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MULTIMEDIA LEARNING

Last century is considered as the starting point of a series of advancements as regards teaching and learning methods; particularly, if we go back with our memory, we are astonished at how they have changed in a period which proves to be of a relatively small extent. During the XX century, in fact, teaching methods were first deeply influenced by the rise of the behaviorist belief assuming human behavior to work according to a stimulus-response principle; although the behaviorist paradigm was useful in many fields of application, yet it was not very convincing when applied to the human brain since it considered the learner as a sort of machine to be programmed according to a pattern of desired instructions. Soon the behaviorist theory was challenged by the cognitive scholars, who, instead of seeing the brain as a passive acquisition device, dedicated their attention to the various unobservable features which characterize the functioning of the human brain such as memory, motivation, reflection and so forth, and considered the learner as an active part in the learning process. Nowadays new paradigms are spreading – such as the constructivist one (which claims that the only reality is the one we build) –, also according to the new discoveries which are being made and to the new technological possibilities which are going to be available.

Apart from the different theories and ideological assumptions, it is a matter of fact that nowadays there are much more useful resources which may be used to improve students' learning and one of the crucial questions is how and to what extent technology may contribute to such an improvement. Although at the beginning of the computer era many people, simplistically, thought that soon the role of the teacher would disappear, this is not a sound line of reasoning. In fact, the point is not whether the computer may supplant the teacher, but if and how the computer may help in improving the process of learning. It is certain that the potentialities which nowadays technology offers teachers and students are much greater than in the past, but we do not have to believe blindly and think that anything which a computer may offer is good as such. It is therefore not surprising that one of the most discussed points in the teachers' scientific community is the role and the importance of multimedia learning.

Although there are several ways of defining what multimedia learning is, one, which appears to be among the most sound, is to consider it as a way of presenting material in order to foster learning through different means, i.e. using both the verbal (either through written or spoken words) and the pictorial (which may be proposed by pictures, animated motions, graphics and the like) forms. Compared with the 'classical' way used to present new material before the development of technology, it takes advantage of two input channels whereas 'old' teaching means, which were generally made up of books, used only one (i.e. written word). The question now is whether using more input ways is helpful in foster learning or not and the answer to

such a question depends on whether you consider multimedia learning from a quantitative or qualitative point of view. If we consider the former hypothesis, that is the one employing multiple channel media to provide more information, we must reasonably agree that presenting the same information first as a written text and then in pictures is of little or no use at all. Much more interesting is the qualitative hypothesis which does assert that a multimedia presentation will not give the 'same' information in two different formats considering the two channels as non-equivalent: the reason for using two different input channels is that doing so each way of presenting information will implement the other, fostering therefore meaningful learning, i.e. the student will take advantage of using the multimodal input system by building stable connections between the verbal and pictorial input.

As already mentioned, using multimedia (and the results aimed at) depend on what are one's theoretical assumptions about teaching. Basically we can distinguish between two kinds of approaches in multimedia design: the former is the one which is technology-centered (which is more concerned in investigating how we can implement our presentation design with the latest technological achievements), the latter is centered on the learner (i.e. it deals with the best ways of tailoring multimedia presentation on the learners' needs). The learner-centered approach is evidently much more appealing, since the technology-centered one sounds as closer to the drawbacks affecting the behaviorist theory, i.e. not considering the addressees as an active part in the process and assuming learning as a way of adding new pieces

of information to the students' archive in the same way we add a new song to the ones previously recorded on an audiotape. Besides, the learner-centered approach seems to be more interesting also because it takes into consideration the functioning of human brain. According to this paradigm, in fact, the learner is the most important element in the process: when he is presented with new information, he tries to create a coherent representation of the new data with the one he already possesses, trying to implement his old knowledge with the new one into a sound structure. Therefore, as the learning process is mostly depending on the learner, the role of the teacher and of the means he employs, such as multimedia, is to support in the best way such a process, operating as a cognitive guide in order to facilitate the acquisition of new knowledge.

After presenting new materials through multimedia, we expect a change in the students' knowledge. There are two levels at which such a change may occur, i.e. the students may just remember the new information, being able to recall it when asked (in this case we talk of retention) or they may be able to use the knowledge presented in similar contexts, therefore showing that they have built a coherent and sound construction of the material presented (in this case we talk of transfer). Basically, the outcome of multimedia learning may be of three different kinds, i.e. after a multimedia presentation we may obtain no learning (student has achieved neither retention nor transfer), rote learning (i.e. student has achieved retention but not transfer) or meaningful learning (student has achieved both retention and transfer).

Therefore in designing multimedia path we must aim at reaching meaningful learning which can be obtained only if we concentrate on having the student achieve both retention and transfer: doubtless, in order to do so we had better work on the learners' cognitive abilities rather than on their behavioral ones (which foster only retention). To do so, it is important to take into consideration the features and the limits of the human cognition system.

One of the most interesting studies on the principles, according to which a learner-centered multimedia learning environment is to be designed, is Richard Mayer's, whose work is based on three criteria, that is intelligibility (principles should be inferred from a sound cognitive theory of multimedia learning), plausibility (principles are grounded on empirical research) and applicability (the principles can be applied to novel multimedia learning environments).

Mayer's cognitive theory of multimedia learning is one of the most consistent. In fact, it is based on three fundamental rules: the dual channel-, the limited capacity- and the active processing assumptions.

Multimedia learning involves the use of different kind of memory: in order to obtain meaningful learning, the material presented, after having been analyzed by sensory and working memory (if the learning is successful), will be added to the learner's long-term memory; the process can be analyzed more closely. As mentioned above, a multimedia presentation exploits different input channels, the eyes and the ears. So, when material is presented in words (either spoken or written) and pictures

(either still or animated), our sensory memory transfers the incoming data to our working memory which is immediately asked to process them. Naturally, when words are supplied as narration, they will be processed by our hearing.

Then, the data, flowing in through our auditory and visual input apparatuses, begin to be processed by our working memory which has the task of selecting the most important data and organizing them into sound models. As the data are coming from different sources, our working memory processes sounds and images using different channels, although this does not mean that such dual processing is absolutely separate: in fact our mind implements these two processes converting sounds into visual images and vice versa, i.e. when our mind processes, for instance, the word *car* using our verbal processing channel, a visual image of a car is recalled. After the incoming data have been selected and organized, they have to be integrated with our prior knowledge, which means that our long-term memory is to be activated.

The dual channel assumption is, naturally, not new and is based on previous research carried out by Clark and Paivio on the dual-coding theory and by Baddeley on the working memory system.

Why is the Mayer's dual channel assumption important to us? Apart from the importance such a hypothesis has by itself, it is very useful to consider it in the light of the second assumption, that is the one dealing with the limited capacity which makes clear that there is a limit (naturally individual) to the amount of information the student can process at a single time. The level of difficulty of the cognitive load

may depend on different factors; when it is mostly linked to the effective complexity of the material, we define it as an intrinsic cognitive load, while we refer to an extraneous cognitive load if the intricacy is caused by a complex and difficult organization of the data presented. This assumption also explains why, when new information arrives, we try to identify the most important elements immediately, i.e. we select the most meaningful parts because our memory span is limited and therefore we have to concentrate only on those elements which are needed to build, after the material has been organized, a sound representation. Naturally, the tenor of the selection depends on the channel through which the material is flowing, which, as already mentioned, may be either verbal or pictorial. When dealing with the information coming from the verbal channel, the learner is at first engaged in selecting the most important words and then to organize them into a verbal model in which he has to build a sound representation of the verbal knowledge. Vice versa, when dealing with the material received from the pictorial channel, after selecting the material, the student has to organize a pictorial model, i.e. a sound representation of the pictorial knowledge. To obtain meaningful knowledge, in fact, the student will have to implement the different verbal and pictorial models with the prior knowledge contained in the long-term memory.

The final assumption proposed by Mayer considers the learner as an active part in the process, i.e. learning is enhanced when the learner applies his cognitive system to analyze the presented data in order to build a sound mental representation to be stored

in the long term memory. Such an analysis requires the student to tackle the incoming material using several investigating techniques such as comparison, generalization, enumeration, classification and processing (representation on a cause-effect basis). It is therefore clear that, if we want to help the learner to obtain a construction of a sound knowledge model, the presentation should provide coherent structured material and be directed toward a facilitation of the learner's cognitive process.

This multimedia learning model has undergone a series of tests which have led to the enucleating of some principles showing and proving its validity.

Among these we have the multimedia principle, according to which it is always better, in order to improve learning, to present the new material using both words and pictures instead of using words alone. Such a principle is naturally based on the dual code assumption, i.e. it is better not to overload a single input channel and leave the other unused, instead of taking advantage of them both, which will help the students to build a verbal and pictorial model to implement. A series of tests have proved that retention is enhanced when material is presented using both channels. This is why, although verbal and pictorial ways of presenting data may implement one another, they do not own the same informational power. Naturally, whether it is possible to use a multimedia presentation only taking advantage of the new technologies or if the 'old book' may be also used for multimedia presentation (strictly speaking, a book can be structured using pictures and words, therefore constituting a multimedia learning environment). Really there is no answer to such a question as this is an

unsound way of putting it because, although the medium used might present implications on the general outcome, there are other factors (such as the theoretical ground on which learning is based, the quality and the effectiveness of the method used etc..) which deeply affect the result of a learning process.

In designing a multimedia learning environment, we must also be aware of giving the due care to the spatial and temporal contiguity principles. The former state that learning is enhanced when pictures and words are presented near each other rather than occupying spaces which are distanced, while the latter affirm that learning is boosted when pictures and the corresponding words are presented at the same time rather than distanced in time. The reason lying behind those principles is based on Mayer's cognitive theory: in fact, considering that students will have to build a mental model and that our memory span is limited, the model building process will be facilitated if our working memory receives the data simultaneously both from a temporal and a spatial point of view. Also in this case, tests have proved the efficacy of the spatial and temporal contiguity principles as a way to improve better learning.

The coherence principle derives from the limited capacity assumption. It asserts that it is better to exclude non-pertinent, superfluous and unrelated material from our multimedia presentation. In fact, if a presentation provides non-pertinent material (either in words, pictures, or music) within the data presented, although appealing, such a material might occupy the working memory span and lead the student astray from the important aspects on which he should focus as well as possibly being of

hindrance to the mental model building or, even worse, it might cause the construction of a distorted mental model. For the same reason, it is useless to add unneeded elements to the presentation.

What is, therefore, the best way of designing a multimedia presentation? Mayer suggests, according to his modality principle, that learning is facilitated when the material is presented using animation and narration rather than having words presented as printed text: in this case, in fact, the auditory channel might remain unused while we might overload the visual channel (eye should be processing both animation and written text). Some scholars wonder whether it would not be better to present the material using narration, animation and written text. Although at first this might seem a good idea, really we might again incur in an overloading of the visual channel; so, according to the redundancy principle, adding written text to a presentation using animation and narration is more of hindrance than enhancement to the learner. Naturally, although all the principles above mentioned are to be taken into the due consideration, we should also be aware that student's individual features may affect the outcome of our multimedia presentation. In fact, tests have proved that the low-knowledge learners are more affected by the design effects than high-knowledge ones. This may be explained by the fact that high-knowledge learners are able to take advantage of their prior knowledge to compensate eventual design drawbacks or faults. Mayer also considers high and low spatial learners, affirming that ,although the two categories show weak results in case of a poor instructional

message, high spatial students' learning – when presented with a sound constructed message – is more enhanced than that of low spatial ones.

So, after considering all the features of an effective multimedia design, the question which still remains unanswered is "does multimedia work?". Naturally, it is quite difficult to find a definitive answer to such an interrogative because, as we have seen, there are so many factors which have to be taken into consideration since what is good for a particular class of students might not be so effective for another. Is it therefore possible to assert that multimedia learning is, though appealing, impracticable? Well, we must not be so strict in judging multimedia or assuming they are the panacea for all the troubles concerning learning. Our personal idea is that the cognitive theory which is behind multimedia is very convincing and, therefore, it is very likely that putting the learner at the center of the learning environment is a good way of helping the enhancement and facilitation of learning through the development of new techniques and tools among which multimedia learning is surely one of the most promising.

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