

Towards a Need-task Functional Homology in the Development of Human-Machine Interface: Modeling According to APC of EIAH in Cameroon, the Case of Educational Software

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Abstract This article entails verifying the analogy of the user's activity in the execution of various tasks – case of an CEHL (Computing Environment for Human Learning). For this, the educational software JAVI (J'apprends AVec l'Informatique) will be used, and an elaboration will be done, in the form of an algorithmic structure, on a didactic profile by Competence Approach which will consist of specified tasks to be carried out by the user. The aim here is to create a useable tool which will be coherent in its Human-Machine interactions (HMI) between the user who is the educationist (pedagogue) and the computer scientist's requirements – the program developer, hence matching the algorithmic sequence to the execution of related tasks. This action will enable the creation a system based on APCs, which could be used as a model for the creation of multidisciplinary educational software in Cameroon.

Keywords: *user, prescribed task, man-machine interface, reusing, human-machine interactions, educational software, competence approach, computing environment for human learning*

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1. Introduction

For over a decade, Cameroon has engaged in the modernization of its educational system, which involves important decision making, amongst which, the introduction of computing in the first and second cycles of secondary education training programs, by the 17th June 2003 decree, and later on 2007 in primary education [1].

Some initiatives significantly boosted this vast program; such is the case of the PAQUEB project [2] of the Basic Education Ministry in Cameroon.

However, if special attention was given to the renewal of computer programs [3] and an improvement in textbooks, it could equally be noted that, up to date, the educational software is slow in gaining ground among official textbooks, whereas it is part of didactic material [3] and « *From Cameroonian experience, the textbook remains a major didactic tool with a significant impact on scholastic achievement* » [4]. This situation can be explained from findings in different seminars and pedagogic encounters between various educational actors, namely: The educational software is absent in pedagogical

(educational) practices and the communication environment [5].

For some, educational software should be well developed, easy to use and made available to as many while abiding to software design requirements, for this purpose, special focus should be placed on its reliability.

For others, computing is just a tool amongst others and is not a priority because school has always functioned smoothly before its arrival, even if educational software existed, the teacher, like the textbook, should be the center of this conception.

These differences show the complexity of the solution to be considered in finding an agreed solution, satisfactory to the majority.

In order to get an answer approach, we thought of working on some software which already exist in the Cameroonian educational system, precisely those developed by some 5th year students of ENS Yaoundé, hence we identified several like DACH for learning Chemistry, DIFOR for learning rock formation..., but it seemed more important to avoid expanding assumptions and carry out an analysis of that which exists by basing on similar work like the K-Made project [6] in France which led us to bring out the following points:

- The lack of educational software is not specific in Cameroon;
- Contents of educational software are not always in line with the official program;
- There is also insufficient or lack of software in all the subjects;
- Lack of basic training in computing for all teachers;
- Inadequacy between the lesson plan and learning interface.
- The working environment is inappropriate.

This study which is the objective of our article enabled us to bring out the fact that lack of educational software as didactic material in official programs constitutes an obstacle in the modernization of Cameroon's educational system. We henceforth assumed that the development of a simple and reusable interface, emulating a notebook and lesson sheet, would constitute a unifying argument to enable every educational community to be identified and

use it as support in all subjects from primary to secondary, since with the least computing capacity, each teacher could design an educational software in his field of competence or use those which are available, this could bring an effective solution to the various problems pointed above.

We think that: since a lesson course sheet is approved in our educational system [7], software with an interface similar to this sheet could be considered and would enable teachers have a better appropriation. The work we are carrying out will therefore consist of conducting a lesson and designing a teaching-learning interface of the simple pendulum displacements. Furthermore, we will verify the need-task homology by the arrangement of programming sequences with Adobe Flash ActionScript® with scheduling of learning activities when it is used.

Simply, we will « *Perpetuate the old methods with new tools* » as shown in the table below by Marcel Lebrun [8].

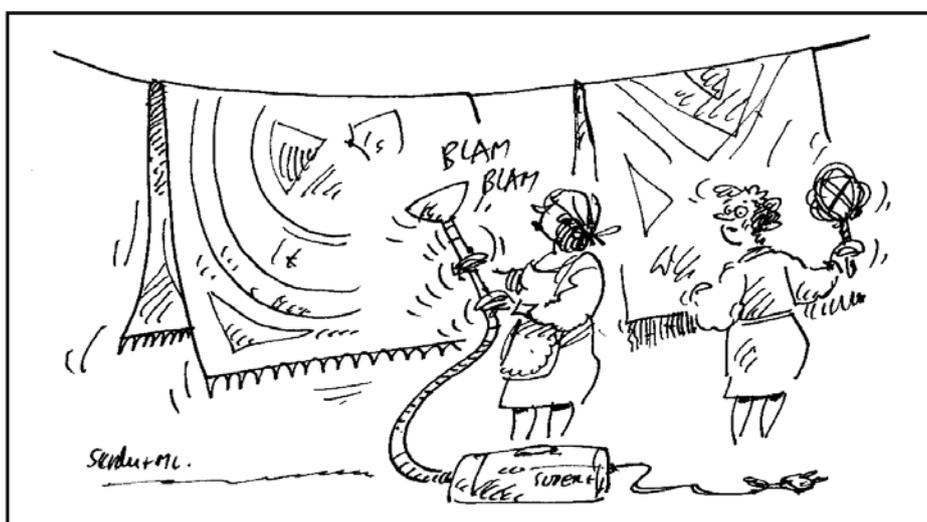


Figure 1. Using ICTs as a tool to improve one's technique

To begin this work, we would need to present a standard model of the user interface in software engineering and the educational limitations in software engineering. Then we would compare the algorithmic execution of an elementary task with the related educational activity. Finally, we would implement the lesson in the JAVI® interface to combine these two structures by assigning specific behaviors to objects using the object ActionScript programming language, to consider the cognitive activities and thus present a multidisciplinary, simple, convivial, interactive and reusable interface.

2. HMI Engineering and Educational Engineering

2.1. HMI Engineering

2.1.1. HMI Modeling in Software

An HMI (Human-Machine Interface) can be defined as the meeting point between a system and its user, modern computers are equipped and these meeting points are usually designed as "user interfaces". Whatever the

structural design, the separation between the functional core and the user remains essential.

2.1.2. Structural Models of an HMI with Graphical Interactions

We did a little run-through on models often used in HMI design, they include:

- The Seeheim model, based on presentation, dialogue controller and field adaptor;
- The PAC (Presentation-Abstraction-Control);
- The MVC (Model-View-Controller).

The model that caught our attention is the MVC model because it is more comparative and above all, the best suited for this work.

Below is a MVC model taken from the Orsay IT research laboratory website: wiki.lri.fr/ISI/_files/cours7.pdf.

With development of other fields such as ergonomics, the user interface has evolved to into a real pathway through designing iconographic objects simpler and easier to use, and resulted in the creation of third generation direct manipulation interfaces. This requires the use of complex algorithms and level languages, which are not without risk because it involves permanent upgrade and complex validation processes which obviously take time.

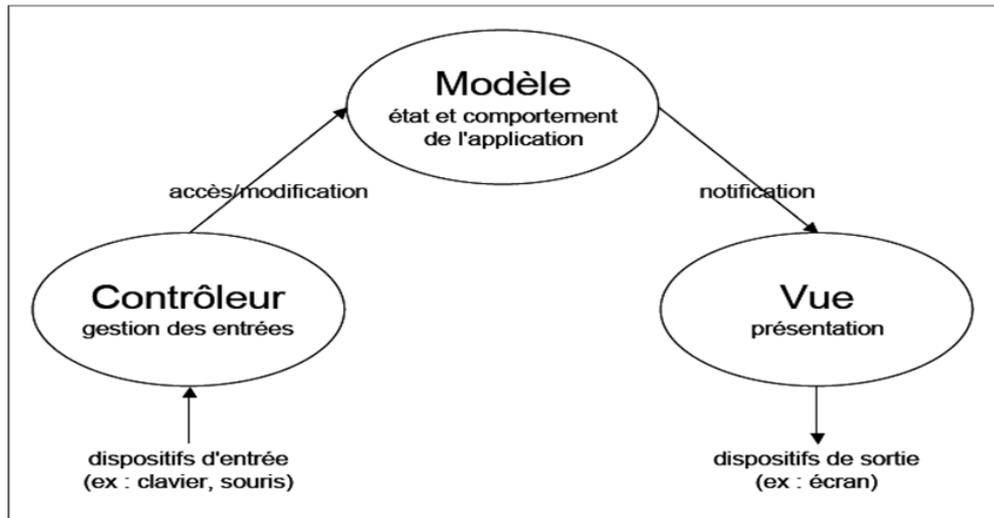


Figure 2. Structure of HMI interactions in MVC mode

It is therefore essential to integrate the multidisciplinary dimension in the software design process.

2.2. Pedagogic Engineering

2.2.1. Structural Model of Pedagogic Engineering

In our work, we chose the ADDIE model [10] which Basque (2004) describes as an implementation process of a pedagogical design which is typically comprised of five phases; analysis, design, development, implantation and evaluation, designated by the acronym ADDIE (Analysis-Design-Development-Implementation-Evaluation). The phases whose constituent tasks may vary depending on the context and type of learning system to be developed.



Figure 3. Structure of ADDIE model

3. Task Model and User Interface

3.1. Implementing the MVC Model in a User Interface

To implement our model in the JAVI interface using Adobe Macromedia® Flash® ActionScript code, we first of all need to define abstract classes (active models) which specify the behavior of MVC [11] components, such as:

3.1.1. Defining classes

- **Class « Model »**
 - ♣ mechanisms for managing dependents;
 - ♣ notification dissemination mechanisms;
- **Class « View »**
 - ♣ deals with interaction between the model and controller ;
 - ♣ deals with interaction between the main view and the sub view;
- **Class « Controller »**
 - ♣ Enables control and manipulation of a model and a view;
 - ♣ Provides only a single controller.

3.1.2. Unfolding Sequence of a Task in Swing

The JAVI® prototype is based a model of prioritized tasks similar to a pyramid which we call “task pyramid”, following the diagram below drawn from Java swing components:

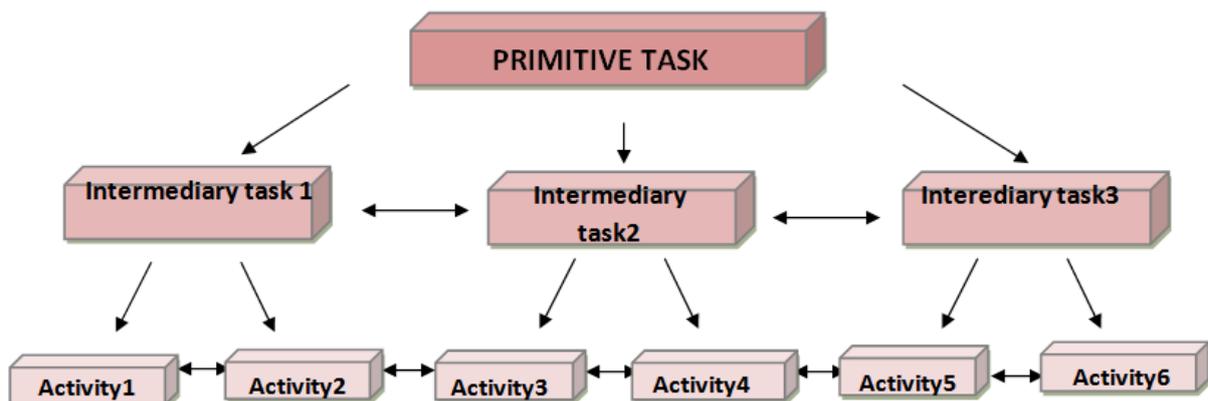


Figure 4. « Task pyramid model »

From this model, the root task can have on one hand, hierarchical links with a hierarchically superior task in an open and more complex system or inferior (Intermediary task), and on the other hand, related tasks, of the same hierarchical level up to the most basic execution level which is the activity.

3.2. Implementing the pedagogic model bases on APCs

Implementing the skills approach (APC) [12] in JAVI[®] is based on instructional storyboarding with high reality [13]. Thus we need to restore a pedagogic sequence plan in a class form:

Defining classes:

- Class « I observe »

- ♣ Allows observation of the new situation;
- ♣ Formulating hypotheses;
- Class « I retain »
 - ♣ Verification of hypothesis;
 - ♣ Validation and synthesis;
- Class « I practise »
 - ♣ Allows control of knowledge according to operational educational objectives; (OPO) ;
 - ♣ Verifying validation of operational educational objectives (OPO).

To illustrate the skills approach, we will suggest the sequence of a lesson typically in the pyramid form on the learner's side, to observe homology with the MVC model interface.

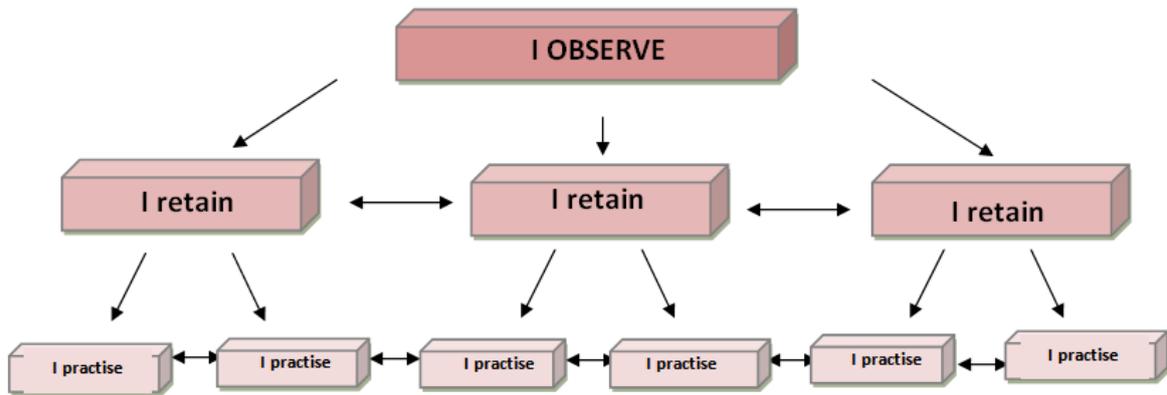


Figure 5. APC « task pyramid » model

Our study in this case is based on conducting a learning sequence from oscillatory movements of a simple pendulum. It describes the actions of the user who designs a simulation of oscillatory movements of a pendulum and observes the variations of these oscillations.

3.2.2. Task Order and Typology

In our JAVI[®] working environment, the order of execution of tasks is decreasing vertically that is – an object found above is executed in priority to that directly below according to a principle of primacy. This hierarchy is equally applied to elements beginning from the left to the right.

The execution of tasks is described according to 4 categories:

- Machine: the task is carried out directly by the computer without direct intervention of the user.
- User: the task is carried out by the user without intervention of the machine;
- Interactive : the task is initiated by the user and carried out in conjunction with the system;
- Undetermined: the task enables the system to select answers by itself.

3.3. Conceptual Homology between MVC and APC Model

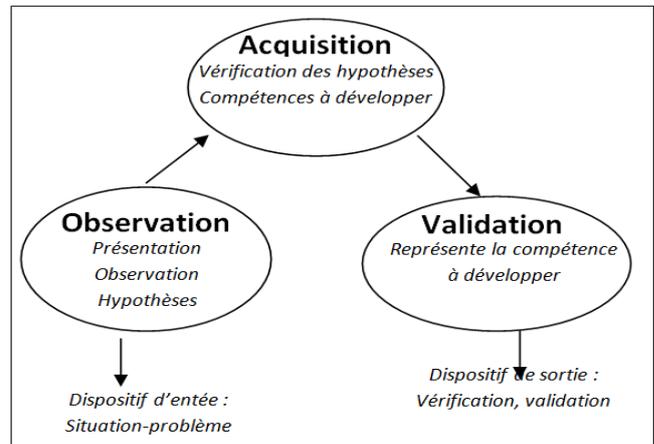
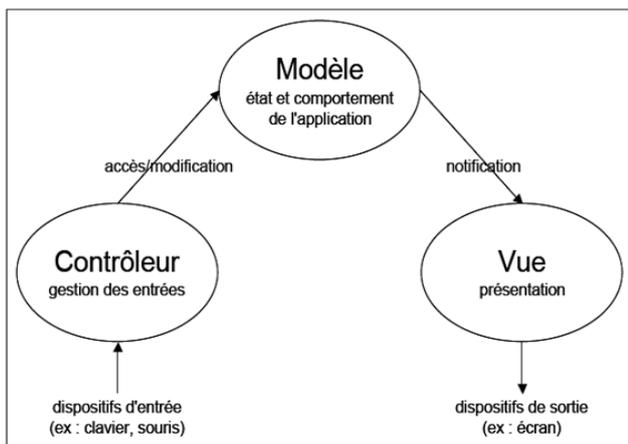


Figure 6. Homology between a basic action of the user interface and that of task model

3.4. Task-need Functional Homology

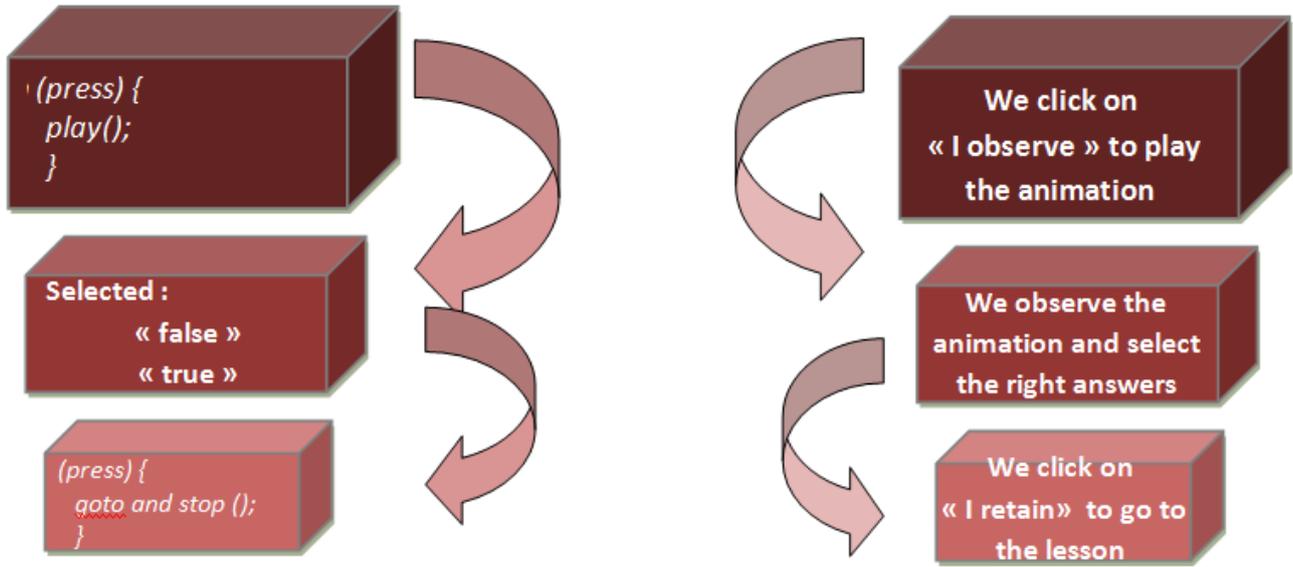


Figure 7. Comparative diagram of a basic action in the user interface and that of a task model

3.5. Implementing in the JAVI[®] Software

We will focus on the basic action which involves observing oscillatory movements of a pendulum by clicking on “I OBSERVE”; (in subsequent publications, we will have the opportunity to review other user interface actions and especially their use.

According to [14] below is the formula for a harmonic oscillation without energy loss, of the physic syllabus in the Lower Sixth science class...

$$y(t) = l_r \cdot \cos(\omega t + \varphi)$$

with $y(t)$ = projection on the x-axis (equivalent of a wave function)

$l_r(m)$ = radius of the circle

$$(\omega t + \varphi)(rad) = \text{phase} \begin{cases} \varphi = \text{initial phase} \\ = \text{angle between the radius passing through point and the } x\text{-axis} \end{cases}$$

$\omega(rad / s)$ = angular speed.

From this formula, we are going to find a functional correspondence and translate this formula to the ActionScript language to simulate a pendulum in oscillatory movements.

Table 1. Homology between elementary actions of the interface and that of the task model

Basic actions of the user interface	Basic actions of the task model
We will enter the following settings : teta_zero = -15; (initial angle) O = 3 ; (Omega : angular speed) t = 0 ; (time) Dt = 0.05 ; (time interval)	onClipEvent (load) { teta_zero = -15; O = 3 ; t = 0 ; Dt = 0.05 ; }
Given that : $y(t) = l_r \cdot \cos(\omega t + \varphi)$ This presents a sine function which we can translate in to an oscillatory movement using ActionScript by : teta = teta_zero*cos(O*t) We select the script: « this._rotation » Then we multiply the mathematical function: « Math.cos » by the initial angle. <i>This enables us to see the vertical angle made by the pendulum with time, hence showing us an oscillatory movement.</i>	onClipEvent (enterFrame) { //teta = teta_zero*cos(o*t) this._rotation = teta_zero*Math.cos(O*t) ; t = t+Dt ; }

3.6. Remark

It should be noted that the various matches in our table are not exclusive; this means that we can proceed otherwise to have a similar result; this can go from duplicating objects to assigning identical behaviors to different objects.

It can also be limited to manual editing of objects on the graphic interface without using any code, it is on this point that we chose the Adobe Flash[®] software given that future users are not necessarily IT experts.

3.7. Screenwriting in JAVI[®]

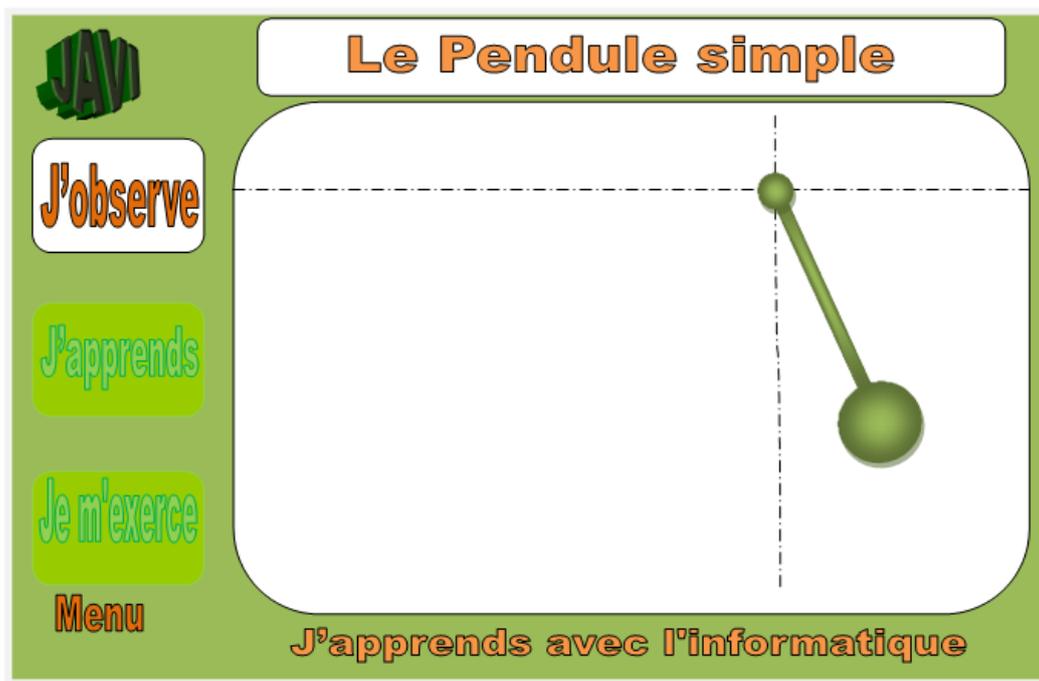


Figure 8. The simple pendulum oscillatory movement (redesigned) in the JAVI interface

4. Analysis of the Solution

The Adobe Flash[®] implementation software which we have adopted to present the solution through the JAVI program, is not a panacea but enabled us to verify the hology of an application with the task it has to carry out. JAVI[®] provides us two important advantages:

- It enables to follow the same pedagogic approach as during face-to-face situations like: reminders, then presentation of the problem-situation which is the actual start of the day's lesson; this feature is visible in JAVI[®] with the "I OBSERVE" button which is the only active button when entering the lesson, this prevents any other input which verifies the conformity of the application;
- It should also be noted that out solution, if it does not totally satisfy the user, still enables him to modify the graphic interface by himself to suit his specific needs without requiring him extensive knowledge in computing. It will not be needless to say for more complex needs, advanced knowledge the ActionScript programming language is essential.

5. Conclusion

The development of HMI is a growing sector, IT users are more and more demanding, and the computing sector is more and more efficient, this calls for need of constant research in the HMI field with more consistent responses to user needs. This will enable a better appropriation of tools and a guarantee of performance, all contributing to the socio-economic development of any society.

Concerning Cameroon's educational system, our work had as aim to bring a direct response to a real need. We think that this tool will popularize and diversify educational software, the work which we carried out is based on the Adobe Flash[®] software. In future work, we

envisage the creation of a range of specific tools for the development of cognitive activity [15] that meet efficient multidisciplinary pedagogic needs, enabling certification of the conformity of HMI.

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