MULTIMEDIA: A POWERFUL TEACHING TOOL

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ABSTRACT: *Nowadays multimedia exerts an immense attraction over people of all ages. To what extent, however, can multimedia be associated with learning? It was in an attempt to determine, within a critical perspective, the relation between learning processes and the structuring of multimedia, that the present article arose. Nevertheless, only after a deep reflection on the implications of the culture of play, was a satisfactory answer obtained.*

INTRODUCTION

Multimedia systems are conducive to the development of play activities, which has made them an exceptionally strong pedagogical support. This statement may astonish the reader. How, then, should it have been written? How could one completely explain a difficult phrase and argument? How does one reduce it to the commonly known and familiar, dissolve it, extinguish it? Why, here in the beginning of the text, must the reader confront new reflections?

Beforehand this is certainly impossible, since the author can satisfy all the demands mentioned only if s/he were literally identical to the reader, that is, if the author and reader were the same person. And if this identity were established, no really new knowledge would result, since there would be no challenge in understanding the concept.

What are the real difficulties found in acquiring new knowledge? The educator cannot ignore this question, for he deals directly with teaching methods and methodologies. For this reason, the introductory statement, "multimedia systems are conducive to play activities, which has made them an exceptionally strong pedagogical support", was not chosen by chance. The text that follows leads the reader to its meaning.

First the appropriation of knowledge is approached from the cognitive viewpoint, which involves, among other aspects, the study of learning with an epistemological focus. Multimedia is then presented as a unique teaching methodology, considering the peculiar nature of its involvement with the learning process. However, the question remained: were these reasons enough to explain the influence and growing attraction of multimedia systems on people? After the study and reflection required to answer this question, it was concluded that the reason for this fascination is the play impulse which multimedia stimulates, and this is what distinguishes it as an alternative teaching methodology. The conclusion of this paper is based on these studies and reflections.

APPROPRIATION OF KNOWLEDGE

Throughout their lives, people are elaborating knowledge in a series, as Piaget [1] has already shown in genetic psychology. Thus, when new knowledge appears, there is a need to overcome a series of epistemological obstacles in order to learn it.

It was Bachelard [2] who first drew attention to this fact: "The student comes to the classroom with his/her empirical knowledge already constituted", so that for him, education did not consist of "acquiring new culture, but rather of changing his/her culture, of removing the obstacles accumulated by everyday life" (author's translation from Portuguese)

Canguilhem [3] taking up Bachelard's ideas, shows that knowledge is built by successive approximations, and that this construction, which is very slow, faces many kinds of resistance: the first evidence, preconceived ideas, habits, and many other epistemological obstacles.

It is important to point out that each individual structures his/her reality, and that each one has his/her own epistemological profile [2]. For this reason, approaches that define, characterize and understand the collective way of thinking, as in social psychology, run the risk of excluding some individual processes for appropriating knowledge.

The name ***conception*** [3] or ***representation*** [4] is given to the process of mental construction of reality. The former term will be used predominantly in this paper. A ***conception*** is a personal process, by which a person progressively structures the knowledge s/he integrates, according to his/her archeology, that is, parental cultural action, to the social practice in the school and the social milieu as a child and teenager, to the influence of different

media, and later to professional and social activity as an adult (club, family, association, etc...).

A conception is effected through the information a person receives through his senses and through the relations s/he maintains with others, individuals or groups, and that remain engraved in his/her memory. This information is codified, organized, categorized in a global and coherent cognitive system [5,6], in relation to the concerns and uses that are attributed to it. At the same time, previous conceptions filter, divide and elaborate the information received, which, in turn, can sometimes be completed, limited or transformed, generating, in this way, ***new conceptions***.

This activity of mental construction of reality is carried out according to modalities that are psychologically and sociologically determined and are interdependent. Reality is the source of the subject's conceptions. This reality, however, is approached, cut into segments, decodified and exploited in terms of each person's questions, frame of reference and mental operations, that allow him/her to construct a frame for reading that is applicable to his/her environment. This tool for analysis leads one to organize the world, or some aspect of the world, in such a way that s/he can understand it, act on it, adapt to it or evade it, at least on a certain level.

The ***conception*** can be modeled according to:

$$\textit{conception} = f(\mathbf{P\ F\ MO\ SN\ S})$$

where

P = Problem → set of rather explicit questions that induce or provoke an implementation of the conception (it is the moving force of intellectual activity).

F = Frame of reference → set of previously integrated knowledge that, set into action and brought together by the subject, giving form to the conception (they are the other representations on which one relies to produce one's conceptions).

MO = Mental Operations → set of intellectual operations or transformations that the subject masters and that allows him/her to relate the elements in the frame of reference, and in this way, produce and utilize the conception , and possibly transform it later through the information received throughout the process (they are invariant operations).

SN = Semantic Network → relation structure that functions as an intermediary for referential knowledge and operations involved. It constitutes a kind of meaning network, the knots of which represent the frame of reference and the links may be considered similar to mental operations. It enables one to give semantic coherence to the set, and, in this way, produce a sense of conception (the sense of construct appears through the logical links among the different major and peripheral conceptions).

S = Signifiers → sets of signs necessary for the production and explanation of conception [7,8].

This fundamental idea of the semantic network is counterbalanced by the notion of operation, that is, of applied transformation, through the process of structuring knowledge. There is, in effect, a change that causes the nature of the products or conceptualization process to be qualitatively different from the original objects. This transformation is the result of codifying activities, with which an item of information of a given nature and is placed in relation to others and expressed in a new form. The codification implemented in this way, even when it becomes representation of a high degree, always shows some information loss, which is actually characteristic of all processes of abstraction [9].

Thus, ***acquiring knowledge*** means moving from a previous conception to a more pertinent one in terms of the situation. Therefore learning is directly related to the ***acquisition of new conceptions*** or also to the ***transformation of conceptions*** (understanding the operations of associating or dissociating, placing or taking away, putting in order or changing the order, etc.)

The efficiency of learning depends on the means utilized to reinforce it and make it easier (media, museums, experiments, schemes, metaphors, models, symbolism, etc...). It is the subject who constructs his/her own learning. Therefore, s/he is the one who, for one reason or another, must find better situations for changing his/her conceptions.

MULTIMEDIA - GENERAL CONSIDERATIONS

Multimedia can be defined as a computer program that makes it possible to create and present interactively a set of knowledge (data in the form of texts, images, graphs, sounds and animation), having three main components [5]:

- a knowledge base;
- a semantic network formed by hierarchical, associative and analogical relations, among different thematic units;
- computer tools that make it possible to create and look for information through the semantic network.

With an architecture similar to the central nervous system, [6] units are developed by junctions, as though they were synapses, and with the value of a variable connection. The units may be words, pages, images, graphs or part of graphs, a sound sequence, complex documents which can be multimedia in themselves [10].

Thus, although a pre-established relation exists between knowledge and conduct (a hierarchical relation) in a multimedia system, it is possible to deal with the semantics and pragmatics of the information (associative and analogical relations). In other words, the possibility of interconnection among the different elements of information makes it possible to compare and analyze them, leading to the development of perspectives and singular and complementary forms of description for the same information [6].

The knowledge base is activated in a recticular form through interfaces that are to provide associative, immediate and intuitive access so that communication with the computer is also metaphoric and sensory-motor. In this way, the interfaces are devices utilized to enable the user to make a connection with both the *hardware* and the *software*. The efficiency and efficacy of the multimedia systems depend directly on the interfaces that are utilized.

The high resolution video terminals are visual interfaces "par excellence". Information storage is done through optic or magnetic supports, chosen for their high capacity and access speed, and are indispensable to the dynamic aspect of multimedia utilization. The interaction between the user and what occurs in the video can be done by using the mouse, luminous pens, keys for moving, joy-stick, monitors sensitive to touch, that offer the same kind of connection between the intention and the result [11].

Digital codification is the principle of interface. Images, texts, and sounds composed of bits can be decomposed, recomposed, indexed, put in order, commented on, associated, combined or filtered.

And, finally, we have the program itself, which is the interface of interfaces, since it is responsible for the management of the knowledge base**,** of the modules for understanding natural language and of the devices for recognizing forms, through video displays (sometimes superimposed), icons, buttons, menus, etc., that is, interfaces that are adapted to making better connections with the users' cognitive and sensory modules.

The development of a satisfactory man-machine interface requires a greater overall knowledge of the principles of relationship between people and systems (*human factors* and of users' characteristics [12].

The purpose of a multimedia program is to make possible the appropriation of some kind of knowledge. For such an aim to be achieved, it should be structured so as to guide the user intuitively towards the actions necessary to reach this objective.

This structuring is based on two kinds of documentation: declarative and procedural [13]. Declarative documentation is the one related to specific aspects that require additional information. It is provided through interactive tutorials, (with the users as participants and not merely passive observers) or included in the help systems.

Procedural documentation is one that is associated with the steps that must be carried out to achieve a given result. The most common methods of procedural documentation are hierarchical menus and key-words.

Hierarchical menus, essential for non-specialized users, consist of a sequence of video displays (pages), each of which contains a limited set of options, so as to make it easier for the user, and thus reduce the margin for errors in decision. These options must be self-instructive, so as to provide immediate access, with no need for previous training. Moving from page to page is known as navigation. The natural progression of the video displays should provide a *tour* of the decision-making process.

The key-word method allows the user to interconnect information in a recticular fashion.

Clarity, legibility and meaningfulness are factors that affect the efficacy of the interface. The meaningfulness depends directly on the target public for whom the system is being developed: the style and grammar must be coherent with the type of knowledge to be acquired and with the aptitudes of the probable user. Clarity also depends on the characteristics of the user, mainly on his/her level of mastery of the information to be appropriated. Legibility is also of great importance, inasmuch as the resources currently available also make it possible to utilize this aspect as a way of emphasizing, in order to transmit sensations. It involves factors such as the size of the printing, spacing, size of the line, margins, color of letter and background screen, sentence format, illustrations and graphs, sound effects, etc. Greater details concerning how procedural documentation is to be structured can be obtained in Kühn A. [14].

Thus, multimedia is a tool that has great potential for creating new and rich learning situations. Adopting a new taxonomy somewhat different from the one presented by Kühn A. [10], we have classified multimedia systems for teaching according to the strategy in the learning process, such as:

teaching systems that contain information on a specific subject, structured so as to build the student's knowledge progressively testing him/her at appropriate stages. The program retains the record of what the student has learned, and adapts its behavior according to this information. Changes to a higher level of difficulty are accompanied by messages of congratulations (which is essential for educational purposes);

expert systems containing knowledge concerning a particular domain, capable of aiding in the diagnosis, in counseling or in selection, similar to computer-assisted project systems, but combining hypermedia resources with those of artificial intelligence;

simulation systems representing, in a tangible and functional form, a model of some natural phenomenon. In these systems the student can alter the variables that affect the process, and the program shows the results of these alterations, leaving the student to make his/her own interpretation. Graphs that are easy to deal with and good student participation are the factors have the greatest influence on the efficacy of these programs.
They also provide important scientific models through a sequence of mathematical statements, which for some reason cannot be investigated in the laboratory (dimension of the experience, whether for the length of time necessary, the degree of danger or the need to sacrifice many animals; industrial processes; or experimental conditions not present in the real world).

modeling systems that make possible the construction of a model through the sequence of mathematical statements by which it may be expressed. It is normally presented by means of multiple work windows, each one of which contains a certain type of information: one window that allows the student to enter with the equations that s/he considers necessary to model a particular phenomenon; other windows that make it possible to attribute values to variables, that provide menus for options, or that show the graphs which the system designs, for example. These kinds of systems make it possible for the student to acquire a perception of the strategies involved in the solution to a problem.

conversation networks, made for collective conception and discussion, where teachers and students interact by means of consultations, problem-solving, notes, comments, or exchange of information. They stimulate group conception and discussion, clarifying questions, positions and arguments by breaking them down. In this way, they aid reasoning, argumentation, creation, organization, planning, etc., inasmuch as the role of these networks is to bring together, not only texts, but also networks of associations, notes and commentaries, which will be linked together by the users [6].

In any of the above-mentioned multimedia systems, there can be many different ways of presenting information: in the form of alphabetical-numerical data (that provide for mathematical manipulations so as to produce even more information), figures or sequences of figures. The latter make it possible to integrate different types of information so as to give a meaning to a series of abstract relations [15]. They are able to transport ideas of space and movement directly, simultaneity and sequence of happenings, transformation of forms and change of relations in time.

The versatility in the presentation is further increased by the concomitant use of color and sound. The sense of color does not produce anything that does not exist in the external world, but selects, simplifies and highlights the information. Variations in color or sound tonality to selecting transitions in the values of any variable.

Due to these and other singular characteristics, multimedia favors the learning process. Multimedia makes it possible for the student [6]:

⇒ to be the **actor** in the learning process, that is, to be the **writer** or the **publisher** of his/her knowledge, rather than a mere reader and listener;

⇒ to have an autonomous learning (individual, particular, differentiated) and one that is cooperative, since the knowledge is not organized in a unitary manner;

⇒ to develop his/her own intelligence and metaflective processes, that are indispensable for autonomy and analytic and synthetic thought to arise;

⇒ to acquire the ability to deal with symbolic and formal systems.

MULTIMEDIA AND PLAY

But, are all the advantages in the use of multimedia systems for teaching, pointed out above, sufficient to explain the fascination these programs hold for people, regardless of age? I believe that these factors alone do not provide a convincing answer. A deep analysis is needed to try to understand these programs, beyond their immediate dimensions.

In my opinion, the main factor responsible for this fascination is the ***play impulse***, the impulse that orients games, that appears in human beings from early childhood and does not weaken with age [16]. The game is an end in itself, that confers sense on the actions, while non-play activities have an aim that is not covered by the action itself. Thus the game shows a disinterested, or *self-justifying* character, as defined by Baldwin [16].

But a game presupposes many other things, other sources. A game is the free and spontaneous manifestation of the inner person, the manifestation of the inner one, demanded by the inner one him/herself. The impulse to play is exercised beyond the natural needs of life and independently of practical interests [17]. It acts along with sensitivity and understanding; it plays with the most diverse aspects of things, with the most varied feelings, and stops at nothing. Its tonic is freedom, for, as a game, it has no result in the real world.

According to Reynolds, the play quality of an act does not stem from the nature of what is done [18]. The game is not a specific behavior, but a situation in which its behavior takes on a specific meaning. It does not originate in any obligation, other than that which is generally agreed on, apparently seeking no result, other than pleasure [16, 19].

Thus, for a game to exist, there must be a decision to enter the game. It appears to be like a system involving a

succession of decisions. This system is expressed through a set of rules, because the decisions build the play universe. However, one must realize that the rule is not the law. A rule of a game is valid only during the game. It can be transformed by the player. It shows clearly the specificity of a situation that is caused by the decision to play, and that can be annulled when the decision is questioned. Thus the rule makes it possible to create another situation that is free from the limits of the real world.

This situation may appear as a highly original space for experiences: in the game behavior is found to be dissociated (and protected) from its normal consequences in real life. That situation arises in a unique space for experiences for the one who plays. He can try to confirm reality without fear; he can learn through his/her own mistake, developing self-confidence in this way, and with great determination and motivation can throw him/herself towards meeting new challenges. Therefore, "the game provides the occasion for trying combinations of conduct, that, under functional pressure, would not be attempted" [18] (author's translation). For this reason, it is a space for innovation and creation. Creativity is relative and not absolute, but essential for the discovery of its consequences.

Explanatory theories concerning the game, developed so far [16] make it quite clear that this phenomenon cannot be understood by the causal laws. Based on this line of argument, I consider that multimedia systems offer some support that gains new significance, through the play activity itself. Their conceptions are based on a symbolic universe that is utilized for the building of a complex of conceptions that are, at the same time, coherent and rich, and capable of providing play functions without creating a rupture or hiatus between the two levels. In this way, they hold a seduction potential, that allows actions and manipulations, in harmony with the representations suggested.

When they propose actions, whether sensory-motor, symbolic or sustained by the presence of a system of rules, or multimedia systems, they stimulate more or less open conduct, structuring behavior, and therefore, appear to be exercising, on this level, the function of facilitators in the learning process.

Multimedia systems never become impatient, never judge or play a moralistic role. In this permissive environment, the student experiences spontaneous conduct, takes risks up to the ultimate consequences (there is no danger or real punishment), fearlessly attempts to go through the necessary stages and go beyond the level of difficulty, to train and perfect abilities, exercise creativity, develop assertive and non-assertive behavior that can actually serve to reformulate or reinforce attitudes.

Multimedia systems, although only one of several different sources for appropriating conceptions, are an especially appropriate means for providing new content for old structures, and even old stereotypes. The same representation can be codified in different ways, thus increasing the possibility of its assimilation.

For this reason, multimedia stimulates the acquisition and transformation of conceptions, by aiding in elaborating information, identifying paradoxes, applying old ideas in new ways, in filtering out non-essential or incorrect data or in reappropriating concepts that had previously been considered irrelevant.

The diversity of dimensions sustained by multimedia have enriched its potentiality as a learning factor. However, its specificity lies in the fact that it stimulates a reaction. It holds a multiplicity of potential reactions. It brings about a motivation that induces a sense of well-being during the learning process, which benefits the efficiency of this process.

Learning via multimedia systems is an activity, that comes from the learner's own initiative, that is, an activity that s/he dominates and repeats because of the interest and pleasure s/he derives from it. The appropriation of the content comes through transformations, through modifications, through adaptations, but occurs according to the rhythm of each individual.

Multimedia systems give importance to spontaneous play activity as a source of learning. They exploit the interest in the game so as to distract him/her from the game itself to the appropriation of its contents. In a way, they can be considered a game by analogy.

CONCLUSIONS

In learning, we expect a progression from intuitive to formal knowledge, and we expect consistency between the two. Much of what is taught is not a surprise: It seems naturally to follow non-verbalized rules of behavior that have already been experienced. Nevertheless some new knowledge is inconsistent with our intuition.

We build our mental model of external reality out of our past experiences. We expect that when we throw balls against smooth surfaces, they will jump up at predictable angles, and that they will lose height each time they hit the floor. We have had no experience with balls that never lose their height, or that, on hitting the floor, go back in the direction of the one who threw them. We have no intuition for Heisenberg's uncertainty principle; our macroscopic world does not behave in this way.

Multimedia systems can offer us a different set of experiences. By means of simulations, submicroscopic behavior of atoms and molecules can come to be part of our primary daily experience, responsible for our intuitive knowledge, rather than an unfamiliar idea based on a variety of pieces of indirect evidence, intelligently interpreted.

Nothing in previous human experience has reacted as images of a monitor do. Multimedia can reverse black and white, show figures in unreal colors, show sounds for phenomena they do not have, and force objects to obey physical laws, different from what our everyday experience tells us that they have to obey.

But the fascination held by multimedia comes, in my opinion, from its play function. It influences and structures play culture, both on the level of play conduct and symbolic content.

Play interaction is associated with pre-existing conceptions and with the stimuli inherent in the meaning and action that emanates from each person. It is a time when the player appropriates the available content, making it his/hers, through his/her own construction process.

To use a game as a teaching support is to follow nature.

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