

*Full Length Research Paper*

## Multimedia contribution (CD-ROM) in the learning of electroencephalography

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**Electroencephalography (EEG) learning is a part of neurologist's training and its interpretation for clinical diagnosis is complex. To evaluate the role of multimedia like CD-ROM in self-training as part of EEG learning, we conducted a survey on medical residents mainly neurologists in active learning of EEG interpretation. Students were interviewed to determine and analyze the educational value of CD-Rom in EEG learning. Approximately 52.9% of learners were beginners in EEG and 78.6% found insufficient conventional learning tools (books, atlases) to acquire professional competence in EEG. The advantages of CD-Rom for learners were reported as an interactivity including the ability to revert at several times a useful adjunct for handling and storage that allows a better visual memorization of diagrams. EEG learning is visual and uses: declarative, procedural and conditional knowledge. According to the principles of andragogy (adult education), an adult student must be the main actor of his learning. Multimedia based on normal and pathological situations can play this role to facilitate learning through interactivity and incentive action. Media can help in EEG learning allowing the acquisition of professional competence in this field.**

**Key words:** Electroencephalography (EEG), multimedia, learning.

### INTRODUCTION

Electroencephalography (EEG) is a technique used for an electrophysiological examination that is a simple and cheap way to assess the brain activity in normal and pathological subjects (Hirsch et al., 1995). The conventional EEG is the graphical visualization of spatial and temporal variations of brain electrical fields collected from the surface of the scalp. Despite the development of

techniques for brain morphological imaging, EEG keeps an important place in neurological practice, particularly in the field of epilepsy, in the management of comas and unexplained disorder of behavior. The contribution of this technique is very dependent on experience and expertise of a practitioner. Interpretation of an EEG is basically hard because of unusual situations and the pitfalls are numerous conditions. The consequences of misinterpretation are individual and social. For example, wrongly labeled EEG in subjects who are clinically nonepileptic but presenting unusual EEG can deprive him

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of driving license, or deny him access to certain professions.

Traditionally, the teaching of EEG is commonly performed during the last classes of specialization or internship in neurology. However, it is undeniable that the acquisition of professional competence requires personal involvement. The future professional must build himself - in an active process of self-learning of theoretical knowledge (declarative) but also actions (procedural and conditional) as it has been well described by Tardif (1997). Mentoring is the usually recommended method of teaching but it is long and demanding. The use of multimedia as an educational tool of EEG is the subject of this study. CD-ROM represents a potential source of self-learning.

The first target of EEG learning is primarily neurologists, including pediatrics neurologists who regularly use this tool. Psychiatrists also sometimes need the contribution of the EEG for positive or differential diagnosis. Resident in training usually wants to perfectly know the EEG as it is very useful working tool for neurologist both practicing in hospital or in private.

## TEACHING PROBLEM

According to the conceptual frameworks of classical pedagogy, the learning objectives of the EEG are generally cognitive while professional competence aimed by the learners induced psychomotor in addition to emotional objectives. This involves ability to solve complex problems. Another well-known conceptual framework is the one of "knowledge, know-how and skills". Here the classical pattern of student-centered learning is required, the learner has to own the skill and return it back.

Instead, we will refer to the conceptual framework with the influence of cognitive psychology on teaching and learning (Tardif, 1997). This is the processing of information provided by EEG and the return of this into action (diagnosis and treatment). The practice of EEG first requires technical knowledge (declarative and procedural knowledge, relatively easy to acquire). The interpretation of ECG is the second step, the most difficult in terms of skills. It requires solid and well structured declarative knowledge. Perfect knowledge of the characteristics of different graph-elements is essential for the interpretation of EEG. It is necessary to remember that to have a stack of information does not mean to know how to do things. EEG cannot be learned only in books by leafing few pages, or even scrolling learning software (Jean, 1993). EEG learning is particular because of the importance of visual analysis, the lack of strict quantitative normative data, by the fact that two tracks will never be completely identical (each patient is different). Declarative knowledge is not enough because we must "know how to act." Progressively, the teacher

seeks to ensure the acquisition of conditional knowledge (knowledge of action to make a decision, taking into account all the data about the raised problem) that determines the hierarchy of achievement and interpretation of tests. Conditional knowledge is the one that leads to expertise (Tardif, 1997).

For educators, learning is typically based on complex problem solving. Learning of EEG interpretation needs to be contextualized. The repeated conceptualization (confrontation to multiple and varied real cases) is typically the most efficient teaching method. If competence can only be acquired in real situation behind an EEG desk (Jean, 1993), it is obvious that an essential part of this training for the learner is related to the time spent to record him and interpret different tracks with the help of an expert. The learner is not commonly put in a real personal position of decision making. Learning a complex technical skill as the EEG requires a personal commitment that means an involvement in both the cognitive and affective sides. Thus this method requires a very long learning time to have a large overview of clinical problems that may be encountered by a practitioner with a progressive responsibility. Strengthening the link between training objectives and training needs of students may consider all clinical situations potentially encountered by a practicing practitioner to integrate them into education. This is very difficult because exposure to clinical problems is really random.

## Can the multimedia (CD-ROM) help to speed up the acquisitions?

In traditional model of teaching, teacher is the source and reservoir of knowledge. He transmits this information to students and timely; he assesses their knowledge, often through control of knowledge with the exams. In a multimedia model, the relationship is different. Knowledge is stored, often in the form of information independently from the teacher. Teacher and students have access to information and collaborate, and students transform this information into knowledge. This is an example of what happens in problem-based learning (PBL) in which students go to library, guided by their instructors, seek information, then structure and study it. Different systems allow them for self evaluation, that is, to check whether they have mastered expected knowledge. In this model, the media naturally find their place. The CD-Rom can make thumbnails (clinical records and EEG) to cover all the problems encountered in learning. The feedback from the teacher is here replaced by an instant feedback tool even if this feedback has not the same pertinence of the one provided by a mastered companionship. EEG is a purely visual examination; it can only be learned when recording and reading tracks. Visual recognition of physiological activities and

**Table 1.** Frequency of the specialty of learners.

Specialty	Frequency	Percent
Neurology	13	76.0
Reeducation re-adaptation fonctionnelle	1	5.9
Rheumatology	1	5.9
Psychiatrics	1	5.9
Pediatrics	1	5.9
Total	17	100

**Table 2.** Advantages and drawbacks of multimedia according to the learners.

Deficiencies of the traditional tools (Atlases, Books, Reviews) about EEG	Advantages of multi-medias (CD-Rom)	Deficiency of multi-medias (CD-Rom)
a) Not clear at all	a) Interactive	a) Absence of a mentor
b) Not interactive	b) Possibility to come back many times	b) Lost of criticism in front of their screen
c) Guilty	c) Possibility to follow one own rhythm	c) Lack of prerequisite for understanding
d) Rather theoretical	d) Complete courses as a personal revision	d) Density of information that overwhelms.
e) Rather far from practice	e) Easy to use	
f) Not easy to use	f) Memorization of particularities	
g) Tired full	g) Allows good detection of graphs	
h) Nothing can be memorized		

pathological conditions is a prerequisite to practice EEG. It is then easy to imagine the importance of the self-study of EEG through media such as CD-Rom that helps in the acquisition of competency in interpretation. However, because of the complexity of EEG, misusing these tools can lead to problem arising.

## METHODS

We conducted a qualitative and quantitative study involving a group of residents in active learning of EEG. CD was not common in the teaching arsenal, but students admit to use frequently this method. An anonymous questionnaire was sent directly outside of classes. The objectives of the questionnaire were to:

- Identify sources of motivation of learners in EEG learning dynamics
- Determine the profile of students enrolled in degree
- Determine their level of competence in EEG before training
- Determine how a CD-Rom can be useful in the EEG learning process
- Identify the concerns of learners and their assessment of multimedia and the educational benefit of such a tool.

## RESULTS

Table 1 shows the distribution of learners according to

their specialties. EEG learning is interested mainly in specialists and residents in neurology (n=13 out of 17 students). 8 learners out of 17 thought that the visual recognition and identification of graphs provide a valuable learning. An equal number of learners share this opinion about visual learning, but also believe that solid theoretical knowledge is required and must precede the visual learning.

Deficiencies reported by subjects on traditional learning tools of EEG (atlases, books, magazines) were as follows: not enough clear, non-interactive, bulky, too theoretical, rather remote from practice, not manageable, tire full to use, not easy to memorize.

According to learners, the benefits of CD-Rom were reported as follows: interactivity, possibility of returning several times to their own pace and adding a personal review, handling, and allow storage of features, good detection characteristics of graphs.

On the other hand, the reported shortcomings of CD-Rom are: the absence of a "senior" that can help, loss of criticism behind the screen, the prerequisite to understanding, the density of information often likely to overwhelm. Table 2 summarizes the views of the learners.

## DISCUSSION

As expected, this study shows that EEG learning interested mainly novice practitioners that is, the neurology residents which represent 76% of respondents

in this study. This result suggests that the learners were fully conscious of their lack of knowledge in this area. In addition, extrinsic motivation is important in our study: 11 learners believe that mastering EEG is important for their future practice. Therefore the learning of EEG for their personal training becomes imperative. As learning technique, the majority of learners chose to combine the theoretical learning in classical references (books and atlases), and practicing by working on an EEG device.

It is amazing to think that this learning approach adopted by most of the EEG learners had already been advocated by Jan Amos Comenius. Since the thirteenth century in his theory, Comenius talks about the concept of parallelism or harmony rather than corresponding legal relationship between cognitive function or organs (*imens, cerebium, ratio*) and the activities themselves (*manus operatus, artes*). But as soon as moving is in the field of teaching, Comenius straightens prospects and constantly affirms the primacy of action, "artisans do not retain their apprentices down to theories, they put them to work soon, so that they learn to build in forging, to carve in carving, to paint in painting, to jump in jumping. So in schools we learn to write by writing, to speak by speaking, to sing by singing, to reason by reasoning etc ... So that schools should only be workshops where one works with zeal. "Thus finally all will happily experience by practice the truth of this proverb: "*Fabricando Fabricamur*" (Vespignani, 2000).

The majority of learners use CD-Rom dealing with EEG. They explain these results from the fact that they learned EEG because of its complexity, requires a visual recognition graphs. CD-Rom may also be an effective teaching tool if used wisely. This learning is so visual and uses the three types of knowledge distinguished by Marzaro et al. (1988).

Declarative knowledge ("what"): corresponding to theoretical and static knowledge; it is purely neurophysiologic knowledge, or even clinical techniques; the description of cortical generators, knowledge of EEG abnormalities in major pathological frameworks, knowledge of the characteristics of the amplifiers used and filtering techniques ....

Procedural knowledge ("how"): about how to perform an action or solve a problem, it is a knowledge of dynamic action sequences. In this case, it is such knowledge of the completion of recording protocols.

The conditional knowledge ("why?"): Also known as strategic knowledge, it refers to the conditions of action, the cognitive abilities to distinguish, generalize or choose: it indicates the time to do something or to use such a strategy. It is such a knowledge involved here in determining the review strategy based on demand, or in the interpretation of EEG and in writing the report at the end of the review. Given the importance of the degree of visual analysis that comprises the electrophysiological studies (this is also true for EMG, EEG as PE). It is possible that the pattern recognition is necessary for the

interpretation of this type of review, this type of knowledge and capacity to contribute very special expertise to the professional clinical neurophysiology.

If visual memory is essential in EEG learning, we can imagine the positive impact of multimedia on this process. Authors like Baticle (1985), stress the impact of image on the process of learning in general.

While learners unanimously recognize the value in the EEG CD-ROM learning, they also recognize that this tool must be a complement to existing tools (books, atlases). To achieve its objective to encourage the learning process, the CD-ROM should, according to Rheume (1985), satisfy the criterion of usability. This criterion is defined as "the new term to overcome the usability and consider whether it is the task of retrieval and constructive information, or more formal learning. But in fact, usable interface is one that can accomplish a task efficiently with minimal effort, with the sweetest slope of learning".

Learners in general stressed the motivators of CD-ROM compared to traditional tools and some of them gave example of existing tools in the area of EEG (<http://www.encyclopedies-online.com>). Thus, Marton (1992) in his work, first noted the impact of media on learner motivation and mentions in the second time the mechanism of action of media on this motivation: it is above while "informing, explaining the situation to be experienced, locating, linking the knowledge to the learner, creating an expectation, by trying to involve from the outset the learner, then motivation is reinforced and stimulated."

When the learner constructs knowledge, that is, adds information to previous knowledge, he can, in situations of multimedia learning that involves words and images, build three types of basic connections between new knowledge to acquire and previous knowledge: The first type involves the construction of representational connections between verbal information which is represented by the multimedia system, and the visual representation of this information, as built by learner. The second involves the construction of representational connections between information that is represented graphically and the visual representation of this information, as the built learner.

These results are consistent with the model of double coding according to which a memorization requires the construction of representational connections and problem solving in the construction of representational as well as referential connections.

The objective of the training in EEG is to enable the acquisition of professional competence, it is therefore essential that these means of evaluation match exactly the goals set by teachers. Also, the evaluation must consider the knowledge acquired during the internship, which will certainly encourage students to use modern tools to build their knowledge.

But we must recognize that our investigation was

limited to the assessment of the interpretation of EEG and was addressed to a majority of learners who had no experience in EEG. The learning of EEG recording technique was not indeed for EEG and recording and interpretation are inseparable, although made in deferred time. In most cases, EEG recordings are assigned in hospitals to ideally technicians and nurses. During the practicum, medical students in companionship with technicians became familiar with the technical equipment of EEG, see all precautions necessary to obtain a quality recording, and learn to recognize the artifacts, their origin and means of correction. It was during the recording that the doctor can observe and learn to differentiate paraphysiological and pathological graphs as well as pinpointing the time of their occurrence.

Learners are aware of the importance of collecting information before recording starts and also during recording. Placed in a real learning, the doctor with his own issues contributes to the motivation of the technician. The relevance of cross-enrichment between doctor and EEG technician, in the area of Epileptology, justified the organization of joint training workshop.

Looking at the impact of additional learning CD ROM, the creation of a CD ROM specifically appropriate to the EEG technique learning would be very useful for both doctors and technicians.

## Conclusion

As pointed out by Carl (1996) "knowledge that can influence the behavior of an individual is that he discovers himself and he appropriates." We believe that to develop professional competence in EEG learners, trainers should develop learner-centered aspects; they must focus on the process of self learning. It appears from this study that the new teaching tools such as CD-ROM can help accelerate the learning process. To enable learners to use these tools, the assessment should be formative in assigning value to the knowledge acquired during the internship.

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