Helping Children with Cognitive Disabilities through Serious Games: Project CLES

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ABSTRACT
Our work addresses the development of a Serious Game for the diagnostic and learning of persons with cognitive disabilities. In reality, many studies have shown that young people, especially children, are attracted towards computer games. Often, they play these games with great interest and attention. Thus, the idea of using serious games to provide education is attractive for most of them. This work is situated in the context of Project CLES. This project, in collaboration with many research laboratories, aims at developing an Adaptive Serious Game to treat a variety of cognitive handicaps. In this context, this article presents a system that generates learning scenarios keeping into account the user's profile and their learning objectives. The user's profile is used to represent the cognitive abilities and the domain competences of the user. The system also records the user's activities during his/her interaction with the Serious Game and represents them in interaction traces. These traces are used as knowledge sources in the generation of learning scenarios.

Categories and Subject Descriptors
I.2.1 [Applications and Expert Systems] *Games*

K.4.2 [Social Issues] *Assistive technologies for persons with disabilities, Handicapped persons/special needs*

General Terms
Performance, Design, Human Factors, Theory, Verification.

Keywords
Cognitive disability, Learning scenarios, interaction traces, serious games.

1. INTRODUCTION
The subject of helping persons in the situation of cognitive disabilities has been investigated by the researchers since long. Many tools has been created either to test the presence of a cognitive disability in a person or to help the person overcome these disabilities like in [1][2]. In this paper, we propose to use Serious Games as an educational medium to teach/help persons in situation of cognitive disabilities.

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In this context, we focus to create a system that is capable of **generating learning scenarios keeping into account the learner's competencies and deficiencies along with the specificities of serious games**. These learning scenarios are composed of a suite of activities selected and parameterized by the system according to the learner's profile and learning objectives. Afterwards, these scenarios are presented to the learner via a serious game. These scenarios are dynamic in nature i.e. they are automatically adapted to the performance of the learner. The user's interaction traces [3] are used to analyze user's performance and accordingly update the user's profile.

Our research work is part of Project CLES[1]. The objective of this project is to create a serious game environment; this environment aims to support learning for children and adolescents with intellectual disabilities related to the following cognitive domains: perception, attention, memory, oral language, written language, logical reasoning, visual-spatial and transverse competencies. The details about this game are presented in [4].

2. PROJECT CLES
The Project CLES (Cognitive and Linguistic Element Stimulation) is financed by the French ministry and is conducted in partnership with the laboratories: EMC specializing in cognitive mechanisms study, LUTIN Laboratory for the usage of digital information techniques and the society GERIP specializing in the creation of digital solutions for cognitive sciences.

The main protagonist of this game is a person named "Tom 'O Connor". Tom is a relic hunter (much like Indiana Jones and Lara Croft). The user takes control of Tom in this game. Tom is assigned to search for a relic, which contains great mystical powers. On his mission, Tom is assisted by two of his colleagues. Their mission is to guide Tom throughout his journey by giving him tips and telling him what to do. In order to search for the relic, Tom is placed inside of a room. This room is attached to one or many other rooms. Tom needs to find the key in order to exit the room and enter the next one. Each room represents one of the eight cognitive domains (attention, perception, etc). Inside each room there are objects, with which Tom can interact and there are also some non-interactive objects as well. The rooms are depicted in the figures 1.

2.1 Examples of Games
In Figure 2 we present a mini-game called "Objets Entérmélés à Identifier" (Identify intermixed objects). The purpose of this game is to test the visual-perception of a child aged between 6-12 years. The game goes as follows: the learner is shown a "Model" which

[1] http://liris.cnrs.fr/cles

contains more than one element that is intermixed. s/he is also shown a number of single elements as responses possible.

Figure 1: Room

The learner needs to identify, among the responses possible, the element which appears in the "Model". Furthermore, the learner has to do it in the allotted time.

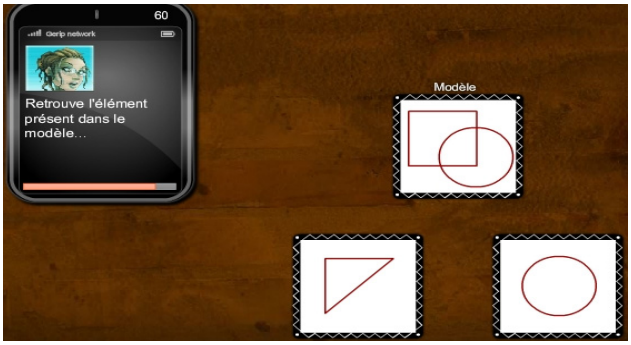

Figure 2: Mini Game

3. Knowledge Representation in System

As our objectives concern both the pedagogical domain and serious game specificities and also is to remain as reusable as possible, therefore it is necessary to identify and separate different aspects of the system. This separation on the one hand will let us to manage the information easily and on the other hand will make different aspects less dependable on other aspects thus, rendering our system more reusable.

We've identified three kinds of knowledge that is represented by our system. They are: 1) domain knowledge, 2) pedagogical resource, and 3) serious game resources. The figure 3 shows the interface for creating the domain's knowledge.

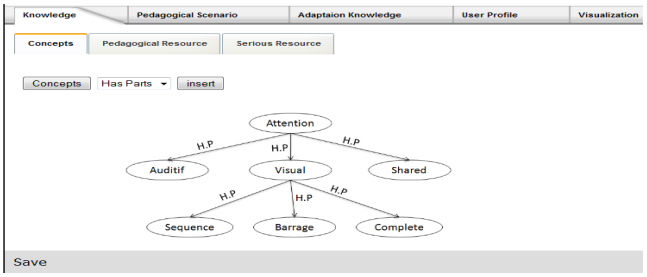

Figure 3: Knowledge editor screen

The first layer 'domain knowledge' represents two kinds of knowledge: the pedagogical knowledge of the domain to be taught, for example mathematics, physics, grammar, biology etc, and the physical and cognitive abilities of the learner, for example attention, perception, etc, this knowledge are composed of concepts and their sub-concepts. A concept is associated or linked with another concept via a *relation*. This relation tells what kind of impact a concept has on other concept. In our system we've identified four types of relations [4] Has-Parts, Required, Type-Of and Parallel.

The second layer contains the pedagogical resource knowledge. This is where all the pedagogical resources are located. All the pedagogical resources are associated with at least one pedagogical concept. A pedagogical resource can be associated with more than one concept. A pedagogical resource is atomic in nature i.e. it is not associated with other resources. The third kind of knowledge is the serious game resource. This represents the serious game resources like chairs, tables, Non Playing Characters, doors etc. A serious game resource is connected with one or more than one pedagogical resource and vice versa.

3.1 Scenario Generator

As the knowledge is divided into three layers, the generation process of the learning scenarios is also performed in three steps. Given the learning objectives (in the form of list of pedagogical concepts) and the user's profile, the first step consists in selecting the concepts from the knowledge domain that are necessary to achieve the learning objectives. This selection is done based on the user's profile.

In the second step, the pedagogical resources are selected for each knowledge concept selected in the previous step. This selection is also done on the basis of the user's profile. The profile tells which kind of resources a user prefers. In the third step, the serious game resources are selected based upon the pedagogical resources selected. These pedagogical resources are hidden behind the serious game resources in the game.

This three steps process is used by the system in achieving its objective of remaining reusable, by separating the generation of one kind of resources from others. Once generated the serious game resources with the pedagogical resources hidden behind them are shown to the user. The user interacts with these serious resources via the serious games. The moment the user is interacting with the game the user's interaction traces are generated and are used by the system to update the user's profile and to modify the generated scenarios if necessary.

4. References

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