Learning Difficulties Diagnosis for Children's Basic Education using Expert Systems

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Abstract

SEDA (Expert System for Learning Difficulties or "Sistema Experto de Dificultades para el Aprendizaje" in spanish), is a software designed using the Expert Systems design methodologies, which contain a knowledge base comprising a series of strategies for Psycopedagogy evaluation, as well as providing tools that allow the teacher to discuss psycofunctions and basic skills for learning. In the vast and complex world of educational work, every day it is highlighted the importance of special education in all its dimensions; across the time it have been better known learning problems and the inescapable responsibility of each specialist in making accurate diagnostics and prompt remedial action. Psycopedagogy evaluation for diagnosis becomes focus of this expert system, in response to the concern of many career teachers, who for various reasons expressed difficulty when preparing assertive diagnostic describing Learning Difficulties of their students.

Keywords: - Expert Systems, learning difficulties, artificial Intelligence.

1. Introduction

Psycopedagogy evaluation used as a strategy for analyzing problems that a child may have in the academic area, can clarify and identify the factors that influence the teaching-learning process [8]. This collection, organization and information analysis activity, facilitates the identification of educational needs of pupils, also identifies the type of support that lead to progress in the development of individual skills in psycofunctional areas.

However, this action generally have to be done by professionals in special education, who are sometimes not enough for the demand of cases that exist in educational institutions, having the classroom teacher to "find" the most appropriate strategies for evaluating and developing educational activities with children with learning difficulties, not having in most cases, the knowledge needed to carry out this work effectively and efficiently. This paper proposes an expert system as an alternative solution to the mentioned problems, giving the opportunity to classroom teacher of obtaining psychopedagogical diagnoses, in addition to providing the best educational activities for children with learning difficulties. This article summarizes the methodology for the design and development of a prototype expert system for diagnosing learning difficulties, aimed for teachers of Basic Education. Its primary purpose is to cooperate with teachers in their diagnostic evaluation practice. Moreover, this material contains basic guidelines and underlying for the general evaluation, providing models of diagnostic tools and educational activities for handling several weaknesses in psycofunctional areas such as: Psycomotricity, SensoPerceptive, intellectual and language.

2. Problem

Learning problems tend to be diagnosed when children reach scholar age, because the schools usually focuses on those things that can be difficult for the child such as reading, writing, arithmetic, speaking, thinking, among other; teacher during encounters with students may note that the child learning is not as expected, it may request an evaluation by a specialist to see what is causing the problem and, if possible, what strategies should apply for the child.

Based on the observation and implementation of unstructured interviews by the researcher, in some basic educational institutions in the "Altos Mirandinos (Venezuela)", it was evident that most institutions have few specialist staff in learning difficulties, not providing an efficient care to the majority of cases

with this type of special educational needs. However, considering that most of the time that children spent in school is with the classroom teacher, it is desirable that he can diagnose certain learning difficulties (LD) and carry out some activities with the student to better care of their problems. For this, it is necessary that the classroom teacher is guided by a specialist in LD.
Based on the previously exposed, it is proposed structuring a knowledge base with strategies for psycopedagogy evaluation, for helping the classroom teacher in diagnosing and applying appropriate strategies for the care of children with learning difficulties.

2.1 Objectives

Developing an expert system for diagnosing learning disabilities and providing strategies for their attention to Basic Education teachers.
To do so, there are presented the following specific objectives:

- Determining the requirements of the proposed expert system.
- Determining the solution to the problem and the strategies using the knowledge of learning disabilities experts.
- Designing a prototype of the expert system.
- Evaluating the developed prototype.

3. Theoretical Framework

3.1 Artificial Intelligence

According to the Artificial Intelligence Encyclopedia, "Artificial Intelligence is a field of science and engineering that deals with the understanding from the informatics' point of view, what is commonly called "intelligent behavior". It also covers the creation of artifacts that exhibit this behavior." Artificial Intelligence (AI) is given by different authors, from two perspectives: science and technology [15], in any of them, there have been accumulating knowledge on how to emulate the different human beings abilities for exhibiting intelligent behavior in systems that have been developed under any of the AI approaches. Some authors consider that the following are sub-disciplines of artificial intelligence:

• Natural Language Processing
• Vision
• Problem Solving
• Knowledge Representation and Reasoning
• Learning
• Robotics

In some sense, AI allows us to learn more about ourselves and differing from psychology and philosophy that focus their study of intelligence, the AI is trying to understand this phenomenon for their replication in the construction of intelligent entities.

3.2. Expert systems

The technology is widely regarded as the efficient and effective application of knowledge to improve the quality of life of people in the goods production, services and other knowledge. Historically, man has been producing knowledge in the process of its evolution, interacting with the natural and cultural environment to meet their needs. Thus has emerged a set of theories, methods, techniques, procedures and values that according to [10] are leaving new cultural events and, in turn, allows a better progress of science, the arts and a more integral and dynamic man developing.
In this sense, the creation of Expert Systems (ES) are a reward to the possibility of using methods for organizing and accessing information, providing knowledge according to individual needs, allowing the location of specific information in various databases and having interactive environments focused on the user [19, 20, 21].
Expert systems are part of artificial intelligence [1] and are interactive computer program that contains the experience, knowledge and skills of an expert or group of experts in a particular area of human knowledge, created to solve specific problems in this area of knowledge in an intelligent and satisfactory way.
Expert systems are part of a strong and genuine breakthrough in artificial intelligence.
In principle, an expert system should be able to:
• Solving the problem in the same way or even better that the human expert, because it is created by the expert's knowledge but in not critic conditions, so he can give analyzed solutions.
• Managing the uncertainty associated with uncertain or incomplete information
• Explain the result
• Restructure the knowledge available on the basis of new data.
There are mainly three types of expert systems:

• Based on rules: Applying heuristic rules that can also be supported on fuzzy logic for evaluation and implementation.
• Based on cases: Applying case-based reasoning, where the solution for a similar previously raised problem is adapted to new problems.
• Based on Bayesian networks: Applying Bayesian networks, based on statistics and the Bayes theorem.
Expert system components are:

- Knowledge Base: It is obtained as a result of structuring the knowledge provided by the expert. It contains facts, rules and structures embedded in the information available. Is the heart of Expert Systems, because contains the information acquired from the expert and correctly organized.
- Facts Base: It is composed of the data collected for the situation that will be considered. Also can be used as auxiliary memory for the results of some calculations and reasoning that is generated in the rules evaluation of the knowledge base
- Inference Engine: This is a program that manages the information in the knowledge base and the facts base, for reasoning about reality between the variables under study. It can be used two reasoning methods: forward chaining and backward chaining. It is the part of the Expert Systems that contains all inference and control strategies that the expert would normally use in order to solve a problem. It selects, decides, interprets and applies the information included in the knowledge base.
- User Interface: It is the element that transmits to the inference engine all inquires made by the user, and presents to the user the proper results.
- Knowledge Base Editor: It is the tool used by the knowledge engineer to "feed" the knowledge base. These tools depend on the computer platform used for constructing the Expert System.
- Explanation Module: It is an optional component of the Expert System, which is designed for indicating the reasoning process involved in the conclusion obtained for a particular inquire.

Figure 1 depicts a scheme with the general architecture of an Expert System.

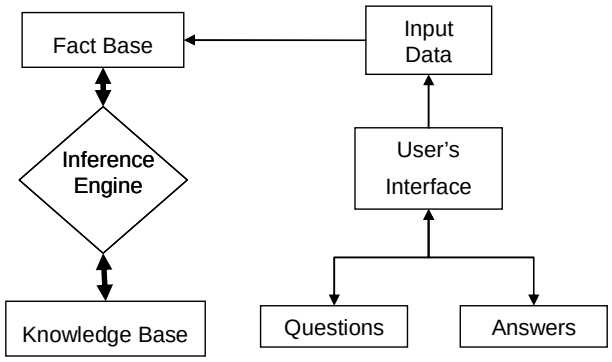

Figure 1. General Architecture of an Expert System

3.3 Learning Difficulties

A learning problem can cause a person to have difficulty learning and using certain skills [9]. The skills that are most often affected are: reading, spelling, listening, speaking, reasoning and calculation. Learning problems vary between individuals [12]. The researchers believe that learning problems are caused by differences in brain function and the manner in which it processes information. Children with learning problems are not "stupid" or "lazy." In fact, they generally have a higher level or average intelligence. What happens is that their brains process information in a different way.
When the child has a learning problem:

- May have trouble learning the alphabet,
- Can make mistakes when reading aloud, and repeat or stop frequently;
- Can not understand what they read;
- May have difficulty with spelling words;
- May take the pencil awkwardly;
- May be hard to express their ideas in writing;
- Can learn the language very slowly and can have limited vocabulary;
- May have difficulty remembering the sounds of letters or hear small differences between words;
- May have difficulty following instructions;
- Can say words incorrectly or use wrong words that sounds similar;
- May have trouble organizing what he or she wants to say or can not think the appropriate word that needs to write or talk;
- Can not follow the social rules of conversation, such as taking turns, and can get too close to the person who listens;

- May confuse math symbols and misread numbers;
- Can not know where to begin a task or how to follow from there.

Considering the contributions of Silver [16], the following is a list of some impediments that affect learning.

A) ***At Sensory Level***:

- **Impairment in visual perception.** Refers to both blindness and other optical disorders.
- **Impairment of auditory perception.** Is a partial or total deficit in auditory perception, which fundamentally affects the communication process.

B) At intellectual Level:

- **Disability for Information Management.**
- **Impairment of abstraction.** In this case, the child is difficult to infer a logical meaning from other information. Most children with learning disabilities have problems in this area.
- **Impairment of memory.**

C) ***At Oral Language Level:***

It is defined as any oral language systematic deficiency that interferes or impedes the ability of verbal communication of a person with the people around [17]. Among the most common spoken language difficulties we have:

- **Changes of the voice.**
- **Changes in the joint.**
- **Changes in verbal fluency.**

D) At Psychomotor Level:

Berruezo [18] refers psychomotor as the potential motor development, expressive and creative from the body, which leads to focus the activity and interest in the movement. It plays a very important role, because it is a valuable influence on the intellectual, emotional and social development by promoting the relationship with their environment and taking into account individual differences, needs and interests of children.

- **At motor level**, It will enable the child to master his body movement.
- **At cognitive level**, enabling improved memory, attention, concentration and creativity of children.
- **At social and emotional level**, enabling children to know how to face their fears and interacting with others.

Areas of Psicomotricity are:

a) Body Scheme: The knowledge and the mindset that the person has on his own body.
b) Lateral: This is the functional predominance of one side of the body, determined by the dominance of one cerebral hemisphere.
c) Balance: It is the ability to maintain stability while performing various motor activities.
d) Structuring Space: This area includes the ability for the child to maintain the constant location of the body, both in terms of the position of objects in space and putting those objects according to their own position, also the ability to organize and arrange the elements in space, time or both.
e) Time and Rhythm: The notions of time and rhythm are developed through movements that involve a temporary order and an awareness of the movements.
f) Motricity: It refers to the control that the child is able to exercise over her own body. The motrrcity is divided into thick and thin.

3.4. Expert Systems application for solving scholar problems.

According to Galvis [6], today, when it is feasible to create virtual networks, browse the electronic highways, explore and create multimedia and interactive programs, making use of computers for communicate, among other things that used to be fantasy, it can be said that technological opportunities have granted power of educational action and that the greatest obstacles for creating new learning environments are not technological or financial, but rather the paradigm changes for teachers in the use of information technology and communication .

While it is feasible the use of expert systems in solving school problems, not only at the administrative level, but also in the teaching and

learning process, because among its benefits is the persistence, its massively diffusion capability, the speed to get information and perform calculations much faster than any human being, are reliable because they are unaffected by external conditions, that a human does (tiredness, stress, etc.).
An expert system for diagnosing learning difficulties may be one way to improve the classroom teacher capabilities when evaluating the student, because not only will observe the skills of the children's academic level, but also consider the psychomotor, perceptual, intellectual, personal and language aspects, to take appropriate decisions if there is any difficulty.

4. Expert System for Learning Difficulties

4.1. Requirements Specification

Once described the general problem, being familiar with the exploratory evaluation process for diagnosing learning difficulties, examining the feasibility of developing an expert system, and having selected the experts who will collaborate on the project, it was proceeded to specify the system's requirements. For that, it was defined the direct and indirect users of the system (teachers and students) for determining the functional and information requirements to be satisfied by the expert system, pointing out the fact that it can provide assertive psychopedagogical diagnostic based on the information received from the teacher, as well as providing strategies that can help the teacher to treat any disorder in the scholar aspect. It was also defined the data entry requirements as well as technological characteristics of the platform where the system will be implemented.
For the process of defining requirements it was used as strategy the open interview with the expert in order to collect all the information associated with the expertise in the area of psycho pedagogical evaluation. On the other hand, the direct users (teachers) were surveyed with the intent to share their knowledge in the area of psycho pedagogical evaluation and computer handling as the final user they must use the computer, but if they are not prepared in computer usage, it should be a phase of a planned training in computer handling for teachers prior to testing and implementation of expert system design.
Additionally, it was collected information on the technology platform where the system will be installed, making the review and inventory of the hardware features of the computer equipment of educational institutions where pilot tests will be conducted with the aim that the resulting application work efficiently on all computers.

4.2. Knowledge Engineering

Is the most important part of the Expert System; it is when the Knowledge Engineer interacts with the expert in order to obtain the information about the appropriate way for solving the problems. Also evaluates the strategies used for obtaining that solution.
The Knowledge Engineering involves the reproduction of the behavior of an expert when it solves a problem well defined, ie, the knowledge engineer should identify specific knowledge that the expert uses to solve problems, analyze the facts and the empiric rules used [14].
Figure 2 presents the different aspects associated with the Artificial Intelligence and Knowledge Engineering.

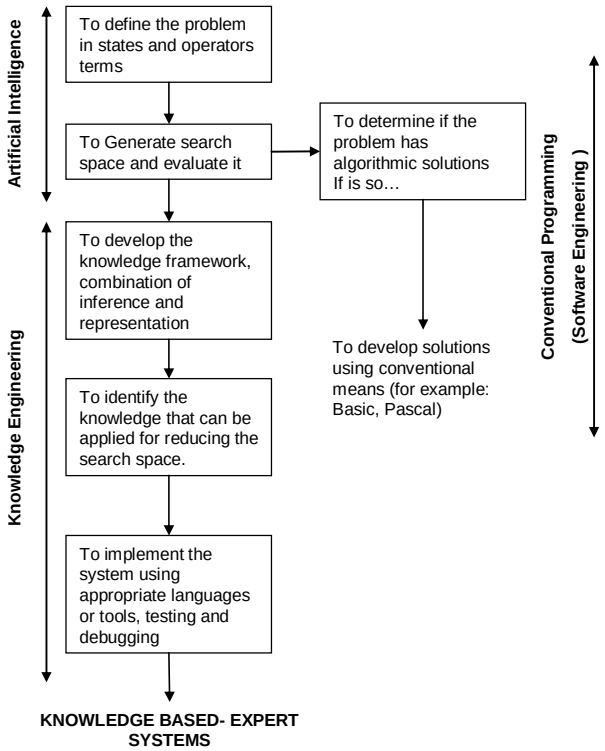

Figure 2. Different aspects of AI and Knowledge Engineering.
Source [14]

In this work it began the knowledge engineering phase with the analysis of the interviews as a result of the meetings of the knowledge engineer with experts in psycho pedagogical evaluation evaluation, trying to identify the relationships between input variables and possible solutions, such relations constitute the structure of the rules that form the knowledge base which emulate human expertise, which should be composed of the various strategies used by experts to obtain solutions to academic problems (learning difficulties). The information provided led to the creation of rules, which later will be incorporated in the knowledge base.

4.3. Expert System preliminary design and development.

At this stage it was made a sketch of the system architecture and it was selected as computational tool (in response to requirements raised) the electronic publications editor NeoBook [13] because it provides the ability to create publications that can perform calculations, search information, determine correct responses, communicate with other programs, store large amounts of information and its language level and interface are friendly. Also it uses logical operators as AND and OR structures and IF-THEN, ELSE decision type.

The design included the programming of rules and outlining the user interface.

In the preliminary version of the expert system, there were introduced 568 rules which represent the knowledge of experts who worked with the system.

Figure 3 shows the input screen to the developed prototype.

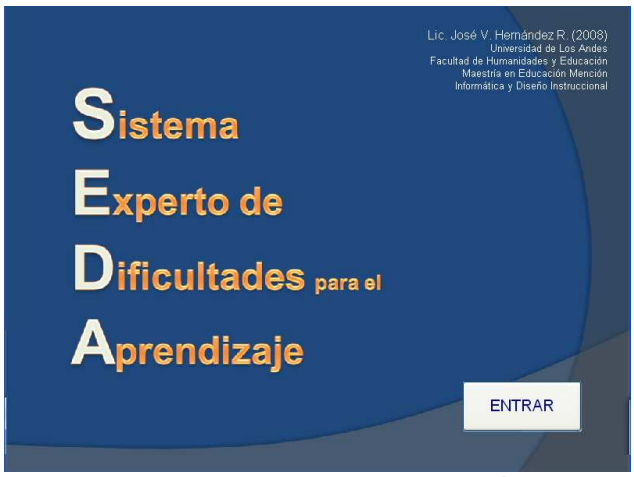

Figure 3. Expert System Presentation Display

The user interface provides an initial section showing the introduction and the objectives of the application (see Figure 4). It was developed in Spanish and the first pilot tests were carried out in the city of Los Teques, Venezuela.

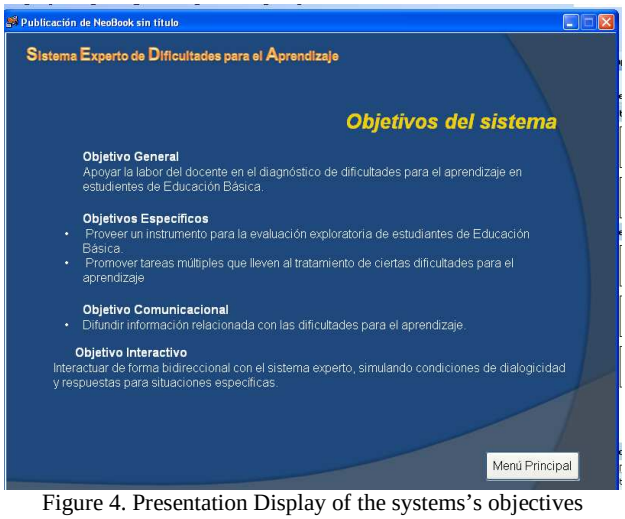

Figure 4. Presentation Display of the systems's objectives

The input variables used for each of the rules are the following:

- Age
- Sex
- Height
- Weight
- Educational Level
- Gross Motricity
- Fine Motricity
- Corporal Scheme
- Spatial relations
- Temporal relations
- Perception
- Memory
- Imagination
- Conceptualization
- Understanding
- Reasoning
- Language
- Attention
- Reading

Figures 5, 6 and 7 illustrate the initial display for exploratory evaluation in which teachers begin to fill the student's information.

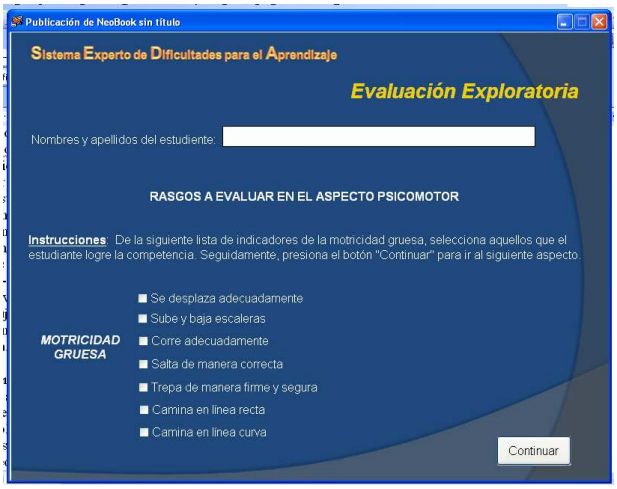

Figure 5. Exploratory evaluation Display.

Figure 6. Tools Selection for Data Collection Display

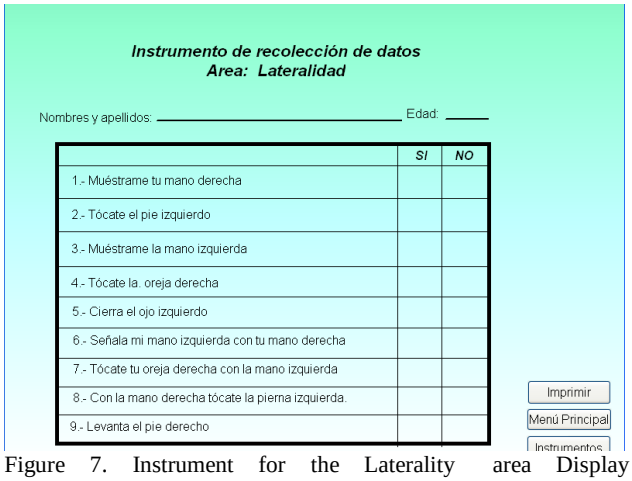

Figure 7. Instrument for the Laterality area Display

The output variables or systems results are:

- Psychomotor Aspect
- Intellectual Aspect
- Perceptual Aspect
- Language Aspect
- Personal Aspect

All of them gives to the expert system's users (classroom teacher) the possibility of know the psychology profile of the student; also offer various strategies (see Figure 3) for attending any of the aspects mentioned above when they are required.
The activities that are presented in Figures 8, 9 and 10 shall be developed by the student whose diagnosis has suggested it. These activities are referential and they also can serve as guides for the teacher choose others that are associated to the area of child care or child being evaluated.

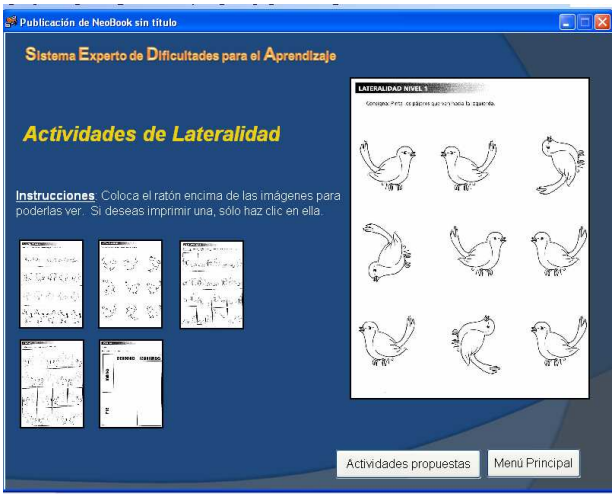

Figure 8. Laterality Proposed activities Display

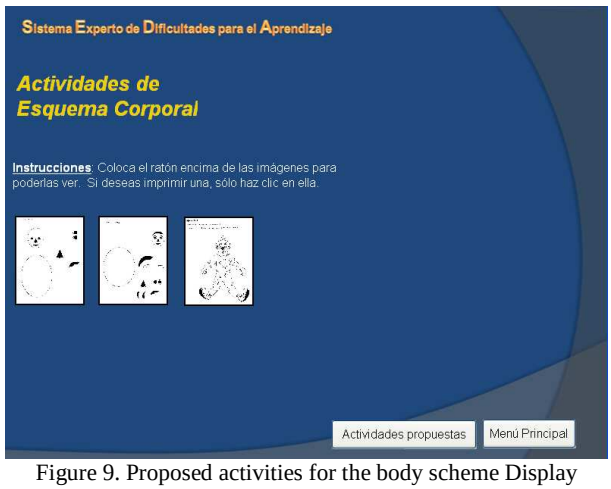

Figure 9. Proposed activities for the body scheme Display

Figure 10. Proposed activities for the concentration Display

The system also refers to the experts who were interviewed (See Figure 11), with the aim of providing better information to the teacher if they want to contact them.

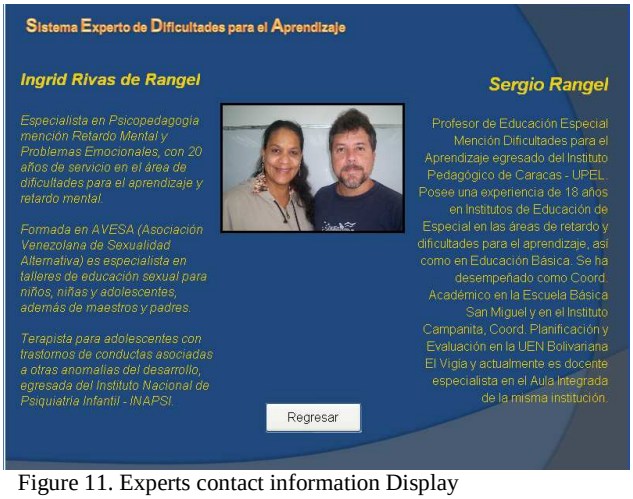

Figure 11. Experts contact information Display

4.4. Implementation and evaluation

Once the expert system was designed, it was selected five (05) assessors, who fulfil the following requirements: Knowledge concerning the learning difficulties area and computer use for taking an active part in the establishment and evaluation of the technological environment, navigation, purpose, objectives and content, among others.

The aim of the questionnaire was to evaluate the system concerning the technology and presented content. For purposes of this deployment and evaluation, it was assumed and validated by the instrument proposed by Cedeño [4], which was structured in two parts: a presentation sheet and another with instructions and fourteen (14) items to evaluate aspects concerning technology and content. There were designed using an estimation scale with three options: Poor, Moderately Efficient, and Efficient.

For the final evaluation, there was given to each assessor a copy of the expert system, and a copy of the questionnaire.

After the expert system implantation, it has been noted that according to the technological aspects regarding installation feasibility, interactivity, navigation Feasibility, interface, fitness to the user, contents, performance objectives and originality, 80% of evaluators have rated the system as *Efficient.*

It follows that most of the evaluators found that the expert system is efficient, in terms of the already mentioned criteria. The evaluators of the expert system have navigated all the displays and subdisplays to sense the entire environment in this technological environment.

5. Conclusions

During the last decades it has been increased the use of information and communication technology in a wide range of everyday activities. The computer has become an essential tool in offices, shops, hospitals, large companies and research projects of all kinds.

Expert System's methodologies can help very much in educational area, where specialized decisions are required in order to help children's appropriate integral development and teacher's way to determine the particular skills of every students and the best way to help them in the learning process.

Education was no exception and should not be left out of the use of these media, because one of its missions is to empower people to understand the culture of his era.

Examples of this are expert systems where clearly there is a software application that solves complicated or specific problems that would otherwise require extensive human expertise.

Based on the analysis and description of the problem presented in this work, it was concluded that there is needed to support basic education teachers in the appropriate care to children with learning difficulties, particularly in the disorders detection and in methods, techniques, resources and activities for treatment, so

designing an expert system to diagnose learning difficulties, is presented as an alternative solution, whose evaluation made by experts showed satisfactory results; so it will be continued the pilot testing and increasing the knowledge base with new information regarding learning difficulties diagnosis and activities.

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