Interactivity in Multimedia: Reconsidering Our Perspective

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Abstract: Touted more often than any other advantage of multimedia is the interactivity that it can provide. Proponents claim that interactive multimedia requires learners to "engage" in the instruction and, thereby, learn more effectively than through passive instructional methods such as text, video, or classroom lectures. The problem with this claim is that interactivity is seldom, if ever qualified. Focusing on closed (non-networked) multimedia systems, the author will review some of the perspectives on interactivity in multimedia, identify the salient characteristics of meaningful interactions, and outline some basic considerations for designers of interactive multimedia instruction.

Resume: Vente plus souvent que tout autre avantage du multimedia est 1'interactivite qu'il permet. Les partisans pretendent que le multimedia interactif requiert que les apprenants s'impliquent davantage dans leur demarche educative, et ils affirment que ces derniers apprennent d'une maniere plus efficace qu'avec les methodes d'enseignement plus passives ayant recours au manuel. au video ou au cours magistral. Le probleme avec cette pretention est que cette interactivite est rarement sinon jamais evaluee ou nuancee. Portant notre attention sur des systemes multimedias autonomes, c'est-a-dire non-interconnectes. I'auteur reexaminera certaines perspectives actuelles sur 1'interactivite du multimedia, identifiera les caracteristiques remarquables d'une interaction significative, et decrira brievement certaines considerations de base pour les concepteurs d'un enseignement utilisant le multimedia interactif.

The Latest Educational Buzzword

In the same way that "user-friendly" once pervaded the computer marketplace and "low-fat" has become a standard in our grocery list vocabulary, the term "interactive" seems to have become the norm for describing educational events and instructional materials. Educational course guides, workshops, discussion groups, and television are commonly billed as interactive, in an attempt to "cash-in" on the prevailing assumption that interactivity translates directly into effectiveness. Nowhere is this better illustrated than in the use of the word "interactive" to promote instructional multimedia programs. A recent memo at the University of Saskatchewan highlighted three proposals that were successful in winning grants for course development; ranging in subject matter from clinical gross anatomy and physical therapy to political science; the one thread common between them was their interactivity billing.

As is the case with any word that is overused by the general public, the word "interactive" has arguably begun to lose some of its impact in recent years. There are so many interpretations of what constitutes interactivity, and so few methods

for determining its effectiveness, that lately programs touted as interactive are more likely to raise skepticism than enthusiasm. This is further complicated by the fact that interactivity varies greatly within educational contexts; the type of interactivity that is possible in a human-to-human experience is qualitatively different than that which is possible between a human and a computer program. Even within the same human-to-computer environment, what's perceived as interactivity may vary greatly between an instructional chemistry course and instruction in political science. While striving to design meaningful interactive experiences in instructional materials remains a worthy goal, unless one has a clear idea of what interactivity is, it can be an elusive target. Does interactivity refer to the concept of learner control and the ability of the learner to determine their own pace and direction through the program? Does it simply mean that multiple media are employed, making the learning experience more of a complete sensory experience? It could be the requirement of clicking the mouse or typing one's response. It could be the ability of the system to recognize and adapt to the performance and learning style of the individual. Perhaps, meaningful interactivity is all of these things combined. Perhaps, it is none of them. Could it be that meaningful interactivity really only exists between two or more people and all of our efforts toward interactive multimedia are merely our best attempts to simulate the real thing?

The goal of this paper is to review some of the various perspectives on interactivity in multimedia that exist in the literature and to identify the salient characteristics of meaningful interactivity in instructional multimedia. The focus will be on closed multimedia systems that are self-contained, stand-alone applications (i.e. programs distributed on either diskette or CD-ROM) as opposed to open or networked systems such as the World Wide Web. A summary of considerations for designers of interactive multimedia will also be presented.

First, There Was Multimedia

Before interactivity in multimedia can be explored, one must first settle on a definition for multimedia. At its simplest, multimedia refers to any program comprised of two or more media, hence the name, multimedia. Schwier and Misanchuk (1993) update this definition by suggesting that today's multimedia productions have their heart, a computer responsible for controlling the actions of the program and interpreting learner responses. For the purposes of this paper, Rada (1995) completes the definition by suggesting that the media involved in a multimedia system must include at least one form of time-based media such as audio, video or animation. By contrast, a product combining only non-time-based media (i.e. text, graphics or photographs) would not be considered multimedia by today's standards.

It is important to further differentiate between the types of multimedia programs that exist. Schwier and Misanchuk (1993) suggest four categories, based on the nature of the content and the intentions of the designer: entertainment,

informational, educational, and instructional. Of these, this paper will concern itself with only the final category.

Instructional multimedia refers to those programs that have been designed, intentionally, with the goal of having the user learn the material presented in the program. The focus tends to be quite narrow, with both content and activities carefully designed to optimize the potential for learning. Often, instructional multimedia programs will also make an effort to evaluate the degree of learning that takes place.

The Main Ingredients of Interactive Multimedia

From a review of the literature on designing interactive multimedia, one finds five common ingredients prevails among recipes. The exact measurement and importance of each ingredient toward the development of meaningful interactivity seems up for debate. Forget to include even one of these items, however, and the odds of creating an interactive program are significantly reduced.

Active learning environment

The idea that active learning is a valuable instructional strategy is well accepted in education. Just ask yourself how many times you have seen or suggested a hands-on approach to learning in order for students to better understand a problem or task. It is this ability to activate the learner that stands out as one of the key advantages of interactive multimedia programs. Through question and feedback routines, interactive programs require learners to actively process the information being presented. This mental activity has been shown to help learners better comprehend and remember the information being presented (Jonassen, 1985).

One may argue, however, that active learning environments are not synonymous with interactive ones. While it is relatively easy to program a computer to ask a question, analyze the response (according to its programmed code), and present appropriate feedback, the experience for the learner is finite. Though the learner may still be active in the process, the limitations of computer programming and learner response options often dissolve the illusion of real interactivity.

Learner control

The concept of providing learner control is highly important to the development of interactive programs. Allowing learners to determine the sequence that they will follow, and the time that they will devote to a particular area of the program, has been shown to motivate learners by decreasing their anxiety and improving their attitude toward the program (Steinberg, 1984).

The question of 'how much control is appropriate' is less understood. Some research shows that too much control can result in the learner feeling increased levels of doubt and insecurity (Bartolome, 1994). The optimal degree of learner control should be determined by learner characteristics, the nature of the content, and the complexity of the learning task (Hazen, 1985). In cases where the learner

is less able or less experienced, the degree of control assumed by the program might be increased.

Feedback

A critical component to any multimedia interaction is the feedback provided following the learner's response: The more individualized the feedback, the more meaningful the interaction (Bork, 1982). While experienced tutors are capable of considering a learner's response and providing timely, appropriate feedback in order for the learner to better understand or proceed with a problem, a closed multimedia system has limitations. Designers of closed systems must anticipate both correct and incorrect responses to a question and then determine whether confirmational, motivational or instructional feedback is most appropriate (Hazen, 1985). They must also try to plan for the unanticipated responses that will inevitably occur, dealing with them in a constructive, helpful manner. The degree to which these challenges are met largely determine how successful the interactions are for the learner.

Multiple media

According to our earlier definition of multimedia, the presence of multiple, time-based media is integral to an interactive multimedia program. Reality may be represented through digitized photographs and video, detail may be shown by computer graphics, and descriptions may be provided by text, audio, or animated sequences (Haugen, 1992). As with active learning environments, however, the mere presence of multiple media does not translate directly into interactivity. Even when combined with elements of learner control, the use of multiple media guarantees no more than a computerized image finder.

As a designer, one must guard against the temptations that media have to offer. The desire to employ the latest popular technology in an interactive multimedia program is a trap that designers fall into all too often. At one time, it was the overuse of clever audio clips to provide feedback to the learner. While initially amusing, the persistent chime, whistle or trumpet blast quickly became an annoyance to the learner and ultimately, a distraction in the learning process. More recently, the "technology trap" can be seen in the misuse of Quicktime VR™ sequences and Java script animations. This tendency to allow the technology to drive the design can have negative implications for learner control and, subsequently, the degree of the program's interactivity.

> The user will often judge the material as 'good' or 'interesting' just because of the new, technical gimmicks... Being afraid that the user will skip some of the gimmicks in order to reach the learning objectives in a more straight forward way, [the designer] tends to lay very rigid tracks through a complex collection of material. Thus, no real choices may be left for the user. (Haugen, 1992).

To overcome this problem, Jonassen (1985) suggests that rather than start with an analysis of the capabilities of the technology, one must remember to begin with an analysis of the problem and then design an effective instructional approach to solving it. By following this method, the odds are improved that the learner activities and interactions developed are those that are most appropriate to the learning task, rather than those that are simply dictated by the chosen technology.

Learner response options

For the most part, today's interactive systems provide users with two reliable methods for entering information: typing and direct manipulation (e.g. mouse, joystick, touchscreen). According to Jonassen (1988), one might consider clicking on a mouse to represent one of the lowest forms of interactivity, given that only a shallow level of cognitive processing is necessary. By the same principle, a slightly higher level of processing and interactivity occurs when the learner is asked to type in their response or to manipulate screen items into their correct position. In some language learning programs, voice capture is used, offering potential for deeper processing and a higher level of interactivity once again. With the ability to recognize only about 1000 spoken phrases, however, today's interactive systems are still inadequate in this regard (Rada, 1995).

Adaptability

According to a number of researchers, one of the most valuable, yet elusive, attributes of effective interactive multimedia is the ability of the program to adapt to the individual needs and style of the learner (Ross & Morrison, 1988; Tennyson & Christensen, 1988; Jonassen, 1988). In many cases, this adaptability is simply a variation of learner control described earlier in this paper-basic decisions involving the pace and sequencing of content are afforded to the learner in an effort to simulate adaptation in an otherwise rigid environment.

The logical alternative to internal (learner) control is to design for adaptability that is controlled by the program (Ross & Morrison, 1988). In this orientation, the learner's movement through the program is predetermined by the program designer and based on the learner's responses during the instruction. The primary criticism of this approach is the often arbitrary process applied in determining what type and quantity of instruction should follow the learner's responses and what performance criteria must be met by the learner.

At their highest level, adaptive systems are referred to as "intelligent learning systems" and are characterized by elaborate programming that employs multiple variables (Tennyson & Christensen, 1988). These systems not only attempt to diagnose the learner's response and provide him or her with individualized feedback, but they are designed to revise and refine their own databases based on their interactions with the learner.

Not All Interactions Are Created Equal

Interactivity or reactivity?

"No one has yet to program a computer to be of two minds about a hard problem or to burst out laughing" - Lewis Thomas

It's been suggested that to understand the essence of interactivity, one might look back in history to a time before computers and technology confounded the issue, to a time when interactive learning was exemplified by the Socratic dialogue between tutor and student (Bork, 1982; Bork, 1992; Jonassen, 1985). These interactions were dynamic, reciprocal and infinite in nature as the communication between tutor and pupil was unrestricted and each party could adapt to the input of the other. Contrast this with the instructional multimedia programs of today. Highly prescriptive, limited in their ability to accept various learner responses, and subsequently, inadequate in their assessment of a learner's true understanding, these programs attempt interactivity in a variety of ways, but only rarely are they successful.

To accept that designing meaningful multimedia interactions is much more difficult than often suggested, one need only consider the basic premise by which computers operate. Programmed to accept user input via some form of electronic device (e.g. keyboard, mouse, joystick, microphone), the computer can only interpret that response to the extent that its programmed code allows. This results in a maze where accesses are created and clues are provided, but progress through the maze is highly restricted. The spontaneity of exchanges between learner and program in this type of environment can be likened to speaking to an answering machine as opposed to speaking directly with someone over the telephone (Vidal, 1992, p. 205). These inherent limitations of the computer can occasionally be disguised by a clever design. However, they can never be overcome completely as some response or desired path is inevitably overlooked by the programmer. When this occurs, the illusion of interactivity disappears and the learning process is interrupted.

If multimedia programs can only simulate true interaction with the learner, how should they be described? Barker (1992) is one of the few that refers to the reactivity of hypermedia electronic book systems, rather than their interactivity. Jonassen (1985) describes interactive programs as those that provide at least the appearance of two-way communication. This suggests that perhaps quasi-interactive would be a more appropriate term for many programs. Again, I believe the key is not so much in forging another label for interactivity as it is to recognize that different levels of interactivity exist and to strive for designing the highest, most appropriate level possible for the task at hand.

What makes a meaningful interaction?

The concept of what is meaningful in education finds its roots in Ausubel's theory *of meaningful reception learning* and the idea that more inclusive concepts

subsume less inclusive ones (McMeen & Templeton, 1985). According to this theory, we tend to store the general, more important aspects of a concept and forget the specific, less important details. What gets stored is what is meaningful. Meaningful interactions, therefore, might be seen as those activities that require the learner to access that meaningful knowledge in order to relate it to new information (Jonassen, 1988). The deeper the level of processing prompted by the interaction, the more meaningful it is.

Jonassen (1985) identifies five types of interactive program with each one representing a different degree of meaningfulness. He suggests that the lowest level of program is the *drill and practice* design as it typically demands only a shallow level of processing by the learner. *Tutorial* designs tend to produce more meaningful interactions, although the opportunity for the learner to relate prior knowledge to the new information is not always provided. *Problem-solving and simulation* designs require that learners apply previous knowledge to a new situation. These designs tend to employ interactions that are highly meaningful as the level of mental processing required is substantially increased. The most meaningful interactive design is the *intelligent or mixed initiative, knowledge-based system.* In this system, natural language processing is enabled to make it easier for the learner to relate to prior knowledge and the system learns from the learner in order to expand its own database of knowledge.

Establishing the right context can also help to produce meaningful interactions (McMeen & Templeton, 1985). Through the use of advance organizers, analogies and comparison-contrasts, designers can help learners access the appropriate knowledge from their memory in order to integrate it with the new information being presented (Jonassen, 1988).

Quality vs. quantity

Two of the most important, yet difficult assessments to make when it comes to interactivity are those *of quality* and *quantity.* Bork (1982) identifies three measures for the quality of interactive multimedia: the type of input required of the learner during the interaction, the program's method of analyzing the response, and the action taken by the program after the input (i.e. feedback). As was mentioned earlier, the deeper the level of cognitive processing required by the learner's input, the higher the quality of the interaction. Similarly, if feedback (Bork's third measure) is appropriately detailed and individualized, the learner will likely perceive the program to be more interactive. Bork's second measure, the program's method of analyzing the learner's response, is dependent on the branching characteristics of the program.

Interactivity in multimedia programs is based, primarily, upon two forms of branching: a multiple choice response or a free form response (Weller, 1988). Multiple choice items can be useful for discrimination tasks or for lengthy responses by the learner. They may take the direct form of a multiple choice question or they may come disguised as a matching, true or false, or drag and drop activity, Free-form or open ended responses correspond more directly to the real world and are,

therefore, preferred over multiple choice items (Bork, 1992). For free form responses to truly simulate a student-tutor interaction, however, they tend to require elaborate planning and programming so that they may recognize a variety of correct and incorrect responses.

The quantity or degree of meaningful interactions in a program is another important aspect of overall interactivity. A program that asks only a single question over an extended period of time might be described as having a low degree of interaction.

By contrast, a program that frequently requires the learner to respond to questions would demonstrate a higher degree of interaction. For the learner to remain actively involved in the learning process, multimedia programs should demonstrate a high degree or frequency of interactions. Unfortunately, a practical measurement for neither quantity nor quality has been developed for designers to be able to apply.

Engagement and immersion

To be introduced to the concepts of engagement and immersion, one only needs to envision the intrinsically motivated youngster who is so enamoured with the recent acquisition of Myst™ that he/she is oblivious to all else around him. What is it that captures our full attention and motivates us to remain with a multimedia program? According to Jacques, Preece and Carey (1995), *engagement* is actually a combination of things - content, media (including type, presentation and controls) and the tasks required by the program. Together, these factors determine how engaging a program will be for the end user.

In a similar vein, Bishop and Cates (1997) describe *immersion* by drawing the analogy between a learner who is immersed in a programmed environment and a rolling cart on an inclined plane. Once the cart overcomes initial friction, it begins to roll. Once it's rolling, it achieves momentum and an inertia that makes it difficult to stop. In the same way, a learner might need to overcome some disinterest or dislike for computers or perhaps for the content of the program they are exploring. Once she becomes immersed, however, she attains a "state of flow". She finds herself drawn to the various features of the program and chooses to remain in the program's environment solely for its intrinsic rewards.

In both cases, although not identified as a unique contributor, interactivity plays an important role. It is hard to imagine a program that is highly engaging or immersive without it demonstrating both a high degree and quality of interactivity. By the same token, it seems likely that interactive programs with a relatively low quality and quantity of interactions, will be less than successful when it comes to engaging or immersing their audience. For this reason, designers might do well to shift their focus from creating interactive products to creating products that engage and immerse their learners. Of course, our definitions of "engagement" and "immersion" would have to be clarified and made measurable in order for us to avoid the same fate that has resulted with the term "interactive".

Designing for Interactivity in Closed Systems

The following considerations are a combination of advice gleaned from the literature on interactivity in multimedia and the author's personal experience as a designer of multimedia programs.

1) While the instructional design process is highly iterative with the sequence of steps being visited and revisited in various orders, you should ensure that your design of effective interactive strategies determines your selection of interactive technologies and not vice versa.

2) Include context in your interactions through the use of advance organizers, analogies and metaphors to allow learners to more easily relate their previous knowledge with the new instruction for example, in the simulation of operating an electronic device, provide the learner with realistic controls and sound effects to allow for previous knowledge to be applied. A changing cursor might also be employed so that when certain parts of the simulated device are passed over, appropriate actions are suggested. An example of this is the cursor changing to a *grabber* style hand when a slider type of control is to be manipulated.

3) Consider the level of mental processing demanded by your interactions. The deeper the level of processing that the learner is required to perform, the more meaningful the interaction for example, based on Bloom's taxonomy, *knowledge* type questions might require only a point and click response, while an *application* level of questioning might require learners to manipulate items on the screen to show their understanding of sequence within a logical process.

4) Consider the age and ability of your target audience. What might be a meaningful interaction for one group (e.g. *Just Grandma and Me* for pre-readers) may be less meaningful for a more advanced or experienced group.

5) Simulate two-way communication as closely as possible by performing a thorough learner analysis, accepting learner responses in a manner that best matches the task at hand, and providing specific, individualized feedback when appropriate.

6) Consider your content carefully. Some content lends itself more easily to interactive opportunities for example, a Physics course offers

potential for the simulation of manipulating simple machines to demonstrate an understanding of the principles and forces involved.

7) Strive to create an engaging, immersive environment through the use of meaningful interactions.

A Final Word

The overuse of the terms "interactive" and "interactivity" by today's educators and instructional designers has resulted in a increasing level of uncertainty and even discomfort as to what the words really mean. This is particularly true when the terms are used to describe closed-system instructional multimedia programs. Although components of interactivity can be identified, we have not yet developed any practical measurements of what constitutes meaningful interaction. Until these measures exist, instructional designers might do well to regain a perspective on what interactivity really means and to become more critical in their use of the term "interactive" when describing their programs.

References

Barker, P. (1992). An object oriented approach to hypermedia authoring. In M. Giardina (Ed.), *Interactive multimedia learning environments: Humanfactors and technical considerations on design issues.* (pp. 132-152)., New York: Springer-Verlag.

Bartolome, A. (1994). Multimedia and interactivity: At least the appearance of two-way communication. A paper presented at the Canadian Multimedia Conference in Calgary, AB,

Bishop, M.J. & Cates, W.M.(1997, February). The physics of immersion: Investing one's energy in designs that motivate learners to get involved. A paper presented at the annual meeting of the Association for Educational Communication and Technology, in Alberquerque, NM.

Bork, A. (1982). Interactive learning. In R.P. Taylor (Ed.), *The Computer in the School:* New York: Teachers College Press.

Bork. A. (1992). Learning in the twenty-first century interactive multimedia technology. In M. Giardina (Ed.) *Interactive multimedia learning environments: Humanfactors and technical considerations on design issues.* (pp. 2-18). New York: Springer-Verlag.

Caudron, S. (1996). Wake up to new learning. *Training & Development,* pp. 30-35.

Gayeski, D.M. (1993). Making sense of multimedia: Introduction to this volume. In D.M. Gayeski *(Ed.}, Multimedia for learning.* (pp. 3-14). Englewood Cliffs, NJ: Educational Technology Publications.

Giardina, M. (1992). Interactivity and intelligent advisory strategies in a multimedia learning environment: Human factors, design issues and technical

considerations. In M. Giardina (Ed.) *Interactive multimedia learning environments: Human factors and technical considerations on design issues.* (pp. 48-66). New York: Springer-Verlag,

Haugen, H. (1992). Multimedia learning environment: An educational challenge. In M. Giardina (Ed.) *Interactive multimedia learning environments: Human factors and technical considerations on design issues,* (pp. 39-45). New York: Springer-Verlag.

Hazen, M. (1985). Instructional software design principles. *Educational Technology,* 25(11), 18-23.

Hoekema, J. (1993). HyperCard and CD-I: The 'Mutt and Jeff of multimedia platforms. In D.M. Gayeski (Ed.), *Multimedia for learning.* (pp. 51-61). Englewood Cliffs, NJ: Educational Technology Publications.

Hooper, S. & Hannafin, M.J. (1988). Learning the ROPES of instructrional design: Guidelines for emerging interactive technologies. *Educational Technology, 28(7),* 14-18.

Jacques, R., Carey, T., & Preece, J. (1995). Engagement as a design concept for multimedia. *Canadian Journal of Educational Communication, 24(1),* 49-59.

Jonassen, D.H. (1988). Interactive designs for courseware. In D.H. Jonassen (Ed.) *Instructional designs for microcomputer courseware.* (pp.97-102). Hillsdale, NJ. Erlbaum.

Jonassen, D.H. (1985). Interactive lesson designs: A taxonomy. *Educational Technology,* 25(6), 7-17.

Kristof, R. & Satran, A. (1995). *Interactivity by design: Creating & communicating with new media.* Mountainview, CA: Adobe Press.

McMeen, G.R. & Templeton, S. (1985). Improving the meaningfulness of interactive dialogue in computer courseware. *Educational Technology,* 25(5), 36-39.

Reeves, T.C. (1993). Evaluating interactive multimedia. In D.M. Gayeski (Ed.), *Multimedia for Learning.* (pp. 97-112). Englewood Cliffs, NJ: Educational Technology Publications.

Rada, R. (1995). *Interactive media.* New York: Springer-Verlag.

Ross, S.M., & Morrison, G.R. (1988). Adapting instruction to learner performance and background variables. In D.H. Jonassen *(Ed.) Instructional designs for microcomputer courseware.* (pp.227-245). Hillsdale, NJ. Erlbaum.

Schwier, R.A., & Misanchuk, E.R. (1993). *Interactive multimedia instruction.* Englewood Cliffs, NJ: Educational Technology Publications.

Steinberg, E.R. (1984). *Teaching computers to teach.* Hillsdale, NJ: Erlbaum.

Tennyson, R.D., & Christensen, D.L. (1988). MAIS: An intelligent learning system. In D.H. Jonassen (Ed.) *\nstructional designs for microcomputer courseware.* (pp.247-274). Hillsdale, NJ. Erlbaum.

Weller, H.G. (1988). Interactivity in microcomputer-based instruction: Its essential components and how it can be enhanced. *Educational Technology, 28(2),* 23-27.

Zemke, R. & Armstrong, J. (1996). Evaluating multimedia. *Training.* 48-52.

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