AN ADAPTABLE E-LEARNING SYSTEM FOR PUPILS WITH SPECIFIC LEARNING DIFFICULTIES

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ABSTRACT

The education of pupils with learning difficulties is very complicated due to great variety of their specific cognitive abilities and psychological factors. It requires the use of personalized learning facilities that can help achievement of their learning goals. For that reason we design an adaptable system for development of tools on the basis of suitable pedagogical methods and learning resources. The system provides facilities for adaptation of learning units to the learning profile of each pupil. The substantial elements of this adaptation technique are carried out by activities of the resource-developer. The paper presents an approach to a description of these activities supported by the adaptable system. The adaptation bases on reusable learning units that can be modified in correspondence with the learner's profile, learning context or scenario.

Index Terms – Learning difficulties, Cognitive abilities, Learning style, Adaptation, Personalisation, Reusable learning units

1. INTRODUCTION

There are many electronic educational systems but for the purposes of school education almost nothing has been done in this regard. Rarely as it may be, e-learning can be found in secondary schools. However teachers don't utilise modern ICT in primary school. Long ago children in kindergartens have been playing on computers, but this interesting "thing" is not set to work in educational process. The reason probably is the difficulty of creating appropriate educational products for young children, because their teaching requires not only a mechanical "dumping" of useful information and knowledge. The learning process is much more complex and includes structured presentation of the learning material in appropriate form and appearance consistent with age and background.

From another point of view, the education in primary school comes across other important problem – certain characteristics of the individuals might hamper them to acquire basic skills such as reading, writing, arithmetic. Many children still lag behind in this early stage of their education not because they are stupid or lazy (common labels), but because they have a special way of perceiving and processing information. These children do not receive teaching adequate to their abilities, the education system rejects them, and society loses specialists with valuable qualities simply because the school failed to discover and develop these qualities on time. Typical examples are children with dyslexia (dyscalculia, dysgraphia), with ADHS and ADS, even with autism.

2. PUPILS WITH LEARNING DIFFICULTIES

Dyslexia, dyscalculia, dysgraphia are disorders in the development of school skills, which are classified in the medical registers, though they are not diseases. The perceiving of environment signals and their processing in the brain shows a specificity that can lead to some distortion of the information and to confusion. For example, in contrast to other people the dyslexics think mostly in pictures [6]. Every thought, every idea and every emotion they "see" as a three-dimensional image in their minds. Consequently, they have problems with two-dimensional symbols and signs which have to be ordered or directed in a certain way to be deciphered correctly. Letters with the same graphical representation but different orientation are confounded (N and Z, b and d). Words without a picture image as prepositions or adverbs hamper them. Therefore, the so-called "cultural techniques" [3] – reading, writing, mathematical expressions are difficult to handle.

3. AN OPPORTUNITY FOR SPECIAL EDUCATION

According to state requirements such children should be integrated together with the others, but they need individual curricula, extra special trained teachers, etc. The aim is to achieve individualization in the teaching process, using pupil's strong skills and personal qualities, and through appropriate exercises to support and develop the weak ones.

That is why these pupils with specific learning (cognitive) difficulties need special education. It could be achieved by development of e-learning system [1] that has to ensure collaboration among all the professionals involved in teaching, generation and adaptation of learning facilities.

Psychological	Pedagogical	Technological
Early screening and identification of children with learning difficulties	Individual curricula, personal teaching assistant	Tool for generation of computerized psychological tests
Detection of cognitive abilities and psychological characteristics	Close collaboration among all professionals concerned with the problem	ICT-based tools allowing collaboration
Defining of psychological profile and learning style	Suggestions for appropriate pedagogical methods and formats: teaching methods arousing interest and catching attention; inducing an emotional connection to the learning matter; illustrative representation of learning units	Authoring tool enabling adaptation of learning resources and building personalized learning paths according to learner's preferences; Incorporation of various instruments for illustration (audio, video, simulation, 3D-modeling, etc.) contributing efficiency to education
Recommendations for learning environment (comfortable, without stress and frustration)	Relaxed and adaptable learning environment enabling to bestow various encouraging bonuses (music, videos, games, etc.)	ICT-based adaptable user-friendly environment (intuitive, language independent, allowing tuning and contextualization)

Table 1 Technological tools meeting psychological and pedagogical requirements for education of pupils with learning difficulties

Table 1 gives an overview of the psychological, pedagogical and technological requirements for the education of pupils with specific learning difficulties.

4. CONCEPTUAL MODEL OF AN ADAPTABLE E-LEARNING SYSTEM

The development of personalized e-learning facilities requires design of adaptable e-learning system that supports production and delivery of learning resources. We suggest a conceptual model of such adaptable e-learning system shown on Figure 1.

The basic elements in this model are the learner's profile, the pedagogical aspects, the resulting pedagogical format and the appropriate learning units.

4.1. The learner's profile

The learner's profile represents cognitive abilities and psychological characteristics. It defines a learning style and appropriate pedagogical methods and tools. The determination of the cognitive abilities depends on the following important characteristics, which are derived during psychological testing:

- Memorizing (short term and long term memory),
- Attention,
- Concentration,
- Absorption capacity,
- Observing ability,
- Working capacity,
- Orientation, Coordination, Balance,
- Motor functions (fine motor skills),
- Communication skills,
- Handling abstract terms and symbols,
- Way of thinking – in terms ("sequential") / in pictures ("quasi parallel").

Some significant psychological features that have influence on the learning process are *self-assessment, imagination, patience, excitability* and *emotionality*. All these characteristics could be easily assessed by computerized psychological tests. They should be in the form of amusing games or entertaining tasks in order to prevent stress and frustration, so that children could do their best. The results and indicators are the basis for the psychological profile of the pupil. This profile determines the teaching style, methods and tools which serve to arrange and to accomplish the education process in the most appropriate way.

4.2. The pedagogical room

The pedagogical room consists of pedagogical methods and pedagogical tools that are in correspondence with the learning style. The most commonly used pedagogical methods are:

- Informational – the teaching is performed using "instructions". Key elements of this method are the messages and the symbols.
- Phenomenological – the knowledge is build up as an event. It is accepted and absorbed through senses and emotions [7].
- Collaborative – this method is connected with the socio-cultural environment. Thus knowledge and skills are formed in a family, in a class, communities, societies, ethnic groups, etc. The knowledge and the skills are "passed over", the experience is shared. Games are typical example of this educational approach.

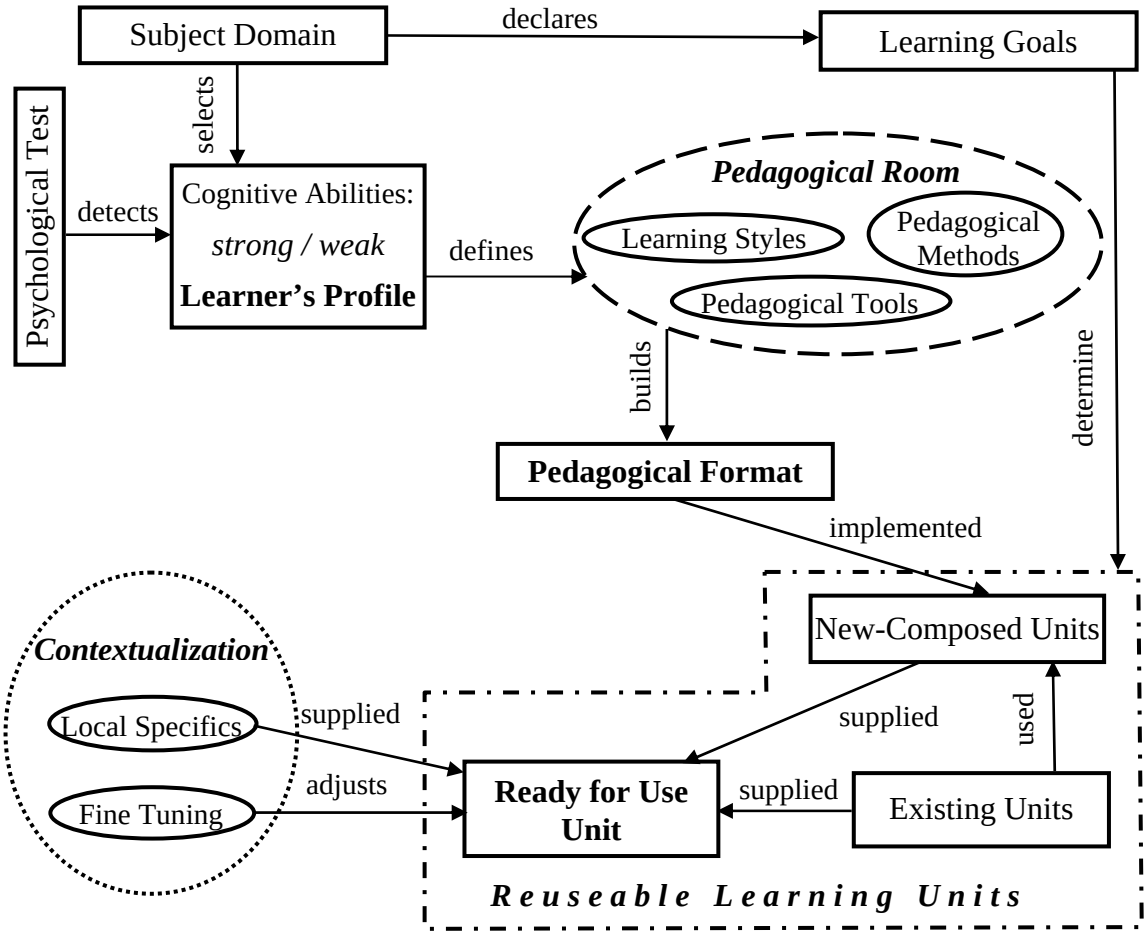

Figure 1 Conceptual model of an adaptable e-learning system

Children with dyslexia are predisposed to learn mostly by the phenomenological method as they can observe the action and get a real idea of the phenomenon. At the same time they can form an emotional connection with the subject matter, which helps focusing attention and supports the memorizing.

4.3. The pedagogical format

The pedagogical format describes the way of knowledge presentation in the learning units. It is built on the basis of the selected pedagogical methods and tools in compliance with pupils' learning style.

4.4. The learning units

The system allows access to learning units stored in databases or repositories. These resources can be modified, adapted and reused in a process of composition of new learning units according to the given pedagogical format [5].

According to the Figure 1, the psychological test detects the strong and week points of cognitive abilities that have to be underlined in the learner's profile. Subject domain contains knowledge about the learning subject(s) (reading, writing, language, mathematics, etc.). It gives the criteria for selecting the appropriate personal features from the learner's profile. On that basis the learning style is determined and the pedagogical methods and tools are chosen. As above mentioned, those are the factors for building the pedagogical format. The latter serves as a frame for composing learning units. The activities regarding constructing of pedagogical formats and learning units are supported by the ICT-based authoring tool. Considering the methodological recommendations and employing the authoring tool, teachers create new learning units, reuse the existing ones or edit, update them and save for future application. Each learning unit done according to the above described procedure is contextualized with regard to the local specifics and learner's preferences. Thus, the composed unit is ready for use.

5. FUNCTIONAL MODEL OF THE E-LEARNING SYSTEM

The functional model of e-learning system can be represented as composed of three parts [4] – the users, the ICT platform and their interactions (Figure 2). Some essential characteristics of the system are:

- To have sufficient technical tools in order to meet the requirements for diverse presentations of the learning matters including sounds, pictures, movies, clips, animations etc.

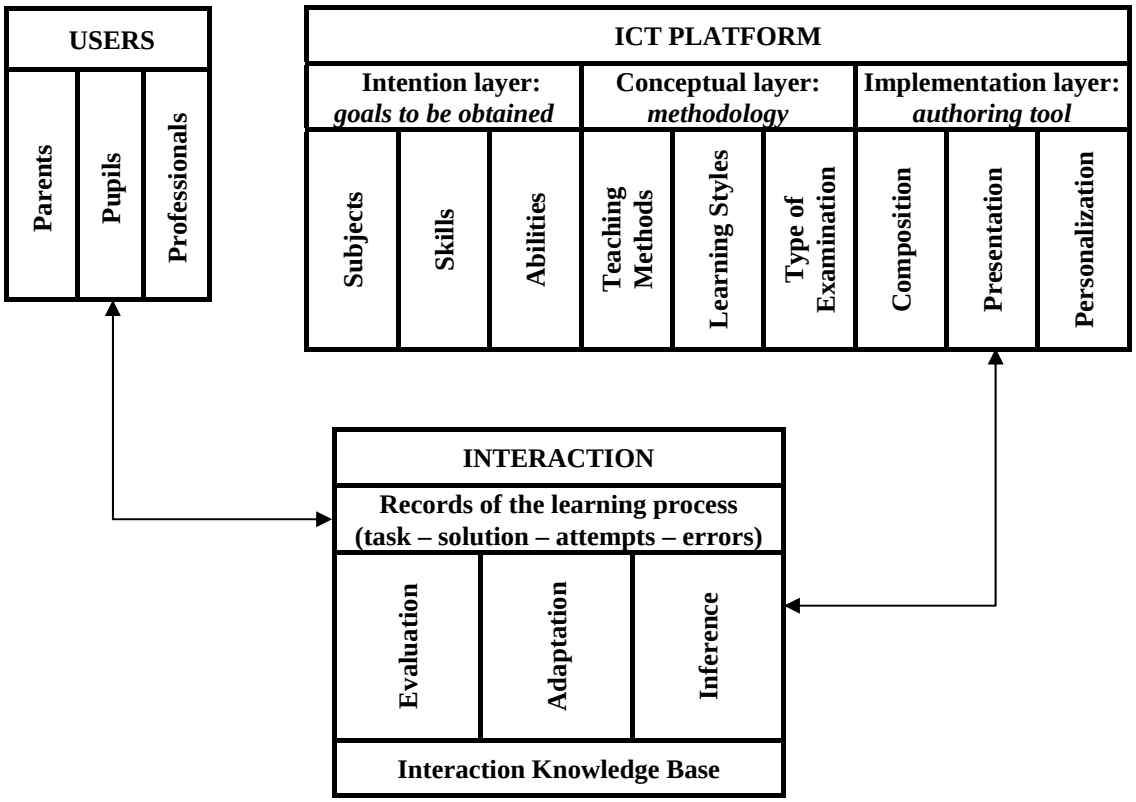

Figure 2 Functional model of the presented e-learning system

- To allow access to appropriate tools for modelling and design of 3D objects.
- To maintain data bases that contain learning resources – learning units, learning facilities.
- To have user friendly design.
- To be flexible and adaptable.

5.1. Users

Among the above mentioned essentials, such a system must have very specific features and characteristics that meet the requirements and perform functions of different types of users:

1. **P**rofessionals (psychologists, pedagogues – methodologists, teachers and speech therapists),
2. **P**upils,
3. **P**arents.

These types of users (**PPP**) exploit the facilities of the system in different ways and in different capacity and therefore they obtain different access rights.

Pupils have access only to learning materials and to some games and entertainment, which they receive as bonuses and rewards in order to be stimulated to deal with the material. It should be noted that the stimulus should only be positive; i.e. there shouldn't be penalties.

Parents have access to the learning outcomes of their children and in case they could support children in their training. Also they can share ideas, impressions and experiences in parental forums. They can seek advices about problems concerning the children's training from the professionals.

Professionals have greater access rights to the system. On the one hand, they must monitor the training process in order to record and analyse the mastering of learning material. Future steps in the learning path are determined by these records and analysis (adaptation). On the other hand, they also participate in the forums – both professional and popular. In the first case they share their problems, ideas, solutions, tips, experiences, arrange conferences. In the latter case, they give advices and suggestions at "common level" in communication with parents, who generally are not experts in the matter.

5.2. ICT platform

The ICT platform consists of three layers – intentional, conceptual and implementation. The *intention layer* presents learning goals that have to be achieved and are built-in parameters of the e-learning system. Those specify the knowledge, skills and abilities (in one or several subjects) that must be acquired, in compliance with the government regulations.

The possible approaches to attain the learning goals are presented in the *conceptual layer*. According to the personal profile of the child the appropriate pedagogical method(s) are selected and

implemented so as to achieve the learning goals efficiently. Furthermore, this profile serves for determination of the learning style and gives guidelines for the choice of relevant modes and forms of the examination. The latter shouldn't be distressful and upsetting, but motivating the pupils to do their best.

Methodologists consider motivation and learner's activity as the most important elements for successful learning strategy. In order to awake the children's activity it is necessary to engage them in the learning process, which could be done best through the emotional connection with the learning matter. Motivation can be provoked by presenting the subject clearly and precisely so as to be understood and absorbed quickly enough. Thus the accomplishment of learning tasks with noticeable results forces the motivation and heightens the self-esteem and self-confidence of the child.

The *implementation layer* includes diverse instruments that serve to gain the learning objectives identified in the intention layer. Modern technologies provide a huge range of capabilities to assist to the full extent the creation of learning units using different pedagogical formats. The latter are implemented by the specially designed authoring tool.

Professionals use this authoring tool to compose learning resources. It supports various functions – development, structuring, reusing and adaptation of learning units, so as to carry out different learning courses and scenarios. In order to meet the necessities of the pupils, determined by their individual cognitive characteristics, the authoring tool must allow adaptation of learning units, regarding the following aspects:

- Volume,
- Presentation (through different types of media – illustrations, simulations),
- Contextualization:
  - Content Localization – language, custom, traditions, etc.,
  - Fine Tuning – font, colour, size; etc.

5.3. Interaction

The interaction part of the system contains a database for every child's reactions (assigned tasks, provided solutions, performed attempts, made errors). On this basis, the professionals can determine the level of the acquired knowledge and infer how to continue the learning path. Besides the above mentioned the system provides opportunities to exchange information – opinions, ideas, plans, experiences, tips – between the different type of users on the one hand and among peers on the other. Therefore the professionals outline and arrange guidelines for both the further development and assembling of learning units and any necessary adaptations to the specific needs of the pupils.

6. AN EXAMPLE

The children with dyslexia (one of the common learning difficulties) need visual representation of every single conception in order to understand its meaning. That is why they have difficulty with prepositions, adverbs and similar words. Therefore a phenomenological approach is applied for solving such problems. The Davis' method [2] is based on this technique. It recommends following steps:

- clear and precise explanation of the selected word;
- helping pupils to use this word in examples;
- motivating them to construct model(s), representing their idea of the word.

The models could be either hand-made of plasticine (clay), or formed using ICT-based tools (e.g. Google SketchUp 6, TopMod3d, etc.). In addition the modelled word has to be written. In this way the child obtains an integral idea of the word: meaning, image and spelling and is able to understand and use it properly. The example on Figure 3 shows the process of building the conception of the adverb "backwards".

Figure 3 "Backwards"

The child's explanation was: "Four balls plus one ball make five balls; '*Backwards*' means the opposite action".

7. CONCLUSIONS

The presented e-learning system exploits effectively ICT for gaining better educational results for all pupils. Obviously, pupils with learning difficulties have characteristics and perceptions that distinguish them from the other pupils. These differences vary in some extent and cause specific knowledge processing. For that reason such pupils demand personalized education. It should be adapted to their individual cognitive abilities and corresponding learning style. This approach is of benefit for all the children as well, but it is crucial for these with learning difficulties as dyslexics.

On the other hand, the composition and adaptation of learning units for learners who need

special education is very complicated and fatigue process, which requires additional teachers' abilities. Hence ICT-based authoring tools are badly needed and of vital importance nowadays. That is the reason for developing a system that integrates ICT tools for:

- Collaboration between professionals,
- Facilities supporting the learning process,
- Creation, reusing and adaptation of learning units.

Furthermore, the system performs a technique for personalisation of learning units in correspondence with the learners' profile of each pupil. All this activities integrated in such a system not only make easier and optimize the teachers' work, but contribute to achieving efficient learning process.

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