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"Cognitive ergonomics and e-learning"

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Summary

Illiteracy is one of the major scourges of our century. According to UNESCO, in 1980, the world had about 870 million illiterates. Today, that figure is around 862 million.

African countries are the first to suffer. They reach nearly 50% in the regions of sub-Saharan Africa. This same institution declared in 1958 that "Anyone unable to read and write, with understanding, a brief and simple statement of facts relating to daily life" is considered illiterate.

However, the very concept of illiteracy has changed a lot because today a person who does not know how to use a computer can be considered illiterate in so-called information societies.

This trend has been reinforced by the development of new information and communication technologies where machines are gradually aiming to imitate the skills of the human expert in their educational approach.

The arrival of these computer systems equipped with multimedia tools and software allowing interactivity gives the possibility of implementing new strategies for transmitting knowledge and in particular learning to read. By imitating the performance of the teacher, computer applications aim to solve aspects related to the problem of learning to read.

Keywords: Cognitive ergonomics, learning, illiteracy, HMI, artificial intelligence.

FRAMEWORK OF THE INTERVENTION:

We are going to focus throughout this intervention on the contribution of "HMI ergonomics" in the design and evaluation of computer environments to help learning to read.

Indeed, a multitude of educational organizations are beginning to offer multimedia platforms as a support for learning to read. This new educational approach deserves to be accompanied by an approach allowing the facilitation of associated pedagogical transfers as well as optimal interactivity between the learner and the machine.

This study was carried out within the language research laboratory (LRL) of the Blaise Pascal University of Clermont-Ferrand in order to optimize the HMIs within the framework of the AMICAL project (Architecture Multi-agents Interactive Compagnon pour l' Learning to read).

The AMICAL Project, aimed to explore the contributions that can be expected from new information processing technologies and cognitive sciences in the development of computer environments for learning and teaching reading. (Chamberuil et al. 2000).

It is characterized by three main objectives. First, it is the subject of fundamental theoretical research in the field of application, learning to read, as well as in the field of computer learning environments. Secondly, it leads to the development of prototypes which are used in experiments, which make it possible to validate the hypotheses resulting from basic research. Finally, it is this research, both fundamental and applied, which makes it possible to provide teachers and learners with validated computer tools.

The notion of learning to read can cover multiple learning situations, ranging from initial learning in school to adult literacy.

The computer environment of the AMICAL project is an environment to help learning and teaching reading provided in the classroom, with a view to individualization carried out either by the system alone or by collaboration between the system and the teacher. (Chambreuil et al. 2000).

GOALS :

• Conceptualization of intervention approaches in HMI ergonomics

• Fight against illiteracy by allowing educational institutions to associate IT environments for learning to read in their educational approach.

• Popularize the contribution of HMI ergonomics in the design of computerized educational platforms.

•Work on an ergonomic approach to optimize the pedagogical relevance of computer environments for learning to read.

MATERIALS AND METHODS :

The evaluation of the HMI within the framework of the activities of the AMICAL project was made on the basis of the evaluation criteria proposed by (Olivier HU & Al) with emphasis on the following parameters:

- Guiding
- Workload
- User control
- Error handling
- Compatibility
- Graphic aspects
- Text
- Media

THE RESULTS :

A certain number of recommendations have been proposed in order to improve and optimize the educational activities of the AMICAL project.

The areas for improvement revolve around the following points:

• The importance of the clarity of the pedagogical instructions

• The importance of audio and visual feedback

• The importance of the syntactic architecture of the pedagogical dialogue

• The importance of semantics in the development of educational HMIs.

• Association of more than one meaning in the process of reading words.

INTRODUCTION

Illiteracy is one of the major scourges of our century. According to UNESCO, in 1980, the world had about 870 million illiterates. Today, that figure is around 862 million. We will have 800 million illiterates in 2015.

African countries are the first to suffer. They reach nearly 50% in the regions of sub-Saharan Africa. This same institution declared in 1958 that “Anyone unable to read and write, with understanding, a brief and simple statement of facts relating to daily life” is considered illiterate. (Unesco, 2006).

However, the very conception of illiteracy has changed a lot because today a person who does not know how to use a computer can be considered illiterate in so-called information societies.

This trend has been reinforced by the development of new information and communication technologies where machines are gradually aiming to imitate the skills of the human expert in their educational approach.

The arrival of these computer systems equipped with multimedia tools and software allowing interactivity gives the possibility of implementing new strategies for transmitting knowledge and in particular learning to read. By imitating the performance of the teacher, computer applications aim to solve aspects related to the problem of learning to read and thus offer inexpensive economic models making it possible to provide classes in Africa with computer applications for help. to learning to read.

We will focus throughout this intervention on the contribution of "HMI ergonomics" in the design and evaluation of computer environments to help learning to read.

Indeed, in e-learning (Computer Environments for Human Learning), the design and evaluation of "learning systems to help reading" are very important steps and often require multidisciplinary intervention (linguist, psychologist, ergonomist, computer scientist).

On a conceptual level, it is an attempt to bring together several paradigms of reflections leading to the development of "EIEH" specialized in reading.

I. THEORETICAL REFERENCES OF THE INTERVENTION

a) The AMICAL Project

A multitude of educational organizations are beginning to offer multimedia platforms as a medium for learning to read. This new educational approach deserves to be accompanied by an approach allowing the facilitation of associated pedagogical transfers as well as optimal interactivity between the learner and the machine.

This study was carried out within the language research laboratory (LRL) of the Blaise Pascal University of Clermont-Ferrand in order to optimize the HMIs within the framework of the AMICAL project (Architecture Multi-agents Interactive Compagnon pour l' Learning to read).

The AMICAL Project aims to explore the contributions that can be expected from new information processing technologies and cognitive sciences in the development of computer environments for learning and teaching reading. (Pellissier, 2005).

It is characterized by three main objectives. First, it is the subject of fundamental theoretical research in the field of application, learning to read, as well as in the field of computer learning environments. Secondly, it leads to the development of prototypes which are used in experiments, which make it possible to validate the hypotheses resulting from basic research. Finally, it is this research, both fundamental and applied, which makes it possible to provide teachers and learners with validated computer tools.

The notion of learning to read can cover multiple learning situations, ranging from initial learning in school to adult literacy.

The computer environment of the AMICAL project is an environment to help learning and teaching reading provided in the classroom, with a view to individualization carried out either by the system alone or by collaboration between the system and the 'teacher. It aims to contribute to supporting teachers, particularly in Africa.

The Friendly project was designed from an inking in the cognitive psychology of reading using a technical device based on the multi-agent system.

Indeed, the Multi-agent system: For Weiss (1999), an agent is a “computational entity”, like a computer program or a robot, which can be seen as perceiving and acting autonomously on its environment. We can speak of autonomy because his behavior depends at least partially on his experience. A multi-agent system (SMA) consists of a set of computer processes taking place at the same time, therefore of several agents living at the same time, sharing common resources and communicating with each other. The key point of multi-agent systems lies in the formalization of coordination between agents. Research on agents is thus a research that revolves around the following points:

- the decision - what are the mechanisms of the agent's decision? What is the relationship between agents' perceptions, representations and actions? How do they break down their goals and tasks? How do they construct their representations?
- control - what are the relationships between the agents? How are they coordinated? This coordination can be described as cooperation to accomplish a common task or as negotiation between agents with different interests.
- communication - what kind of messages are they sending each other? what syntax do these messages follow?

Different protocols are proposed depending on the type of coordination between the agents. Multi-agent systems have applications in the field of artificial intelligence where they make it possible to reduce the complexity of solving a problem by dividing the necessary knowledge into subsets, by associating an independent intelligent agent with each of these subsets and by coordinating the activity of these agents (Ferber, 1995).

b) Learning to read

Reading can be defined as an interactive process in which the reader uses the resources at his disposal to construct the meaning of the written word from a visual stimulus; stimulus being in the form of graphs, that is to say lines, curves as well as their orientations (Rumelhart, 1985).

There are six types of resources:

1. Perceptual resources: these relate to vision and allow a learner to discriminate what he sees.

2. Linguistic resources: they relate to morphology, phonetics, syntax and semantics.

3. Metalinguistic resources: these relate to the categorization of language and include, for example, syntactic categories (noun, verb, etc.).

4. Cognitive resources: these relate to problem-solving abilities. These are either general abilities of comparison, discrimination or memorization, or abilities relating to reading such as understanding the functioning of the written system and its relation to the spoken word.

5. Metacognitive resources: these refer to the conduct of the construction of meaning by the reader, to his ability to use strategies and to evaluate them according to his reading objective.

6. Affective resources: these include the general attitudes of the reader's behavior, motivations or expectations.

II. DESIGN METHODOLOGY:

Educational technology offers us a systematic and systemic approach to analyzing problems related to learning situations and to designing, developing and evaluating solutions to these problems through the planned use and exploitation of available educational resources. (Marton, 1992)

The systematic approach allows us to operate according to specific steps and operations, and the systemic approach allows us to consider these steps and operations as a system, where they are interrelated and where the elements are continuously interdependent.

The production of a SAMI, after the preliminary study of a project, will follow the stages of the process of educational visualization (Marton, 1992), making it possible to structure audio-scripto-visual messages with a view to a precise situation of 'learning. However, this process is adapted to the situation and is divided into five main parts, each of which includes steps and operations (see table below).

Table 1: Process steps for producing an Interactive Multimedia Learning System (AMIS)

Procédure	**Stage**	**Operation**
I- Planning(Preliminary study)	1- Recording of subject data	- Needs - Population
	2- Content Accuracy	- Parts, elements
	3- Goals definition	- General and specific objectives
	4- Structuring of content Estimate: schedule, budget	- Elements, Sequences, Order
II- Design	5- Learning strategy	- Resources, methods, messages
	6- Pedagogical integration	- Pedagogical factors
	7- System design	- Approach, links, organization chart, architecture
III- Développement	8- Realization of the design	- Parties, links, relations
	Viewing messages	- Signs, meaning
	Pedagogical integration	- Activities, factors, interactivity
IV- Evaluation	9- Realization of instruments	- Questionnaires, interview, observations
	Terms and Conditions	- Location, timing, responsibilities
	Testing	- Déroulement
	Analysis and processing of	- Presentation

	results	
	Proposed fixes	Recommendations
V- Correction	10- Indicated adjustments	- Changes, corrections
	Vérification	- Testing, results

III. E-LEARNING ERGONOMICS:

The ergonomics of e-learning aims to improve human-computer dialogue. Achieving this objective often requires the use of cognitive ergonomics methods, and in particular analysis of the "Man-Machine" system. This is particularly the case when an operational language must be integrated into a learning application.

The extraction of such a functional language, supporting the realization of the tasks, necessarily passes by an analysis of the activity.

Designing an ergonomic approach to help learning to read involves studying a set of determinants to optimize "understanding" between the different protagonists of the dialogue.

1. Representation of knowledge

According to Falzon, the notion of representation in humans (in our case the learner) refers to the idea of an internal model developed by the subject to deal with situations. This internal model results from a construction, which is based on an analysis of the data of the situation and on the evocation of knowledge in memory.

Different knowledge representation models are currently used in psychology and Artificial Intelligence. We will focus here on the models allowing the understanding of the concept of knowledge representation in the dialogue situation. So the point of view adopted here is that of cognitive psychology.

1.1 The category of propositional models

The basic unit is the proposition. The proposition is the minimal semantic unit. The proposition can be represented as a set comprising a relation and a list of arguments. The knowledge is then presented either in the form of lists of propositions, or in the form of semantic networks. These make it possible to clearly visualize the links between the proposals. (Kintsch, 1998)

1.2 The category of schematic models

This model refers to the notion of schema, script and frame. These notions have been developed to account for knowledge in different fields: vision for frames, understanding of scenarios for scripts, understanding for diagrams.

A diagram is a structure which makes it possible to represent the concepts stored in memory. Diagrams can represent various entities: objects, situations, events, actions, sequences of actions, and can describe these entities at various levels of abstraction. A schema is an organized set of variables that can take different values.

2. Types of knowledge:

2.1 General knowledge:

The learner may be confronted with a situation for which, in the context in which he finds himself and for the objectives he is pursuing, he has no finalized knowledge allowing the immediate treatment of the situation. In these cases, the knowledge that he can evoke in order to deal with the situation will be (Falzon, 1989):

- Either knowledge not finalized by an objective: general knowledge relating to the field in question, to other fields or to problem-solving methods. This is knowledge characterized as representations that reflect reality in all its complexity.

- Either knowledge finalized by other objectives, acquired in other contexts.

2.2 Operational knowledge:

Operative knowledge has the characteristic of being specific to a domain and an activity. It is therefore finalized knowledge. The situations encountered were identified, analyzed and structured based on the action and its objectives.

Operative knowledge results from memorizing the schema underlying the circumstantial representations developed by the subject. Only some of these representations will give rise to the development of operative knowledge: these representations are those for which the subject will have been able to identify structural constants. Ehrlich (1976) writes thus "A circumstantial structure becomes permanent when it is frequently reconstructed and used by subjects in identical or similar situations"

The elaboration of operative knowledge therefore requires a certain stability of the environment, so as to allow the repeated occurrence of close conditions, and therefore the construction of multiple parent representations.

2.3 Routine knowledge:

According to Falzon (1989), this knowledge is generated by the recurrence, under extremely similar conditions, of the same classes of situations. Two cases are also possible:

The first case corresponds to an environment in which certain situations occur systematically in the same way. In this case, the schema cannot be built. Indeed, the absence of variations hinders this elaboration. It is possible to identify the elements that are not relevant for the definition of routine knowledge, but, with regard to the information that actually participates in the definition of the schema (the relevant variables), it is not possible to distinguish between value and variable. It is then directly the values of the variables (and not the variables) that are stored. In this case, we cannot speak of a routine "schema", because the characteristics specific to the schemas (existence of variables and constraints on these variables in particular) are not present.

The second case corresponds to an environment in which the repetition of situations of the same category allowed the subjects to build knowledge adapted to the operational activity.

3. General properties of human-computer dialogues within an e-learning

a- relevant pedagogical dialogue must have a number of properties, among which.

on the initiative

The initiative refers to whether it is the learner or the computer that directs the transactions within the dialogue. If the computer asks questions, presents alternatives, and the learner answers them, it is a computer-initiated dialogue. If, on the contrary, the learner enters commands directly without such guidance, the dialogue is then at the initiative of the learner. Of course there are varying degrees of initiative.

In general, however, it can be said that computer-initiated dialogues are preferable for inexperienced or casual learners. Such dialogues make it possible to implement recognition processes, which are easier than recall processes. They provide the learner with a model of the system, and therefore allow the use of the system by operators who have not yet internalized this model.

On the other hand, such a type of dialogue, which does not make it possible to anticipate, to skip steps, can only be acceptable for an experienced learner insofar as the number of transactions is relatively small and the response time is short. . A slow dialogue initiated by the computer is indeed very disruptive for a learner.

In fact, for most systems, it is desirable to allow learners to choose one of these modes.

b – Flexibility

Flexibility can refer to two different notions. The first is the one that has been used before and which actually corresponds to the ability of the software to adapt to various sub-populations that can be differentiated according to their level of experience. This kind of flexibility, as has been said, is desirable.

The second is rather "internal" flexibility and corresponds to the number of different ways (procedures, options, commands, etc.) made available to the learner to achieve the same objective. A great flexibility can be obtained for example by providing many commands, by allowing the learner to define or redefine new commands.

c – Complexity

Complexity is related to flexibility: it is indeed characterized by the number of options available to the learner at a given point in the transaction. A low complexity can be obtained by using few commands or by subdividing these commands so that the learner only has to select a sub-part of them at any time during the dialogue. We can think that there is an optimal level of complexity, for a task and a particular learner. Studies show that a large number of redundant or irrelevant commands hampers performance, but that an extreme simplification of the dialogue by over-prioritization is also bad.

d – Power

Power represents the amount of processing done by the computer in response to a single user command. In a dialogue with powerful commands, the learner can accomplish with a single command what would require several less powerful commands. In a number of applications, powerful commands may be desirable. The problem is that in general the existence of very powerful commands (and therefore by extension, often very specific), reduces the generality of a system, its adaptability to other tasks.

e - Information load

Information load is the degree to which the interaction demands the user's memory and processing resources. In most tasks, learners' performance is negatively influenced when the information load is too high or too low.

This load can be measured empirically or estimated. It is possible to vary it by intervening on the display methods, the types of channels requested, the power of the commands, the use of default values, the type and structure of the command languages and other aspects of the interface to which we will return.

An ergonomic design of a relevant man-machine dialogue will encourage us to take an interest in the cognitive characteristics of the learner. His way of processing information, his ability to memorize it, the limits of his memory are all elements that we will develop in this part of the thesis.

Let's start by presenting the model of the human processor:

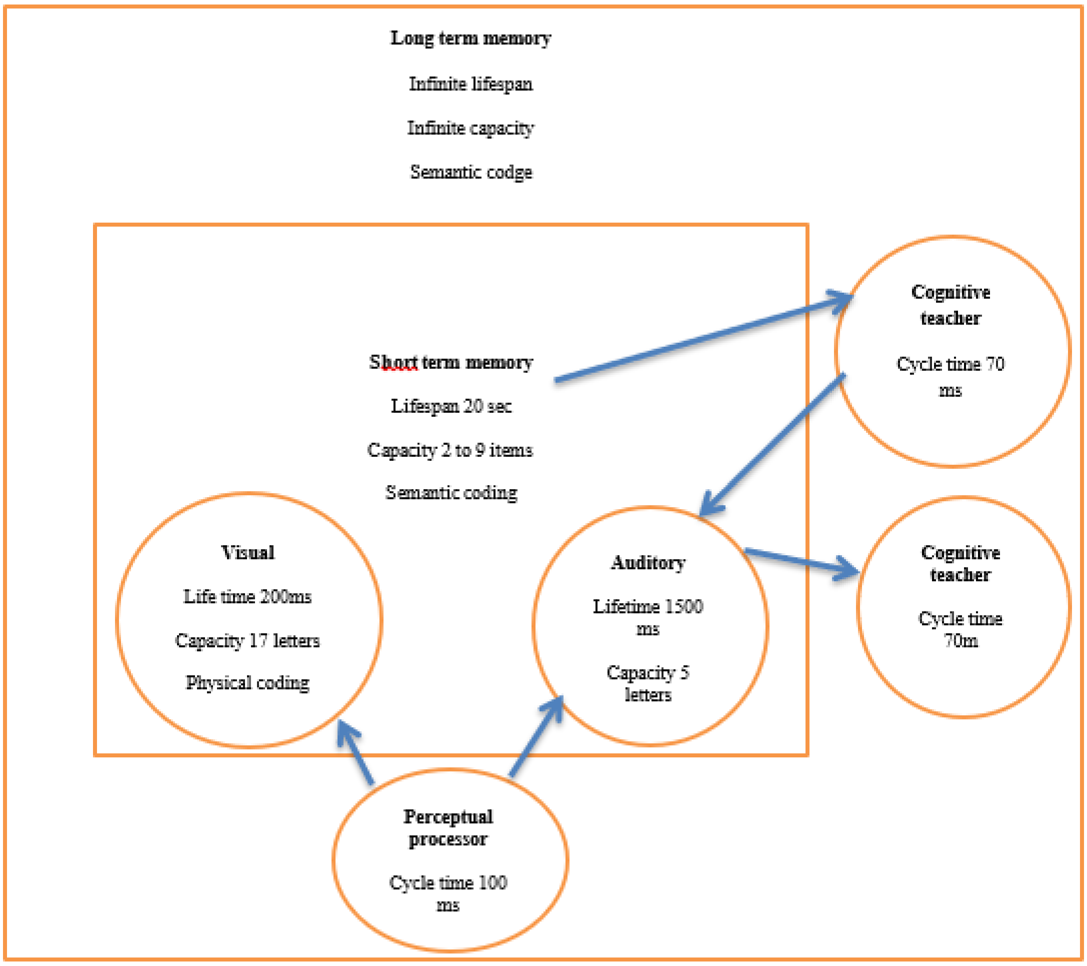

Figure 1: “Model of the human processor of Card, Moran and Newell”

The model of the human processor, the individual is presented as an information processing system governed by a set of rules. The human processor comprises three subsystems, sensory, motor and cognitive, each of which has a memory and a processor. The memory of the cognitive system includes a short-term memory (containing the information being manipulated) and a long-term memory (containing the permanent information).

The performances of a memory or a processor are characterized by parameters constituting interesting indications which make it possible to adapt the interface according to the performances of the learner. These parameters only make it possible to evaluate the measurable performances of the individual, without providing indications on the models of representation and reasoning implemented.

This model is formal enough to be used by learning specialists; however, it offers oversimplified and reductive modeling.

According to the theory of action, an individual acts according to mental models, developed by the individual himself and evolving with experience. In a process of interpersonal communication, individuals confront and adapt their mental representations. In the case of a learner-application interface, communication involves:

- the learner.

- and the interface (production of a perceptible representation (image) of the system from which the learner adapts his representation.

The designer must reduce the gap between the mental models of the learner and the image produced.

This model proposed by “Moran” and “Newell” allows us to know how our short-term memory processes the information received:

• It stores and groups items in the form of acoustic or visual patterns.

• It has a storage capacity of items limited to 9.

• The search is sequential and exhaustive.

• She forgets after 20 seconds.

From there, it is important to adapt the dialogue proposed by the system to the cognitive characteristics of the learner. We therefore propose that the dialogues in the HMIs respect the following points:

• Limit the number of choices in the menus to 7 items.

• Use formats, locations, to establish links between elements.

• Avoid overloading the screen.

• Avoid storing between successive screens by using windows to recall previous screens.

IV. "ERGONOMIC EVALUATION METHODS OF E-LEARNING"

The ergonomic evaluation consists of examining each of the components of the software to precisely identify the “usability” problems.

Ergonomic evaluation therefore consists in evaluating each of the components of the software against a grid of ergonomic criteria.

Different grids of criteria are used to assess the usability of software, including:

• The Purdue University index of usability (complete questionnaire in appendix).

• Dominique Scapin's ergonomic guide.

• The grid built on the basis of the ISO 9241 standard.

According to Bastien (1992): “The methods for evaluating interactive systems currently available are numerous and varied. All have advantages and disadvantages and none of them can claim a complete evaluation of the interface (not only the presentation of information but also navigation, location within the application, etc.).

There are generally two main categories of methods:

• Methods requiring the direct participation of users.

• The methods applying to the characteristics of the interface.

The first category notably includes user tests, software tools, questionnaires and interviews. The second category includes formal models, methods and languages, recourse to experts, inspection methods and automatic evaluation tools.

• Methods requiring the direct participation of users:

In this category of methods, the user is the source of the assessment data. Two sub-classes can be identified: a first where the user interacts with the system (use tests) and a second where the user is questioned about the interface (questionnaires and interviews) following an interaction with the interactive system.

User testing:

During user testing or user testing, one or more users participate in the execution of tasks representative of real tasks (according to scenarios defined before the test) or even in free exploration with commentary. These two approaches give different but complementary results. This last approach is particularly used in the case of websites.

These tests can be conducted in the field or in an environment that recreates as much as possible the real work environment when the latter does not allow the conduct of tests.

In this type of assessment, the test sessions are usually recorded on video. We are interested in the performance and behavior of users during interactions with the system. Depending on the context of the study, for example, we will measure the time or number of actions required to perform a task, the accuracy of the result, the number of errors made, their type, the position of the gaze on the screen and/or on the various data input/output devices (mouse, keyboard/monitor, etc.).

It is therefore a question here, from the behavioral and performance indices, of identifying the design choices (for example the structure of the menus, the labels of the menu options, the error messages, etc.) which can lead to user errors, raise questions or hesitations, make the use of the application more cumbersome, etc. While the aim here is to assess the quality of a given system, the results of usability tests can also be used to compare the ergonomic quality of competing systems. We then speak of "benchmark" or comparative evaluation.

Software tools:

Evaluators have extremely useful tools both for recording behaviors or traces of user behavior as well as for coding and analyzing them. Although the recording of user behavior can be done using fairly simple techniques such as observation grids (on paper or in electronic format), this technique can, in certain contexts, prove to be very limited, or even inapplicable. This is particularly the case of situations where the behaviors are very frequent or very rapid (for example pressing the keys on the keyboard, taking furtive visual information, etc.).

Among the relatively common tools used (other than video recording) for collecting and analyzing data, we can note the electronic cookies which make it possible to record all user events (launch of applications, opening of windows , selection of menu options, etc.). Some of these tools save the events just like their moments of occurrence, in files (log files). From these files, descriptive data is calculated (average durations, frequencies, relative frequencies, etc.) for each event and data on the temporal organization of these events can also be provided.

When the interaction between users and interactive systems is recorded on video, the problem arises and above all the difficulty of coding these recordings. Software such as "The Observer" helps the evaluator. This software makes it possible to define the behaviors to be identified (analysis grid) and to control the video recorder or the digitized video sequence. The identification of the beginning and the end of the behaviors is thereby facilitated since the video tape can be coded frame by frame, which allows very high precision. This type of tool is however cumbersome to use (training, analysis time, etc.) and is generally reserved for longer studies than those generally required of ergonomists during design or evaluation (it is more generally used in research).

Questionnaires and interviews:

Questionnaires and interviews allow the collection of subjective data relating to the attitudes, opinions of users and their satisfaction. This data is generally used to supplement the objective data collected during usability testing. Some of these questionnaires are presented in software form and can be administered on a website.

The design of this type of instrument requires specific skills and knowledge to ensure in particular the validity and reliability of these instruments.

Methods applying to the characteristics of the interface:

This category of methods is essentially distinguished from the previous one by the absence of direct interaction between a user and a system. In these methods, the users as well as their tasks are represented. In this category will be discussed: models, methods and formal languages; recourse to the expert; and inspection methods.

Methods based on formal models:

Evaluations that are based on theoretical and/or formal models make it possible to predict the complexity of a system (for example, by the number of production rules of the type "To do-this Then do-this") that must be known an ideal user to accomplish a task with the system offered to him and therefore the performance of users. The evaluation from these models is however a very long and costly task and is difficult to implement by non-specialists.

Recourse to the expert:

Expert evaluation is generally defined as an informal evaluation where the expert compares the performance, attributes and characteristics of a system, whether it is presented in the form of specifications, in the form of models or prototypes, with existing recommendations or standards. for the purpose of detecting design flaws.

Inspection methods:

Usability inspection methods bring together a set of approaches that call on the judgment of evaluators, whether or not they are experts in usability.

Although all these methods have different objectives, they are generally aimed at detecting aspects of interfaces that may cause difficulties in use or increase the workload of users. Inspection methods are distinguished from each other by the way assessors' judgments are derived and by the assessment criteria on which their judgments are based.

Among the inspection methods, we can cite here: cognitive inspection (Cognitive walkthrough); analysis of compliance with a set of recommendations (guideline reviews); and analysis of compliance with standards (inspection standards), principles, dimensions, heuristics.

The BASTIEN and SCAPIN ergonomic evaluation criteria:

The work of INRIA “BASTIEN é Al) provides a list of eighteen elementary criteria which serve as the basis for a good number of evaluation methods.

These criteria are:

- Guidance (Incentive, Grouping and distinction by location, by format, Informative feedback, Clarity).

- Workload (Conciseness, Minimal actions, Density of information).

- Explicit Control (Explicit Actions, User Control).

- Adaptability (Flexibility, User experience).

- Error management (Protection, Message quality, Error correction).

- Homogeneity, Significance of codes and denominations, and Compatibility.

In the context of educational multimedia software, (Olivier HU & Al) had to adapt the criteria mentioned above to better meet the expectations of evaluators in front of these products.

The main change concerns the addition of the Navigation, Graphics aspects and one criterion per media category (Images, Sound and Video), but almost all the other criteria have had their definitions adapted.

a) GUIDANCE: (Navigation)

The definition of the main Guidance criterion is as follows: all the means implemented to advise, guide, inform and lead the user during his interactions with the computer.

The context of the multimedia entailing a scripting of the presentation, the actions of the user can be general or linked to the navigation within the script. Good navigation implies that the position and possibilities of movement within the scenario must be clearly indicated. The user must always visualize what he has already accomplished and what remains to be done. The navigation must be adapted to the type of exploration but in general, you must have access to the commands “Continue”, “Return”, “Contents” and “Exit”.

As a result, there are two distinct criteria: Incentive, which concerns guiding the user in these general actions, such as help, exit, specific actions, etc., and Navigation, which concerns the information provided and the means implemented in the exploration of the software scenario.

b) WORKLOAD: (Perceptual load)

Workload concerns elements having a role in reducing the perceptual or memory load of users and in increasing the effectiveness of dialogue.

Since the purpose of educational multimedia software is to transmit knowledge, the notion of relevant information and that of perceptual and memory workload must be put into perspective. In addition, the information is, most often, of an educational nature, and one must not interfere with the underlying educational intention. The problems of conciseness and overload of the screens measured in the Perceptual load criterion will therefore concern information related to use and navigation within the system and not that of the content transmitted.

The aspects related to the conciseness of the information and the density of the information displayed are therefore grouped together in a single sub-criterion “Perceptual load.

Relevant information should be present and highlighted. Secondary displays (time, date, etc.) should not clutter the interface. The number of possibilities for action must be limited. For example, the number of commands in a drop-down menu should be limited to seven for good memorization. In the same way, the icons used should not require too great an effort of memory or comprehension.

C) User control:

This criterion concerns the system taking into account both the explicit actions of users and the control they have over the processing of their actions.

Here again, it is the specificity of educational software that motivates this grouping. Indeed, these software have few autonomous actions to perform, their role being mainly to display a certain amount of information, graphics or media and to wait for an intervention on the part of the user. The power of the system is dedicated to the graphic and sound aspects, and apart from the more or less extensive processing of the interaction with the user, there are hardly any significant autonomous actions left. All this will therefore be measured by a single criterion.

On the interface, it follows that the control of the system must be in the hands of the user.

d) Error handling:

This criterion measures the quality of the means to avoid, reduce and correct errors.

Good error management implies that the system must take into account possible user errors. For example, all windows must have a "Cancel" button or command. Dangerous manipulations (exit, save, etc.) must be protected. Error messages should be clear, they should provide explanations and advice, not display.

e) Compatibility:

It measures the correlation between the interface and the characteristics of the users (perception, habit, experience...); We take into account both the attributes of the interface (data format, presentation, etc.) and their evolution during use (possible modification of the interface, consideration of experience, etc.).).

Example :

Does the organization of the interface seem to correspond to the habits and characteristics of the user?

F) Graphic aspects:

This criterion quantifies the overall graphic qualities of the interface facilitating or hampering its proper use.

Indeed in some software, the graphical aspect is of particular importance. The choice of colors, the contrasts, the decorations, are all features that facilitate or hinder the pleasure of use and the acceptance of the user.

The interface should not be overloaded, aggressive or inconveniencing the user. The graphic characteristics must serve the proper use of the interface. Thus the use of fluorescent colors, blinking, fast animations must be adapted to the context (software for children in kindergarten for example).

g) text:

Set of lexical and graphic characteristics allowing the good assimilation of written information.

The quality of the text, a medium in its own right, is essential. The vocabulary must be adapted to the user and the language must be clear and concise: no too long sentences or convoluted language.

The graphic characteristics of the text (font, size, style, color, etc.) must highlight it without interfering with its reading. For example, it is better to avoid sentences in Gothic, size 6 and green on a blue background.

h) media:

Measurement of the quality and proper use of the media:

The quality of the media is an essential point since it is precisely one of the aspects often put forward in educational software. It is therefore necessary to quantify the quality and proper use of each medium: sound, image and video (which we will consider as a particular medium).

Images: Quality and use of images, photos and graphics:

The images must be clear and adapted to the context of use: specific information, additional information, decoration.

Sound: (Quality and use of the sound channel)

The sound should be clear and understandable. The sound channel must be adjustable by software and its use, as for images, must be judicious (no alarm beep for a current action, for example).

Video: (Quality and use of video and animations).

Animations and videos must be fluid, sharp images, no abusive compression... Scrolling control must be offered: "Stop, Pause..."

The questionnaire allowing the analysis of a pedagogical sequence in AMICAL:

We opted in the context of this research, to focus on the analysis of a pedagogical sequence based on the criteria of (HU & Al, 1998). Attached are some elements of the analysis questionnaire.

a) Guidance:

- Are the operations performed by the system known to the user? Is the position within the scenario indicated?
- Is the user assisted
- in the way of using
- software? The trends

b) Workload:

- Are the items visible, accessible according to their use? Are memorization activities kept to a minimum?
- Are the window texts concise?

c) User control:

- Are the commands always explicitly activated by the user?
- Can the user quit, give up easily?
- Can the user interrupt a treatment in progress?
- Is it possible to go back?

d) Error handling:

- Are the codes and denominations meaningful?
- Does the system provide ways to avoid errors?
- Is the use of the keyboard minimal?
- For irreversible actions is confirmation requested. Are the messages visible or audible?
- Are the messages explicit?

e) Compatibility:

- Are different means offered to the user to trigger the same command?
- Are the commands also accessible from the keyboard?
- Can the user configure the software according to his preferences?
- Is the software adapted to the profile of the intended users?

f) The graphic aspect:

- Is the position of the cursor clearly indicated?
- Is the use of colors relevant and consistent.
- Is there a reasonable number of colors?

g) The text

- Is the vocabulary compatible?
- Does the font interfere with readability?
- Are typographical enhancements used appropriately?

e) Media:

- Is the media loading fast?
- Are all actions on active images followed by a system action?
- Does the media serve informational content?
- Are they relevant?
- Does the user have control over the media?

V. The main results of the study

From the questionnaire of (Olivier HU & Al), we asked 70 users "Students-Ergonomists" to evaluate the didactic sequence. The main results were the following:

Regarding the variables:

• Guidance: Excellent guidance, User assisted throughout the progression. Positioning of the menu very relevant.

• The workload: The Items are visible and accessible according to their use. Memorization activities are reduced to a minimum. However, the texts in the windows can sometimes overflow onto the “educational instructions”.

• User control: The learner has little control over his interface. Only the "Exit" and "Back" buttons are controllable by the user.

• Error management: The use of the mouse is more solicited than the keyboard. The GUI avoids errors when the learner returns the answers. A confirmation message appears for each irreversible action.

• Compatibility: The commands are accessible from the keyboard, the user can configure the software according to his preferences.

• The graphic aspect: The position of the cursor is clearly indicated and the use of colors is relevant and evolves throughout the progression of the didactic sequence thus adopting the atmosphere of the questions asked.

• The text: The vocabulary is compatible and was chosen according to the grade level of the learners and inspired by school textbooks for classes “CP” and “CE1”.

• Media: The loading remains however long sometimes, the user does not have control on the media.

From these results, we argue that the analyzed didactic sequence meets the performance and usability criteria. However, it will evolve during the different production versions, in particular with regard to the downloading of media as well as the control of the interface.

CONCLUSION

The problem of learning to read remains one of the major challenges in Africa. This work aims to provide avenues for reflection and feasibility on the relevance of developing HMIs in order to fight against illiteracy. The scientific literature is becoming abundant, only studies are still necessary to better understand the cognitive strategies of learning to read in front of display screens.

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