

Diagnosing Learning Disabilities in a Special Education by an Intelligent Agent Based System

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Abstract—The presented paper provides an intelligent agent based classification system for diagnosing and evaluation of learning disabilities with special education students. It provides pedagogy psychology profiles for those students and offer solution strategies with the best educational activities. It provides tools that allow class teachers to discuss psycho functions and basic skills for learning skills, then, performs psycho pedagogy evaluation by comprising a series of strategies in a semantic network knowledge base. The system's agent performs its classification of student's disabilities based on its past experience that it got from the exemplars that were classified by expert and acquired in its knowledge base.

Keywords—Intelligent Agent; Learning Disabilities; Special Education; Semantic Network; Psych Pedagogy Evaluation; Exemplar Based Classification

I. INTRODUCTION

Educational software programs in science education have become increasingly complex in both concept and design. Thus, there is a paradigm shift in the role of computer from solely a transmitter of knowledge to a tool that aids in the construction of knowledge. This is due to the fact the science concepts are abstracts, as in [1].

Students in a special mental education have disabilities in their learning, especially in the basic education. They need psycho pedagogy evaluation as a strategy for analyzing problems that children may have in the teaching-learning process. This evaluation can be done manually by specialists and professionals in the special education, who are sometimes not enough in the special education schools.

Class teachers, who are always, keeping track of students whose learning is not as expected. This student should be evaluated by a specialist, who diagnose the case and specifies reasons of that problem. If possible, the specialist also determines strategies that should be applied on that case to help in decreasing his LDs.

In the time being, Artificial Intelligence algorithms, techniques, and applications have wide use in education and tutoring systems. One of the AI techniques is the intelligent agent, which can be used in education.

An intelligent agent is an autonomous calculated entity. In the dynamic changes information environment without prior modeling, it can independently plan complex operation steps to solve practical problems, can independently discover and

obtain the available resources the learners needed and then provide the corresponding services under the circumstance that the learners do not take part in [13].

Currently, the state of intelligent is focused on one-to-one learning instruction. Some examples include ACT systems [1], DEBUGGY [2], and PIXIE [11] and. specifically, the kind of learning modality used is centered on learning by being told [3]. The agent has to collect users' personal interests and give fast response according to the pre-specified demands of users. The personal agent can discover users' personal interests voluntarily without bothering the users. It is very suitable for personalized e-learning by voluntarily recommending learning materials [7].

An agent is something that perceives and acts in an environment. The agent function for an agent specifies the action taken by the agent in response to any percept sequence as in [10]. Intelligent agents are task-oriented software components that have the ability to act intelligently. They may contain more knowledge about the needs, preferences and pattern of the behaviors of a person or a process as in [8].

Intelligent agents should have the ability of adaptive reasoning. They must have the capability to access information from other sources or agents and perform actions leading to the completion of some task. Also, they must control over their internal state and behavior and work together to perform useful and complex tasks. Thus, they should be able to examine the external environment and the success of previous actions taken under similar conditions and adapt their actions as in [9].

According to the observation and implementation of unstructured interviews with specialist in the special basic education institute (in a primary school in Makkah AlMokaramah area, Saudi Kingdom), it was evident that most institutes have a few specialist staff in LDs, not providing an efficient care to all students who have special educational needs.

The presented paper proposes a framework design for an Intelligent Agent Based classification System. It provides a methodology for the design and development of an intelligent agent-based system for diagnosing of learning and disabilities with children in special education.

Regarding that those students spend most of their times with their classroom teacher, it is desirable that he can diagnose

certain disabilities and carry out some activities with the student for better care of their problems. So, it is necessary that that the classroom teacher is guided by a specialist in LDs.

The proposed system performs structuring a knowledge base with strategies for psycho pedagogy evaluation, for helping the classroom teacher in diagnosing and in selecting, applying appropriate strategies in the care of children with LDs.

II. DISABILITIES IN TEACHING-LEARNING PROCESS

LDs do not include, "...learning problems that are primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage." In the last few years an increasing number of children who have difficulties in learning their school work have been referred to child psychiatrists and child psychoanalysts. This increase in problems of learning may be real or it may be an apparent one.

Some of those problems, particularly reading problems, may be inherent in the difficulties in learning to read, write and spell the English language. This means that many children, who are really not capable of higher learning, have to try and their failures may increase the relative high percentage of these difficulties. In recent years psychologists and educators tend to regard the majority, if not all, of the children who seem [4].

A. What is LD

It is a general term that describes specific kinds of learning problems. A LD can cause a person to have trouble learning and using certain skills. The skills most often affected are: reading, writing, listening, speaking, reasoning and doing math [17].

LDs vary from person to person. One person with LDs may not have the same kind of learning problems as another person with LDs. One person may have trouble with reading and writing. Another person with LDs may have problems with understanding math. Still another person may have trouble in each of these areas, as well as with understanding what people are saying (National Dissemination Center for Children and Youth with Disabilities [17]).

Researchers think that LDs are caused by differences in how a person's brain works and how it processes information. Children with LDs are not "dumb" or "lazy." In fact, they usually have average or above average intelligence. Their brains just process information differently [17].

The definition of "learning disability" just below comes from the Individuals with Disabilities Education Act (IDEA). The IDEA is the federal law that guides how schools provide special education and related services to children with disabilities [17].

Our nation's special education law, the Individuals with Disabilities Education Act, defines a specific learning disability as "a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do

mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia."

There are some common red flags for learning disorders. Children who don't have LDs may still experience some of these difficulties at various times. The time for concern is when there is a consistent unevenness in child's ability to master certain skills. Grades 5-8 signs and symptoms of LDs include : Difficulty with reading comprehension or math skills, Trouble with open-ended test questions and word problems, Dislikes reading and writing; avoids reading aloud, Spells the same word differently in a single document, Poor organizational skills (bedroom, homework, desk is messy and disorganized), Trouble following classroom discussions and expressing thoughts aloud, Poor handwriting [5].

B. Problems with reading, writing, and math

LDs are often grouped by school-area skill set. If a child is in school, the types of learning disorders that are most conspicuous usually revolve around reading, writing, or math. Children with difficulties in mathematics-only seem to be superior to children with difficulties in mathematics and reading in areas that may be mediated by language but not in ones that rely on numerical magnitudes, visuospatial processing, and automaticity. Both groups performed worse than normally achieving groups in most areas of mathematical cognition. The two groups did not differ in approximate arithmetic and understanding of place value and written computation [6].

a) LDs in reading (dyslexia): There are two types of LDs in reading. Basic reading problems occur when there is difficulty understanding the relationship between sounds, letters and words. Reading comprehension problems occur when there is an inability to grasp the meaning of words, phrases, and paragraphs.

Signs of reading difficulty include problems with: letter and word recognition, understanding words and ideas, reading speed and fluency, and general vocabulary skills.

b) LDs in math (dyscalculia): LDs in math vary greatly depending on the child's other strengths and weaknesses. A child's ability to do math will be affected differently by a language learning disability, or a visual disorder or a difficulty with sequencing, memory or organization.

A child with a math-based learning disorder may struggle with memorization and organization of numbers, operation signs, and number "facts" (like $5+5=10$ or $5 \times 5=25$). Children with math learning disorders might also have trouble with counting principles (such as counting by 2s or counting by 5s) or have difficulty telling time.

c) LDs in writing (dysgraphia) : LDs in writing can involve the physical act of writing or the mental activity of comprehending and synthesizing information. Basic writing disorder refers to physical difficulty forming words and letters. Expressive writing disability indicates a struggle to organize thoughts on paper. Symptoms of a written language learning disability revolve around the act of writing. They include problems with: neatness and consistency of writing, accurately

copying letters and words, spelling consistency, and writing organization and coherence

C. Other types of LDs and disorders

Reading, writing, and math aren't the only skills impacted by learning disorders. Other types of LDs involve difficulties with motor skills (movement and coordination), understanding spoken language, distinguishing between sounds, and interpreting visual information.

a) LDs in motor skills (dyspraxia):

Motor difficulty refers to problems with movement and coordination whether it is with fine motor skills (cutting, writing) or gross motor skills (running, jumping). A motor disability is sometimes referred to as an "output" activity meaning that it relates to the output of information from the brain. In order to run, jump, write or cut something, the brain must be able to communicate with the necessary limbs to complete the action.

Signs that your child might have a motor coordination disability include problems with physical abilities that require hand-eye coordination, like holding a pencil or buttoning a shirt.

b) LDs in language (aphasia/dysphasia):

Language and communication LDs involve the ability to understand or produce spoken language. Language is also considered an output activity because it requires organizing thoughts in the brain and calling upon the right words to verbally explain something or communicate with someone else.

Signs of a language-based learning disorder involve problems with verbal language skills, such as the ability to retell a story and the fluency of speech, as well as the ability to understand the meaning of words, parts of speech, directions, etc.

D. Treatments of LDs

The most common treatment for LDs is special education. Specially trained educators may perform a diagnostic educational evaluation assessing the child's academic and intellectual potential and level of academic performance. Once the evaluation is complete, the basic approach is to teach learning skills by building on the child's abilities and strengths while correcting and compensating for disabilities and weaknesses. Other professionals such as speech and language therapists also may be involved. Some medications may be effective in helping the child learn by enhancing attention and concentration. Psychological therapies may also be used [16].

There is no "cure" for LDs. They are life-long conditions. However, children with LDs can be high achievers and can be taught ways to get around the learning disability. With the right help, children with LDs can and do learn successfully. In some people, several overlapping LDs may be apparent. Other people may have a single learning problem that has little impact on their lives [15].

III. THE MAIN PARTS OF THE SYSTEM

The proposed system has the following main parts:

- **User Interface;** which is a menu-driven dialogs to help the user to interact with the tool directly in easy manner. The user could present new disable student to the system to be diagnosed.
- **Intelligent Agent;** which manages the process of diagnosing and classification. During diagnosing process, the agent acquires disabilities (categories), builds an indexing structure through its semantic network, and acquires the domain knowledge needed for explanation and reasoning processes. Consequently, the agent learns to classify accurately and efficiently and is able to explain its classification. The agent uses explanation to aid in its heuristics classification, because great variation possible in disable student descriptions. It uses links which are filled with indices to restrict and guide the agent search for a solution of the presented student.
- **Semantic KB;** which is a semantic network used to represent all knowledge of LDs in its nodes and links (relations between nodes). It holds an indexing structure used by the inference engine to locate questions. Each node or link is represented by an object of a suitable class.

IV. LDs'S SEMANTIC NETWORK KNOWLEDGE BASE

The knowledge manipulated by the proposed system is represented in frames that are allocated in nodes and links of a semantic network, that shown in Fig. 1. Each node may be related (linked), from zero to many times, to other node.

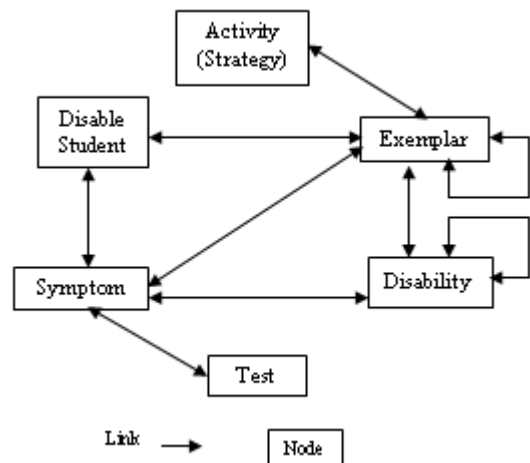


Fig.1. The Semantic Network Knowledge Base.

A. Knowledge Represented in Nodes

The semantic network, shown in Fig. 1, has six types of nodes. Four nodes store some substantive (descriptive) knowledge such as: *disability*, *disable student*, *exemplar* and *symptom*.

The other two nodes store some action knowledge such as: *test* and *activity (strategy)*. The description of each node is as follows:

- The *disability* node represents a concept or a solution (name of category and classification of a disability for certain disable student).
- The node of *disable student* stores the name of the diagnosed disable student.
- The *exemplar* node represents the acquired, retained and previously classified disable student.
- The *symptom* node represents the feature of disability recognized that describe a disable student.
- The *test* node represents the test to be done on a diagnosed disable student.
- Finally, the *activity* or *strategy* node represents the action to be done as a treatment or skills to be performed.

B. Knowledge Represented in Links

The semantic network, shown in Fig. 1, has nine types of links. Those links are very important to relate the nodes listed above and hold majority of the knowledge acquired and represented in the semantic network. They hold substantial (descriptive), search control and strategic knowledge.

Each link is manipulated as a frame with its more specialized slots. The first seven links hold substantive and search control knowledge, while the last two links mainly hold strategic knowledge beside substantive knowledge. The description of those links is as follows:

- The *Disability-Disability* link relates disability categories to formulate the category tree. It links a category with its family in the network to enable inheritance of properties between categories. (It holds search control knowledge).
- The *Exemplar-Exemplar* link relates two exemplars located in the same category or in different categories. It used to discriminate an exemplar from another. (This link named a difference link).
- The *Symptom-Disability* link stores free text relation-name and qualifier beside the parameters assigned to the linked symptom, which are both combined to explain the relation of a feature with certain category in the network. It is used for describing to what extent the symptom *reminds* or *rejects* certain disability category to be a predicted classification. Only one explanation (one link) is needed over the entire network to explain the relation between certain symptom node, having certain parameters and certain disability node.
- The *Symptom-Exemplar* link relates symptoms to their exemplars. There may be different links between an exemplar and several features. Also, this link holds the importance of a symptom to an exemplar which depends on the strength of the relation between that symptom and the classification

(disability) of that exemplar. (It holds substantive knowledge and search control knowledge).

- The *Disability-Exemplar* link relates the retained disable students (exemplars) to their classification (disabilities). It holds the family-resemblance of the exemplar which depends on the strength of relations of the features of that exemplar to its classification. It specifies to what extent an exemplar cover range of the category space. The summation of family-resemblance of all exemplars assigned to certain category is equal to one unit. Each exemplar share part of that cake. So the family-resemblance of an exemplar depends on that of brothers exemplars within the same category.
- The *Symptom-Disable Student* link relates a new presented disable student with its symptoms.
- The *Exemplar-Disable Student* link relates a new presented disable student to the most similar Exemplar (classified disable student). Both of them have the same classification.
- The *Symptom-Test* link holds strategic knowledge. It specifies how to apply certain tests on a newly presented disable student if he has a symptom.
- The *Exemplar-Activity* link holds strategic knowledge. It holds the method of executing certain activity or strategy.

V. AGENT PERFORMS DIAGNOSING

The proposed system performs diagnosing of disable students through heuristic classification of LDs and reasons under uncertainty. Its classification and reasoning performance are always tuned. It uses the presented disable student (problem) and closest-matching exemplar to generate a solution. This solution is validated through feedback and approval from the expert. The system incorporates expert classification with agent classification.

A. The Reasoning Process and Expert Diagnosing

In the first use of the system, an expert presents a disable student data to the system to be diagnosed; it performs reasoning through several steps, as shown in Fig. 2, Most of the steps done in the reasoning process, incorporate knowledge acquisition and learning with heuristic classification of LDs.

B. Agent Diagnosing Procedure

If the reminding list, in Fig. 2, is empty or if it is rejected at all by the expert, the agent will initiate expert-classification procedure, shown in Fig. 3, for acquiring diagnosing from the expert. It also acquires explanation of rejecting the reminded LDs's categories to prevent reoccurring of this failure. Then, it retrieves an exemplar from the knowledge base, and uses it as a model for matching with the new case. If the matching is not correct, it retrieves another exemplar from the same category or from next category in the reminded list.

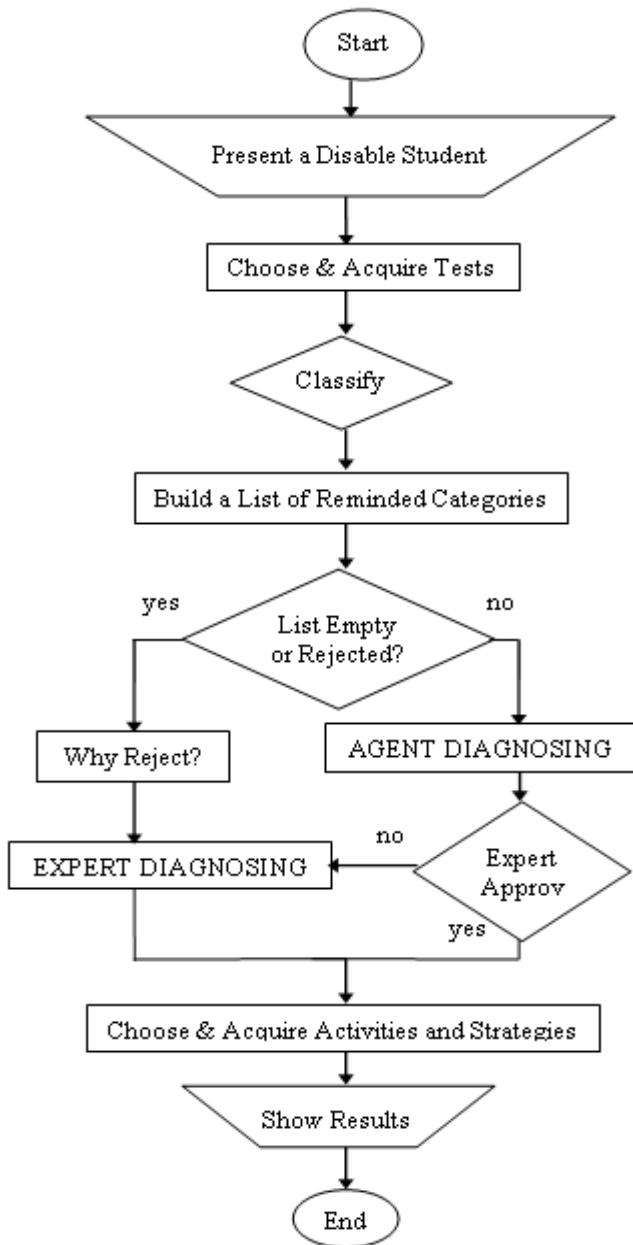


Fig.2. Reasoning Process Algorithm.

Looking for a matched exemplar is done by Knowledge-Based Pattern matching process. This process continues until one similar exemplar is found and approved by the expert or the agent fails to find a similar one. In this situation, the agent invokes Expert-Diagnosing procedure to get diagnosing from the expert.

C Knowledge-Based Pattern Matching

This is the most important module in the diagnosing process. Its function is to compare the symptoms of a new diagnosed disable student with exemplar symptoms, and to compute the matching ratio between the student and the

exemplar. The matching ratio is computed by accumulated the importance of all matched symptoms of the retrieved exemplar. This module incorporates learning with reasoning. It performs its process in two different phases; direct matching and indirect matching shown in Fig. 4.

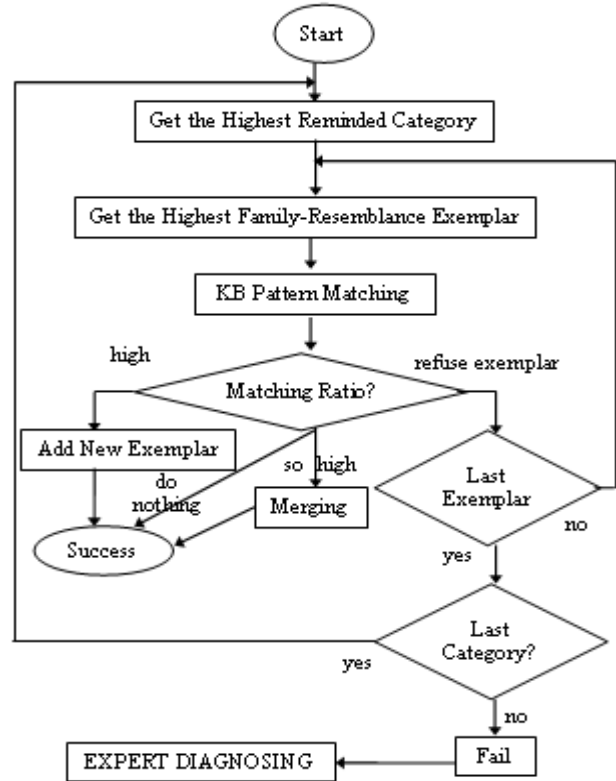


Fig.3. Agent Diagnosing Algorithm.

VI. CONCLUSIONS

The proposed systems is an agent based classification system that provides interactive aid in problem solving and acquires new domain knowledge by generalizing from training examples acquired through the normal course of its use. It performs diagnosing of disable students through heuristic classification under guidance of the domain expert. It demonstrates the viability of engaging the expert in a debugging style dialog, acquiring knowledge in the context of a running application. It performs classification and reasoning as a problem solving method to make use of specific past experiences rather than a corpus of general knowledge.

The system enables classroom teachers to get psycho pedagogical evaluation for student who has LDs. It also, provides teachers with the best educational activities for those students. It cooperates with teachers in a diagnostic evaluation practice. It incorporates the basic guidelines for general evaluation, and provides models of diagnostic tools and educational activities handling several weaknesses in psycho functional areas.

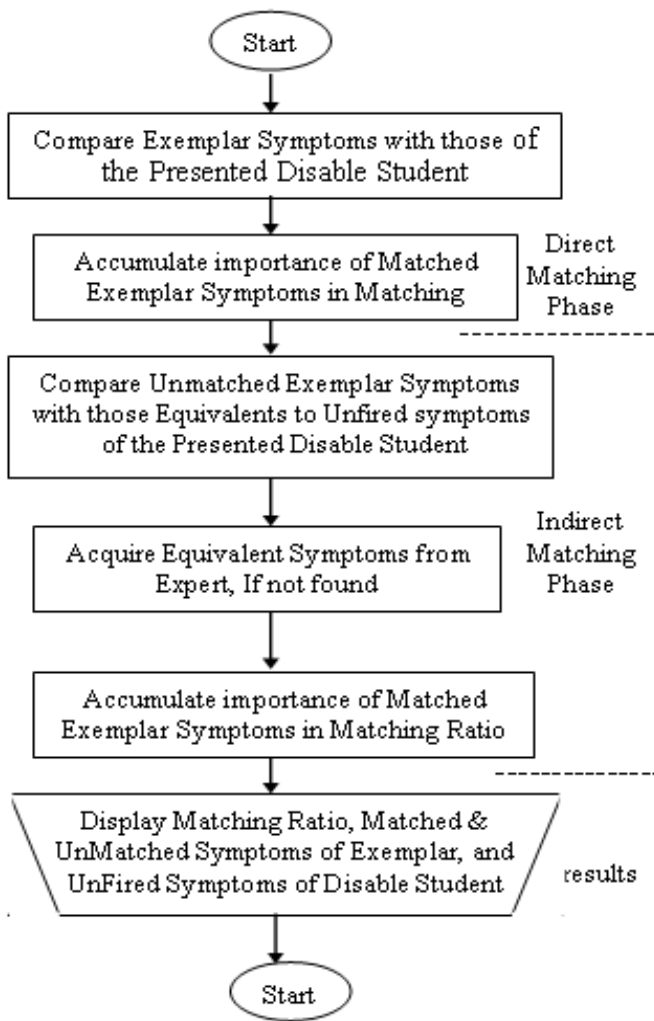


Fig.4. Block Diagram of Pattern Matching Process.

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