International Journal of Engineering Education Vol. 28, No. 6, pp. 1366–1372, 2012
Printed in Great Britain

0949-149X/91 $3.00+0.00

Artificial Intelligence in Special Education: A Decade Review*

ATHANASIOS S. DRIGAS and RODI-ELENI IOANNIDOU
N.C.S.R. Demokritos, Institute of Informatics and Telecommunications, Telecoms Lab—Net Media Lab,
Ag. Paraskevi, 15310, Athens, Greece. E-mail: dr@iit.demokritos.gr, elena.ioan@hotmail.com

Artificial Intelligence (AI) technology has developed computer tools for carrying out a number of tasks, simulating the intelligent way of problem solving by humans. AI techniques have also been identified as one of the most valuable applications in the field of special educational needs (SEN). The goal of these tools is to enhance the way children interact with their environment to promote learning and to enrich their daily life. Due to the implicit characteristics of special educational needs, the diagnosis has been an issue of major importance. At the same time intervention strategies need to be highly individualized to be effective. In this report we introduce some of the most representative studies over the last decade (2001–2010), which use AI methods in making accurate diagnosis and prompt intervention action.

Keywords: artificial intelligence; special educational needs; diagnosis; intervention

1. Introduction

The steady progress in the area of technology has devolved computing power into many aspects of our daily life. Across the educational sector there has been an increased trend to increase the accessibility of education. A large volume of research is currently addressing the use of computers in education in order to develop learning environments, which support the learning process in different settings [1]. Several years ago various researchers and specialists of computing science have started to study the implementation of Artificial Intelligence techniques in education.

Artificial Intelligence (AI) has been an active area of research for over fifty years [2]. It is usually defined as the study and development of intelligence agents that can perceive their environment and take actions that increase their possibilities of success [3]. Artificial intelligence agents can be either in a physical form of the device (e.g. humanoid robots) or in software form with 'intellectual' capacity (e.g. a virtual avatar). The nature of technology has changed since a few years later Artificial Intelligence in Education (AIE) was conceptualized as separate research community. AI techniques in education were claimed to create powerful learning environments and to increase positive interactive experiences for all students. Some of the most typical AI applications in the educational field involve knowledge representation, intelligent tutoring, natural language processing, autonomous agents etc.

The benefits of A.I. in education have been acknowledged for many years. However, during the previous decade's one of the research communities of Artificial Intelligence in Education deals with the intersection of A.I. and Special Education [4]. The benefits of AI techniques have been gradually used to improve the life of those people with special educational needs.

The field of 'Special Educational Needs' covers a large number of difficulties which can cause problems during the learning process. Even though various terms of special educational needs have been presented during the past years, experts in this field have not yet completely reach an agreement. Terms like 'Learning Difficulties' or 'Learning Disabilities' are also widely used [5]. Our scoping study drew upon the various national and international publications and we decided to use the definition of the 2001 Special Educational Needs Code of Practice, as a framework for organizing the literature under a manageable number of headings. According to the 2001 SEN Code of Practice the areas of needs are: Communication and Interaction, Cognition and Learning, Behavior and Emotional and Social Development, Sensory and/or Physical [6]. Moreover, the Code of Practice highlights the fact that not all children will progress at the same rate and that each child is an individual, with different strengths and needs. It is then necessary to understand and model learners and the settings where they interact in a way that enable us to develop and evaluate technology to most efficiently support learning across multiple contexts, subjects and time [7].

Recent development in the area of Artificial Intelligence and Special Education may enable development of collaborative interactive environments and facilitate the life of individuals with special educational needs and the people around them. Our goal in this paper is to explore the

* Accepted 27 July 2012.

potential of the most representative of AI applications of the last decade. The studies that will be presented in the following sections deal with diagnostic and intervention tools of some of the most common learning difficulties. These proposed models can be used from teachers, special educators, psychologists, therapists and parents as well. Due to the implicit characteristics of learning difficulties, their high similarities and comorbidity of their symptoms, AI assessment tools may be one way to improve the teacher or parent capabilities when evaluating the child. These tools can help them observe the child's academic level and if necessary they will consider taking appropriate decisions to advise a specialist if there is any difficulty. AI training interventions are an important part of the education of children of special educational needs since they are able to integrate the freedom of action of the student with a more explicit control and guide [8]. This paper will introduce diagnostic and intervention tools developed in the last decade for every one of the following categories

2. Sensory and/or physical impairments

Learners with long-term or more complex physical impairments require educational services that will help them to maintain their independence and well-being, and to lead as fulfilling a life as possible. In most cases physical and sensory impairments are assessed from doctors during the first years of their lives. This is why AI applications concerning parents and teachers mostly aim at training students rather than diagnosing their needs.

Georgopoulos et al., 2003 presented a fuzzy cognitive map approach for differential diagnosis of specific language impairment (SLI). Fuzzy cognitive maps are a soft computing methodology that uses a symbolic representation for the description and modeling of complex systems. The aim of this tool is to provide the specialists with a differential diagnosis of SLI from dyslexia and autism, since in many cases SLI is difficult to be discerned due to its similar symptoms to other disorders. The system has been tested on four clinical cases with promising results [9].

In the same year Schipor et al., (2003) attempted to create a Computer Based Speech Therapy (CBST) system using a fuzzy expert system for helping learners with speech disorders. The aim of this approach was to suggest optimal therapeutic actions for every pupil based on the information selected, so they designed an improved CBST system, called LOGOMON (Logopedics Monitor) and developed its classical architecture with a fuzzy expert system based on forward chaining. The role of the expert system was to store the precise evolution and progress of each child and adapt the exercises to each child's current level and progress. The validation of LOGOMON was performed by a three month experiment which involved two equivalent children groups, taken from the Regional Speech Therapy Center of Suceava in Romania. The first group used LOGOMON, but the expert system was deactivated and all therapeutically decisions were taken only by the speech therapist. The second group used LOGOMON with inference facilities, so that, a part of therapeutically decisions was provided by expert system and the other one was provided by speech therapist. The results indicated no significant difference between the two groups. However, there were other advantages using the expert system such as more therapy time, predictability and the explanation of results [10].

Pavlopoulos et al., (2008) implemented a neural network approach for the self-assessment for the learners, optimized with the aid of Genetic Programming. The purpose of this method is to assess the user's answers from both single and multiple questions in an e-learning environment. Test data of this application evaluate the answers against the five areas of learning: grammar/sentence structure, reading, writing, letter recognition and alphabetical order, spelling/vocabulary. The implementation of the Genetic Programming Neural Network (GPNN) methodology for e-learning purposes is effective for all students who exhibit difficulties in the above areas but can be specifically appropriate for individuals with physical or sensory impairments. This platform was applied and evaluated successfully the user's answers, while the generalization of the assessment process could later lead to the development of an intelligent e-tutor [11].

In 2008 Drigas et al., presented 'Dedalos' project which deals with the teaching of the English language as a second language to hearing impaired people, whose mother language is the Greek sign language. In an educational e-content adapted to the needs of every user, the whole procedure consists of audits and evaluation of the linguistic abilities of the e-learners. The system uses an intelligence taxonomy system which is developed for the evaluation of the pupil and the setting of pedagogic material. The approach promotes a complete support system for the education of hearing impaired Greek students while at the same time opens the way for their inclusion [12].

3. Learners with Autistic Spectrum Disorders

Autism Spectrum Disorder (ASD) is a pervasive developmental disorder characterized by the 'triad' of impairments. Children with ASD exhibit impairments in social skills, language and communication skills and a tendency towards repetitive patterns of interest and behavior [13]. AI techniques can facilitate early intervention and provide specialists with robust tools indicating the person's autism spectrum disorder level.

In 2006 Sebe et al., implemented an emotion recognition computerized tool based on joint visual and audio cues. This human-computer interaction application besides the 6 universal emotions (happy, surprise, angry, disgust, fear and sad) is able to recognize other affective states such as interest, boredom, confusion and frustration. It can be used from all children but it can be very affective in children with speech problems as well as in training children with ASD since they display difficulties understanding other people's emotion. This approach analyzes 11 affective states, on 38 subjects by applying Bayesian Networks for bimodal fusion. In addition, a variable is integrated into a Bayesian Network which indicates whether the user is speaking or not. Once the model is fitted, head motion and local deformations of the facial features such as the eyebrows, eyelids, and mouth can be tracked. The recovered motions are shown in terms of magnitudes of some predefined motion of various facial characteristics. This system was tested on 38 graduate and undergraduate students in various fields. The results indicated that emotion recognition accuracy is greatly improved when both visual and audio information are applied in classification [14].

In 2007 Riedl et al, designed a platform which can aid adolescents with High Functioning Autistic Spectrum Disorders (HFASD) rehearse and learn social skills with reduced help from parents, teachers, and therapists. A social scenario game is presented— for example going to a movie theater-which challenges learners with HFASD to role-play and complete tasks involving social situations. Artificial Intelligence is used to assist the above groups with the authoring of tailored social scenarios. An A.I. system automatically examines the causal form of the narrative plan, searching for points at which a student's actions can undo causal relationships. The alternative narrative scenario is a branch developed for handling the contingency of the learner's action. This Artificial Intelligence tool embed in this particular platform decreases the manual authoring burden where application of intervention strategies can be handled by specialists. This social scenario intervention approach is complete and currently undergoing evaluation with promising results [15].

Arthi and Tamilarasi (2008) introduced a model which helps in the diagnosis of autism in children by applying Artificial Neural Networks (ANN) technique. The model converts the original autistic data into suitable fuzzy membership values and these are given as input to the neural network architecture. Moreover, a pseudo algorithm is created for applying back propagation algorithm in predicting the autistic disorder. This approach is proposed to support apart from medical practitioners, psychologists and special educators who are involved is assessing children. Experimental results indicated an 85–90% accuracy of this method. In future the autistic disorder could be predicted using k-nearest neighbor algorithm for a comparative research [16].

4. Learners with reading, writing and spelling difficulties

Within a classroom there is an incredible spread in reading, writing and spelling abilities among the pupils [17, 18]. Each and every student requires support at their own level and for their own specific needs. These kinds of problems tend to be diagnosed when children reach scholar age. In most institutions there are not specialist staff in learning difficulties, it is then desirable that teachers have access in some diagnostic and intervention tools to better care of the students' problems.

Srihari et al., (2008) presented two computational method of automatic scoring of short handwritten essays in reading comprehension tests. The aim of this system is to assign to each handwritten response a score which is comparable to that of a human scorer. This tool has to contend with not only the standard difficulties of recognizing handwriting but also the writing skills of children. Assessing reading comprehension tests will not only allow timely feedback to students but also can provide feedback to education researchers, parents and teachers. In this study two systems are described. The first is based on latent semantic analysis (LSA), which needs a reasonable level of handwriting recognition performance. The second developed an artificial neural network (ANN) which is based on features collected from the handwriting image. Both systems were trained and evaluated using a test-bed of essays written in response to prompts in statewide reading comprehension tests and scored by humans. Even though there were observed errors in word recognition during the evaluation of this platform scoring performance still remains a promising tool [19].

Jain et al., (2009) proposed a model called Perceptron based Learning Disability Detector (PLEDDOR). It is an artificial neural network model for identifying difficulties in reading (dyslexia), in writing (dysgraphia) and in mathematics (dyscalculia) using curriculum based test conducted by special educators. This computational diagnostic tool consists of a single input layer with eleven units that correspond to different sections of a conventional test and one output unit. The system was tested on 240 children collected from schools and hospitals in India and was evaluated as simple and easy to replicate in huge volumes, but provides comparable results based on accepted detection measures [20].

Hernández et al., (2009) introduced SEDA ('Sistema Experto de Dificultades para el Aprendizaje' or 'Expert System for Learning Difficulties' in English) a diagnostic tool for Learning Difficulties in children's basic education. It is developed using the Expert Systems design methodologies which include a knowledge base consisting of a series of strategies for Psycopedagogy evaluation; trying to identify the relationships between input variables (e.g. age, sex, educational level, reading, perception, understanding) and the output systems (psychomotor aspect, intellectual aspect, perceptual aspect, language aspect, personal aspect). All of the above provides the expert system's users the possibility of acknowledge the psychological profile of the pupil. 80% of the evaluators rated the system as Efficient using an estimation scale of: Poor, Moderately Efficient and Efficient [21, 22].

In 2010 Baschera and Gross introduced an adaptive spelling training system which can be used from all students who exhibit spelling difficulties. This platform is based on an inference algorithm designed to manage unclassified input with multiple errors defined by independent mal-rules. The inference algorithm based on a Poisson regression with a linear link function, estimates the pupil's difficulties with each individual mal-rule, based on the observed error behavior. This knowledge representation was implemented in a student model for spelling training such as optimized word selection and lessons for individual mal-rules to pupil adjusted repetition of erroneously spelled words. This system was tested on a two large-scale user studies and showed an important increase in the learner's performance, induced by the student adapted training actions [23].

5. Learners with dyslexia

Dyslexia is one of the most common and most studied cases of Developmental Disorders causing troubles in literacy and especially in reading, writing and spelling. It is neurologically based and lifelong condition [24]. Diagnosing dyslexia is a complex process that depends on many different indicators. Even though applying artificial intelligence techniques for identifying dyslexia can be a complex procedure, the preliminary results of recent studies are satisfactory and open new ways in the field of diagnosis.

In the same year Palacios et al., presented a rule-based classifier for the diagnosis of dyslexia with low quality data with genetic fuzzy systems in early childhood. It can be used by parents and school staff for detecting those symptoms that will suggest taking the child to a specialist for a more thorough examination. This application consists of a fuzzy rule based system (FRBS), whose knowledge base is to be obtained from a sample of data by means of a genetic cooperative-competitive algorithm (GCCL). The FRBS includes collected data from 65 schoolchildren in Spain whose answers were comprised to graphical tests (e.g. BENDER, ABC) while the output variable for each dataset is a subset of labels; no dyslexic, control and revision, dyslexic, inattention/hyperactivity or other problems. This genetic fuzzy system can operate with the above low quality data and provide us the appropriate results for determining whether the student should visit an expert. The experimental results indicated that the FRBS from low quality data can provide the unqualified personnel with a diagnosis. However the percentage of misclassifications was high and future improvements need to be made [25, 26].

Kohli et al., (2010) introduced a systematic approach for identification of dyslexia at an early stage by using artificial neural networks (ANN). This approach is amongst the first attempts which have been made for addressing the dyslexia identification problems with the use of ANN. Moreover, it can be distinguished from other platforms of its kind because it is based on test data, covering the evaluation results of potential dyslexic pupils, between the years 2003– 2007. These test data consist of the input data of the system while the output results classify the students in two categories (dyslexic and non-dyslexic). An error back-propagation algorithm is responsible for mapping college performance to the underlying characteristics. The initial results obtained using test data were fairly accurate and suggest the application of this platform to real data as well [27].

6. Learners with difficulties in mathematics

Mathematical skills are essential to all students and they are also a subject where many students display various difficulties. During the latest years methods and techniques of artificial intelligence were developed to assess the mathematical level of pupils and to also help them acquire specifics skills [28].

Melis et al., (2001) introduced ActiveMath, a web-based intelligent tutoring system for mathematics. ActiveMath is an Intelligence Tutoring System (ITS), which allows the students to learn in their own environment whenever it is convenient for them. It uses a number of Artificial Intelligence techniques to realize adaptive course generation, student modeling, feedback, interactive exercises and a knowledge representation which is appropriate for the semantic Web. In ActiveMath the user starts his/her own student model by self-assessment of his/her mastering level of concepts and later chooses learning goals and scenario, for instance, the preparation for an exam. The capabilities of the student are adapted in course generation and in the suggestion mechanism as well. Moreover, a 'poor man's eye-tracker' is designed which is able to trace child's attention and reading time in detail. This application has reported many positive outcomes in the following years by a large number of studies, all of them supporting the effect of this ITS during the learning process [29–31].

Livne et al., (2007) implemented an online parsing system that automatically assesses students' constructed responses to mathematics questions, based on the errors in each response. A parser is the basic element of a free college readiness website in mathematics. During learning sessions, users are asked to provide constructed answers to mathematical questions. The parser analyzes the students' answers, gives immediate feedback on their errors and provides accurate partial-credit scoring as well. This tool apart from providing a good match to human grader scoring, it reflects the overall response and it also distinguishes the types of errors into two types: conceptual and computational. The parser clearly illustrates that natural languages and artificial intelligence principles can be applied successfully to detect student error patterns. Overall, the system's total scoring closely matched human scoring, but the parser was found to surpass humans in systematically distinguishing between students' error patterns [32].

Anthony et al., (2008) designed an Intelligent Tutoring System (ITS) for students learning algebra equation-solving. Algebra is one of the subjects in which students display several difficulties. This platform aims at improving student performance via ITSs that accept natural handwriting input. The type of ITS used in this method is known as 'Cognitive Tutors', who pose authentic problems to students and give emphasis to learn-by-doing. In Cognitive Tutor Algebra, students represent a given scenario, graph functions and solve equation while the tutor provides help and feedback. A Freehand Formula Entry System recognizer is also used, which has been trained from data derived from over 40 high school and middle school algebra students. Results from this study showed benefits for general usability and for learning. In addition, this platform is likely to generalize to other types of mathematics and to other levels of learners [33].

Gonzalez et al, (2010) designed an automatic platform for the detection and analysis of errors in mathematical problems to support the personalized feedback of pupils. This method is referred to all students and particularly to students with special educational needs such as those with Down syndrome, who exhibit difficulties in the arithmetic operations of addition and subtraction. An error detection algorithm was developed which is able to analyze the data gathered as a result of the interaction between the students and the platform, while afterwards the output of the error is available to the teachers about the specific difficulties and to allow them to personalize the instruction. Moreover, they designed a model which returns the set of errors made by the pupils in the corrected exercises so as the students can learn from their own mistakes. The system was tested on a group of students with Down syndrome and the results confirm that the module exhibits the proper behavior [34].

7. Attention Deficit Hyperactivity Disorder (ADHD) and Attention Deficit Disorder (ADD) learners

The terms ADHD and ADD refer to a wide range of difficulties that become apparent at some stage during the developmental period in a child's life. They are usually characterized by a set of behavior problems of inattention, hyperactivity and impulsivity or their combination. These problems usually show up in early childhood and more specifically they should be present before the age of seven in order for a diagnosis to be made [35, 36]. The use of artificial intelligence applications has offered some improved diagnostic and intervention tools of these behavior difficulties.

In 2004 Rebolledo-Mendez and Freitas presented the NeuroSky MindSet (MS) which is able to detect attention levels in an assessment exercise by combining performance data with user-generated data, taken from interaction. NeuroSky consists of a headset with three electrodes, which are put beneath the ears and on the forehead. The electrical signals read at the above locations are used as inputs by NeuroSky's algorithms to assess the attention levels. An A.I. driven avatar was also designed to pose questions and have limited conversation with the users. It is a low-cost, non-clinical and easy to use tool designed for leisure. This model was tested on first-year undergraduate students in the following years and the results indicated that there is a positive relation between measured and self-reported levels of attention [37, 38].

Aguilar et al., (2006) designed a fuzzy instructional planner, which models the tutor module in an intelligent tutorial system (ITS). It is an interactive instructional method which uses a combination of text, graphics, sound and video in the learning procedure. It is especially useful for students who have with ADHD or attention difficulties as well as in distance learning situations. The fuzzy instructional planner consists of a rule base, an inference, a fuzzification interface and a defuzzification interface. The aim of this system is to mimic the behavior of the teacher able to manage learning process satisfactorily. The input information is derived from human expert who supplied linguistic information. The ITS is a flexible system which adapts the teacher's rules to the student's performance and it has been shown useful in several applications with promising results [39].

Anuradha et al., (2010) developed a platform for a more accurate and less time consuming diagnosis of Attention Deficit Hyperactivity Disorder (ADHD). They used one well-known Artificial Intelligence technique, the SVM algorithm. According to the authors, this is the first attempt at identifying ADHD using SVM algorithm. Support vector machines (SVMs) are a set supervised learning techniques suitable for classification and regression. A data-set which was verified by a doctor including the results of a questionnaire used by the doctors to diagnose the disorder was given to the SVM module. After that the data-set was introduced and afterwards returned to the SVM module, which finally provides us with the diagnosis. The most important advantage of applying the SVM algorithm is that it can control the complexity of the diagnostic process. This method was tested on children between the ages six to eleven years old and the results indicated a percentage of 88,674% success in diagnosing [40].

In the same year Delavarian et al., (2010) introduced a decision support system to distinguish children with ADHD from other similar children behavioral disorders such as depression, anxiety, comorbid depression and anxiety and conduct disorder based on the signs and symptoms. A differential diagnosis of the above mentioned behavioral disorders is of major importance and practically difficult due to their similarities and comorbidity of their symptoms. This tool was initially developed in assisting psychiatrists but it can also be used in schools for a more specific examination of high-risk students. For designing the decision support system two types of neural networks were compared: radial basis function (RBF) and multilayer perceptron (MLP) neural networks. The system was trained and validated to assist the diagnosis of the disorders. The system was tested on 294 children of 12 elementary schools. The classification by MLP networks achieved 95.50% while the RBF classifier reached 96.62%. The limited number of diagnostic errors compared to the errors done by specialists indicated a system that can work as a reliable and valid tool for ADHD assessment [41].

8. Conclusions

During the last decade an important number of studies are currently addressing the use of Artificial Intelligence systems in the education of students with special educational needs. This paper drew upon the most representative studies that try to solve major issues in diagnosis and intervention of specific difficulties. AI application tools have successfully been applied to solve problems in the field of special education. Based on the studies presented in this work, it was concluded that there is a need to support teachers, parents and therapists in the appropriate care to students with special educational needs, particularly in assessment and treatment methods. Saving time and cost, gaining more therapy time, increasing the early diagnosis and intervention efficiency by creating more efficient learning environments are some major advantages that AI computational tools offers us. However, the issues to be covered in special education are still plenty due to the wide range of difficulties and the various needs of every individual. Further research across all types of learning difficulties and nationally regulated adaptations of diagnostic tools have to be resolved in order to relieve teachers and parents workload. Nevertheless, artificial intelligence has been considered as a promising educational aiding tool for all children who call for an embracing and cooperative approach to service delivery.

References

1. L. Nanni and A. Lumini, Ensemble generation and feature selection for the identification of students with learning disabilities, *Expert Systems with Applications*, **36**, 2008, pp. 3896–3900.
2. B. G. Buchanan, A very brief history of artificial intelligence, *Artificial Intelligence Magazine,* 25th anniversary issue, 2005, pp. 53–60.
3. S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach* (2nd ed.), New Jersey, 2003.
4. T. K. Wu, Y. R. Meng and S. C. Huang, Application of Artificial Neural Network to the Identification of Students with Learning Disabilities, *International Conference on Artificial Intelligence*, 2006, pp. 162–168.
5. J. M. Fletcher, W. Coulter, D. J. Reschly and S. Vaughn, Alternative approach to the definition and identification of learning disabilities: some questions and answers, *Annals of dyslexia*, **54**(2), 2004, pp. 304–331.
6. Department for Education and Skills, *Special Educational Needs Code of Practice*, London: DfES, 2001.
7. J. Brodin, Can ICT give children with disabilities equal opportunities in school? *Improving Schools*, **13**(1), 2010, pp. 99–112.
8. R. Lanzilotti and T. Roselli, An Experimental Evaluation of Logiocando, an Intelligent Tutoring Hypermedia System, *International Journal of Artificial Intelligence in Education*, **17**, 2007, pp. 41–56.
9. V. C. Georgopoulos, G. A. Malandraki, C. D. Stylios, A fuzzy cognitive map approach to differential diagnosis of

specific language impairment. *Artificial Intelligence in Medicine*, **29**, 2003, pp. 261–278.
10. O. A. Schipor, S. G. Pentiuc and M. D. Schipor, Improving computer based speech therapy using a fuzzy expert system. *Computing and Informatics*, **22**, 2003, pp. 1001–1016.
11. J. Pavlopoulos, J. Vrettaros, G. Vouros and A. S. Drigas, The Development of a Self-assessment System for the Learners Answers with the Use of GPNN. *WSKS*, (1), 2008, pp. 332–340.
12. A. S. Drigas, D. Kouremenos and J. Vrettaros, Teaching of English to Hearing Impaired Individuals Whose Mother Language is the Sigh Language. In: M. D. Lytras et al. (eds), 2008, pp. 263–270.
13. I. Rapin and R. F. Tuchman, Autism: Definition, neurobiology, screening, diagnosis. *Pediatric Clinics of North America*, **55**(5), 2008, pp. 1129–1146.
14. N. Sebe, I. Cohen, T. Gevers and T. S. Huang, *Emotion Recognition Based on Joint Visual and Audio Cues*, Proceedings of the 18th International Conference on Pattern Recognition, 2006.
15. M. Riedl, R. Arriaga, F. Boujarwah, H. Hong, J. Isbell and L. J. Heflin, Graphical Social Scenarios: Toward Intervention and Authoring for Adolescents with High Functioning Autism, *Virtual Healthcare Interaction*, Papers from the AAAI Fall Symposium, 2007.
16. K. Arthi and A. Tamilarasi, Prediction of autistic disorder using neuro fuzzy system by applying ANN technique, *International Journal of Developmental Neuroscience*, **26**, 2008, pp. 699–704.
17. B. M. Macmillan, Rhyme and reading: A critical review of the research methodology, *Journal of Research in Reading*, **25**(1), 2002, pp. 4–42.
18. L. Roberts and S. McDougall, Explaining Performance in the Orthographic Analogy Task: Phonological Priming, Phonological Skills and Letter-sound Knowledge. *Journal of Experimental Child Psychology*, **84**(4), 2003, pp. 310–337.
19. S. Srihari, J. Collins, R. Srihari, H. Srinivasan, S. Shetty and J. Brutt-Griffler, Automated scoring of handwritten essays in reading comprehension tests, *Artificial Intelligence*, **172**, 2008, pp. 300–324.
20. K. Jain, P. Manghirmalani, J. Dongardive and S. Abraham, Computational Diagnosis of Learning Disability, *International Journal of Recent Trends in Engineering*, **2**(3), 2009.
21. J. Hernadez, G. Mousalli and F. Rivas, *Expert System for the Diagnosis of Learning Difficulties in Children's Basic Education*, Proceedings of the 8th WSEAS International Conference on Applied Computer and Applied Computational Science, Italy, 2008.
22. J. Hernadez, G. Mousalli and F. Rivas, Learning Difficulties Diagnosis for Children's Basic Education using Expert Systems. *WSEAS Transactions on Information Science and Applications*, **7**(6), 2009.
23. G. M. Baschera and M. Gross, Poisson-Based Inference for Perturbation Models in Adaptive Spelling Training. *International Journal of Artificial Intelligence in Education*, **20**, 2010, pp. 1–31.
24. P. Thomson and P. Gilchrist, Dyslexia: *A Multidisciplinary Approach*, Nelson Thornes, 1996.
25. A. M. Palacios, L. Sanchez and I. Couso, Extending a simple genetic cooperative-competitive learning fuzzy classifier to low quality datasets, *Evolutionary Intelligence*, **2**(1), 2009, pp. 73–90.
26. A. M. Palacios, L. Sanchez and I. Couso, Diagnosis of dyslexia with low quality data with genetic fuzzy systems. *International Journal of Approximate Reasoning*, **51**, 2010, pp. 993–1009.
27. M. Kohli and T. V. Prasad, *Identifying Dyslexic Students by Using Artificial Neural Networks*, Proceedings of the World Congress on Engineering, London, U.K., **1**, 2010.
28. R. Abbott, Automated expert modeling for automated student evaluation. In Intelligent tutoring systems, eighth international conference, ITS 2006, Jhongli, Taiwan, June 26–30, 2006, proceedings, pp. 1–10. Lecture Notes in Computer Science 4053, Springer.
29. E. Melis, E. Andres, J. Budenbender, A. Frischauf, G. Goguadze, P. Libbrecht, M. Pollet and C. Ullrich, ACTIVEMATH, A Generic and Adaptive Web-Based Learning Environment, *International Journal of Artificial Intelligence*, **24**(4), 2001, pp. 1–25.
30. E. Melis and J. Siekmann, ActiveMath: An intelligent tutoring system for mathematics. In L. Rutkowski, J. Siekmann, R. Tadeusiewicz, & L. A. Zadeh (Eds.), Seventh international conference artificial intelligence and soft computing (ICAISC), pp. 91–101. Springer-Verlag, 2004.
31. P. Libbrecht and E. Melis, Methods to Access and Retrieve Mathematical Content in ActiveMath. *Lecture Notes in Computer Science*, 2006, 4151, pp. 331–342.
32. N. Livne, L. Nava, O. Livne and C. Wight, Can automated scoring surpass hand grading of students' constructed responses and error patterns in mathematics? *MERLOT Journal of Online Learning and Teaching*, **3**(3), 2007.
33. L. Anthony, J. Yang and K. R. Koedinger, Toward Next-Generation Intelligent Tutors: Adding Natural Handwriting Input, *IEEE Multimedia*, **15**(3), 2008, pp. 64–68.
34. C. S. Gonzalez, D. Guerra, H. Sanabria, L. Moreno, M. A. Noda and A. Bruno, Automatic system for the detection and analysis of errors to support the personalized feedback. *Expert Systems with Applications*, **37**, 2010, pp. 140–148.
35. World Health Organisation, International Classification of Diseases, Tenth Revision (ICD-10). Chapter V: Mental and Behavioural Disorders. Geneva: World Health Organisation, 1993.
36. American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders (DSM 4th edn), Washington, DC: APA, 1994.
37. G. Rebolledo-Mendez and S. De Freitas, Attention modeling using inputs from a Brain Computer Interface and user-generated data in Second Life. In: The Tenth International Conference on Multimodal Interfaces (ICMI 2008), Crete, Greece, 2008.
38. G. Rebolledo-Mendez, I. Dunwell, E. A. Martínez-Mirón, M. D. Vargas-Cerdán, S. de Freitas, F. Liarokapis, A. R. García-Gaona, Assessing Neurosky's Usability to Detect Attention Levels in an Assessment Exercise, *Human Computer Interaction*, **5610**(1), 2009, pp. 149–158.
39. R. M. Aguilar, V. Munoz, M. Noda, A. Bruno, L. Moreno, Teacher Strategies Simulation by Using Fuzzy Systems, *Computer Applications in Engineering Education*, **18**(1), 2010, pp. 183–192.
40. J. Anuradha, Tisha, V, Ramachandran, K. V. Arulalan, B. K. Tripathy, *Diagnosis of ADHD using SVM algorithm*, In Proceedings of the Third Annual ACM Bangalore Conference, 2010.
41. M. Delavarian, F. Towhidkhah, P. Dibajnia, S. Gharibzadeh, Designing a decision support system for distinguishing ADHD from similar children behavioral disorders. *Journal of Medical Systems*, 2010 [Epub ahead of print].

Athanasios Drigas is a Senior Researcher at N.C.S.R. Demokritos. He is the Coordinator of Telecoms Lab and founder of Net Media Lab since 1996. From 1985 to 1999 he was the Operational manager of the Greek Academic network. He has been the Coordinator of Several International Projects, in the fields of ICTs, and e-services (e-learning, e-psychology, e-government, e-inclusion, e-culture etc). He has published more than 200 articles, 7 books, 25 educational CD-ROMs and several patents. He has been a member of several International committees for the design and coordination of Network and ICT activities and of international conferences and journals.

Rodi-Eleni Ioannidou is a special education teacher. She has participated in various research projects regarding the use of Information and Communication Technologies (ICTs) in special education.