a figure who guides the student in the cognitive process of assimilating and constructing knowledge.

Beyond simply considering that Mayer's opposite positions are part of a continuum and that they are situated ideally as the two extremes of the continuum, the

positions are clear and respond to a current vision of how to envisage the process of teaching and learning. The learning objectives must be added to this. Basically they are divided into capacity to remember and capacity to understand. The first one enables the reproduction of taught information, while the second one would be closer to significant learning, that is to say the capacity to establish connections between what is learnt and previous knowledge. Both objectives are based on differentiated cognitive capacities that can be measured using tests: retention and transference. From all this it can be deduced that there are various types of learning results: an absence of learning, learning routines, and significant learning.

In spite of saying that the differences are very general, they represent a map on which many options can be situated. Thus, the vast majority of educational programs can be easily placed in a specific position, and those that are not in any specific position are examples of more complex forms or are examples that are situated at some point in the continuum. Furthermore, these distinctions are habitual in scientific literature and they take us back to more conventional questions of educational psychology and pedagogy, such as asking ourselves what do we learn for. It is not obvious that multimedia programs always look for profound knowledge, nor that they promote the capacity to transfer what has been learnt, but it is obvious that often they are limited to showing multi-coded information, emphasising more the support in different media than the learning strategies and learning objectives.

In practice the problem of multimedia learning is to understand how the multi-coded arrangement of the diverse elements promotes better learning or not. But to be able to understand this question, learning (not just 'multimedia') must be placed in a theoretical perspective that provides a reference framework for the subsequent analysis. In the case of Mayer, the theoretical framework has three general principles: Paivio's

Dual Coding Hypothesis, which has been referred to above, the limited capacity of humans to process information and the recognition that the subjects are active at the moment of constructing their learning.

The fact that the capacity for processing information is limited is well known. It is difficult to even remember a long list of numbers. The same occurs with advertising messages that in a couple of seconds may mix dozens of images. And, in some way, the same thing happens with multimedia products that use a wide range of media simultaneously: we can only remember some essential aspect of a narrated text (as it develops over time), or we focus our attention on a graphic or on an animation, without paying the same attention to the text that is shown. What we do is to process the total cognitive load that we can manage in our short-term memory, but the cognitive load that is presented often surpasses our limited processing capacities.

The cognitive load, related to the difficulty of the messages presented, can be either intrinsic or extrinsic. Some messages, intrinsically, require maximum concentration to be processed, since the topic that they deal with is, in itself, complex, or because attention must be paid to the different forms of representation (for example, what is explained verbally is different to what appears in video, or in some images). The extrinsic load refers to the form in which the message has been designed: in a simpler or more complex manner, with more or less redundancy, visually or narratively complex etc. This complexity of the message format is the responsibility of the teacher who has designed it.

Mayer introduces the question of the activity of the subject who is learning. The idea at the heart of this is that the best learning results are produced when the subject is cognitively active. This assumes that there is an attempt to understand the conceptual structure of the material taught, that is to say that an attempt is made to create a mental

model in which this conceptual structure is included. Meaningful learning would require this internalization, which in its turn would be a consequence of the cognitive operations and processes that the subject carries out in an active manner. These processes would basically be three: selection (words and images), integration (into the respective mental models) and the organization of both with respect to each other and in relation to previous knowledge. Therefore, this concept of multimedia learning assumes that there are five steps, splitting the processes of selection and integration according to the channel.

Ultimately these cognitive differences lead to what is called the 'Multimedia Principle', which states that learning is better if two channels (verbal and graphic) are presented instead of just one. Its experimental basis is to be found in studies that refer to the effect of illustrations in textbooks and subsequently in studies that make a comparison between instruction with on-screen text and instruction with animations or graphics to illustrate what is being taught. From the point of view of the instructional designer, the question is centred on how to structure the different media that make up a multimedia message (for which Mayer states seven principles: spatial contiguity, temporal contiguity, redundancy, coherence, modality and individual differences).

Mayer's work is on multimedia learning is without doubt the broadest and most systematic carried out to date. It also clearly distinguishes multimedia from other similar but different digital phenomena like hypermedia and variants on hypertext (Rouet *et al*, 1996; McKnight *et al*, 1993). It is not, however, any more than an analytical approach, which clearly brings its own methodological and other limitations, often the result of deliberate decisions designed to enable tight experimental design and control.

Firstly, the idea of multimedia that is used is over-simplified and limits generalization of the results obtained. The products designed and produced are normally much more complex than just having graphics and simple animation included to support informational text. It is a very analytical approach and uses a reduced conception so as not to be overloaded by the complexity of an 'authentic' multimedia application or environment. But this minimal methodological self-limitation still generates a certain paradox, since the very object of study is almost outside of the model after such a dramatic simplification.

Secondly, what happens with other studies of more complex products? And, in any case, what do we truly understand for 'multimedia'? Is multimedial complexity needed for an application to be 'truly' multimedia? On the one hand, it seems clear that the very idea of 'multimedia' comes more from the information technology and software industries than from academic research. On the other hand, a lot of the interest in multimedia as we have already shown, from both users in general and researchers, comes from a certain 'promise' of a new technology that would facilitate the access to complex forms of expression and communication, making learning simpler at the same time (Smith, 1999). This perceived promise has a lot to do with the anticipation of a new media to replace 'old' writing formats and techniques, bringing new capacities for narration, not the least that the reader can influence the development of the text. For the moment, such promises are seriously limited by the difficulties that arise in developing applications that really can be adapted to the user and change their internal narrative Despite this, there is a growing field of 'adaptive multimedia' that has this aspiration (see Kinshuk, 2002). Whatever, increased data storage capacity, processing speeds and internet bandwidth make the production and use of sophisticated multimedia texts combining a variety of media and complex narrative more and more accessible.

Thirdly, there are limitations associated with the explanatory format of cognitivism. No matter how much Mayer and other authors echo constructivist approaches, it is clear that that all their experimentation is guided by cognitive principles. As in conventional instructional design, greater emphasis is placed on the design of the messages than on students' activities. Although this is consistent with what teachers can do, that is to say to design better multimedial messages, and probably with what they should do, it continues to pose its own problems when isolating very simple messages. It also continues to assume an artificial teaching/learning situation. The descriptions Mayer and colleagues give indicate the use of highly decontextualized learning situations, which are completely removed from what happens in classrooms and other everyday pedagogic settings. There are neither group activities, nor questions for teachers. Teaching consists of presenting information in different formats, checking later on how certain aspects have varied (retention or transference). As with research on the difference between different media, the content cannot be separated from how it is dealt with, and, in this case, from its ecological validity which seems to be very limited. In general, the implicit model of teaching/learning does not match current practice, and is more appropriate to very traditional and formal educational contexts.

Finally, interaction is absent from these experimental approaches. The comparison is made between an application that offers a text to be read and another one that adds a graphic, audio or a small animation to complement to the text; that is to say both forms are non-interactive media. The role of the user seems to be limited to reading a text or to looking at some complementary materials, but not interact with the text or materials. This certainly has to do with a methodological decision again, for instance finding the simplest way of distinguishing between a textual message and a multimedial one. Although this decision has a logic which enables the changing of conditions for the

presentation of the stimuli, what is certain is that this refers more to static media (such as a billboard, or a text book) than to interactive media like those which characterize the idea of 'multimedia'. As many authors have stated, it is within the idea of interaction that the promises of new media converge, as much as or more than in multimediality.

To summarize: although the idea of multimedia learning is clearly an advance on stating a problem that has been explored little, some of the methodological decisions taken for its study have imposed severe limitations. The specifics of interactive media have been sacrificed in order to compare messages composed of one or more media, normally in a very simplified manner, at the same time that the learning situation has been reduced to an experimental situation far removed from real life. On the contrary, and if one does not question its ecological validity, fundamental ideas on the composition of simple multimedia messages have started to arise.

THE SOCIAL USES OF MULTIMEDIA LEARNING

Beyond this basic research, the applied problems of interactive multimedia learning continue to be important, especially because of the technological and representational standardization reasons stated at the beginning of this article, but also because of the absence or the confusion of the pedagogical designs of many applications. There are various routes at this junction that are being traversed simultaneously, although not always together.

Perhaps the main route is through communities of practice and of learning. Along with its theorization (especially Wenger, 1998; Brown and Duguid, 2000; Barab and Duffy, 1999), a large number of practical experiences have arisen, linked in many cases to virtual spaces and to educational portals as a way to channel virtual learning.

Many of these communities are full of 'lurkers', peripheral members although not always clearly legitimate, if we follow the terminology of Lave and Wenger (1991). There are some doubts as to whether these virtual encounters really constitute communities of practice or are rather 'pseudocommunities' as Hung and Nichani (2002) state, being limited by the characteristics of the electronic medium. However, the most interesting aspect of the communities is, curiously, their fundamentally linguistic character. The forums and email systems hardly incorporate multimedia elements at all. Written language (or new linguistic genres that are appearing, see Cassany, 2003) and dialogue, as well as the forms of collective debate, and, in general, what we can call interpersonal electronic interaction, are dominant.

Other routes that are traversed are the many different forms of 'personalization' of the interaction. A substantial number of approaches have contributed to this. These have emphasized a concept of learning based on sociocultural principles in the broad sense, from learning and situated cognition, Problem Based Learning and case studies, to methodologies with other theoretical approaches like adaptive educational multimedia (Kinshuk, ed, 2002). In some way in all of these an attempt is made to construct learning situations that make sense for the learners and that intrinsically motivate them, independently of whether multimedia elements are used or not.

We can state that in third place, in a list that could be longer, is the creation of systems for help or for interaction based on the translation of the Vygotskian concept of 'zone of proximal development' from interpersonal interaction to person-machine interaction. Some recent interactive learning environments, such as The Ecolab which helps children aged 10 and 11 years to learn about food webs and chains (Luckin and du Boulay, 1999), and the creation of intelligent help agents clearly go in this direction.

These routes are not exclusive, although they have seemed to be so far. If multimedia has to 'make itself invisible' for the fact of being present in all developments, and if it has to be integrated into the different approaches stated, it is worthwhile to put into question its utility as an analytic category. If everything is multimedia, what falls, or will fall, outside as 'mono-media'? In some way this multimedial line of thinking entails going back to the primacy of the relationship between the media over the meaning of each medium taken separately. But it is evident that the forms of meaning of every medium (text, image, audio, the moving image) have their own logic and language, and it is not easy to find a hierarchy to decide in what order to read them. It is not as simple as thinking that the graphical nature of screens subordinate text to its visual composition as Kress (2003) suggests, because the way of differentiating meaning of both the image and the written language means that often it is the text that accompanies an image that in the end decides the meaning of the image (Vilches, 1987).

Despite the theoretical question of the place of multimedia (as a language, but also as an educational application) remaining open in a digital environment where everything is, in some way, 'multimedia', the practical consequences of this new digital environment and its generalized use are very important. For example, when posing the question again of what are the basic forms of digital literacy, as has been suggested (The New London Group, 2000; Snyder, ed, 2002), although not only the different media that together form a message but also the interactive component that digital technologies introduce and that is the nucleus of the idea of multimedia. Digital literacies and how they are used are closely linked to learning, but not to the point where it is not possible to separate them. For this reason the questions posed by Mayer, and other authors, continue to be important. This is also the case even from the applied point of view: how

to integrate multimedia elements into the communicative space of digital communities, or in the forms of individual help. It is clear that there are many questions that affect its semantic aspects, as well as pragmatic ones, and these constitute an authentic research program.

Finally, from an educational point of view, multimedia learning is at a crossroads where it has to decide whether to mix multimedia into the applications and forms of educational communication, and to concentrate on learning without presupposing that just by adding media that learning will happen. Almost the opposite can also happen with multimedia, as occurs with navigating the Internet, an effect of cognitive dispersion that is the opposite of what is desirable for learning to occur.

REFERENCES

Ambron, S and Hooper, K (eds) (1988) *Interactive Multimedia*, Microsoft Press, Redmond WA

Ambron, S and Hooper, K. (eds) (1989) *Learning with Interactive Multimedia*, Microsoft Press, Redmond WA

Barab, S and Duffy, T M (1999) From practice fields to communities of practice, in *Theoretical Foundations of Learning Environments*, ed D H Jonassen and S M Land, pp 25-55, Lawrence Erlbaum, London

Brown, J S and Duguid, P (2000) *The Social Life of Information*, Harvard Business School Press, Cambridge MA

Burbules, N C (2002) The Web as a rhetorical place, in *Silicon Literacies: Communication, Innovation, and Education in the Electronic Age,* ed I Synder, pp 75-84, Routledge, London

Cassany, D (ed) (2003) *Los Nuevos Géneros Electrónicos*, special issue of the journal *Cultura y Educación*, Madrid

Dijkstra, S, Jonassen, D and Sembill, D (eds, 2001) *Multimedia Learning*, Peter Lang, Berne

Gaskin, R (2003) [accessed 30 August 2003] Beyond the browser: rediscovering the role of the desktop in a Net-centric world, [Online] http://www.fourthworld.com/embassy/articles/netapps.html

Hepp, P (ed) (2003)) [accessed 30 August 2003] *Latin American Perspectives on Educational Multimedia*, special issue of the journal *Interactive Educational Multimedia* [Online] http://www.ub.es/multimedia/iem

Hung, D and Nichani, M (2002) Differentiating between communities of practice (CoPs) and quasi-communities: can CoPs exist online? *International Journal on E-Learning*, **1** (3), pp 23-29

Kinshuk (ed) (2002)) [accessed 30 August 2003] *Adaptative Educational Multimedia*, special issue of the journal *Interactive Educational Multimedia* [Online] http://www.ub.es/multimedia/iem

Kress, G (2003) *Literacy in the New Media Age*, Routledge, London

Kress, G and van Leeuwen, T (1996) *Reading Images: The grammar of visual design*, Routledge, London

Lave, J, and Wenger, E (1991) *Situated Learning: Legitimate peripheral participation,* Cambridge University Press, Cambridge

Luckin, R and du Boulay, B (1999) Ecolab: the development and evaluation of a Vygotskian design framework, *International Journal of Artificial Intelligence in Education*, **10**, pp 198-220

Mayer, R E (2001) *Multimedia Learning*, Cambridge University Press, Cambridge

McKnight, C, Dillon, A and Richardson, J (eds) (1993) *Hypertext: A psychological perspective*, Ellis Horwood, London

Paivio, A (1986) *Mental Representations: A dual coding approach.* Oxford University Press, Oxford

Plowman, L (1994) The 'Primitive Mode of Representation' and the evolution of interactive multimedia, *Journal of Educational Multimedia and Hypermedia*. **3** (3/4), pp 275-93

Rodríguez Illera, J L and Suau, J (eds) (2003) *Tecnologías Multimedia para la Enseñanza y el Aprendizaje en la Universidad*, Edicions de la Universitat de Barcelona, Barcelona

Rouet, J F *et al* (eds) (1996) *Hypertext and Cognition*, Lawrence Erlbaum, London

Rouet, J F, Levonen, J, and Biardeau, A (eds) (2001) *Multimedia Learning: Cognitive and instructional issues,* Pergamon, Amsterdam

Smith, G. (ed) (1999) *On a Silver Platter: CD-ROMs and the promises of a new technology*, New York University Press, New York

The New London Group (2000) 'A pedagogy of multiliteracies designing social futures' in *Multiliteracies: Literacy learning and the design of social futures*, ed B Cope, and M Kalantzis, pp 9-37, Routledge, London

Vilches, L (1987) *Teoría de la Imagen Periodística*, Paidós, Barcelona

Wenger, E (1998) *Communities of Practice*, Cambridge University Press, Cambridge