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Recommendation learning management system for autism using deep convolutional neural networks and gene expression programming

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Abstract: Autism is a complex condition that affects children at an early stage and interferes with their daily activities in life. People affected by autism have problems with social interaction, communication, and exhibit repetitive behaviors. A personalized recommendation learning system modifies an academic subject, educational program, and the environment in which the student learns according to the individual student's learning style and interests. This paper creates a personalized recommendation learning system tailored for autistic students affected by Rett and Asperger's syndromes to meet their needs using Gene Expression Programming and Deep Learning via Convolutional Neural Networks. Gene Expression Programming creates a recommendation-based learning content based on the autistic student's profile. Deep Convolutional Neural Networks (DCNN) identify the student's facial emotions and detect disorientation towards the course. If any disorientation is identified, the course is terminated immediately, and an alternate learning style that reduces the disorientation is provided. To evaluate the efficiency of the proposed approach, extensive experiments are conducted. DCNN's ability to predict the student's emotions to avoid challenging courses is 98% effective.

Keywords: *Asperger syndrome, Autism spectrum disorder (ASD), Deep learning, Gene expression programming rett syndrome.*

1. Introduction

As a complex developmental disability, autism spectrum disorder is that is characterized by difficulty communicating and interacting during childhood. The term autism spectrum disorder describes a set of behaviors that affect individuals differently and to varying degrees. Although the real cause of autism is unknown, early diagnosis can have significant effects. Students with autism have the following difficulties: difficulty learning a new language, difficulty making eye contact with people they are talking to, difficulty making decisions, poor motor skills, and sensory difficulties. Although autism is not curable, complete treatment leads to positive outcomes for autistic people. People with autism are diagnosed based on their behavior and the severity of their condition. There is a great deal of confusion surrounding the Autism Spectrum.

As well as autism, many autistic people suffer from hyperactivity/attention deficit disorder, dyslexia, and oppositional defiant disorder. There is no neurological disorder associated with autism people. They have neurodiversity. Every person suffering from autism has a different problem, and some

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need less treatment, while others require extensive treatment. Every autistic person cannot be categorized based on a single autistic person they met; they are all classified differently.

Autism can be termed as a personality disorder rather than a disease. Ordinary personalities of humans can be categorized as nervous, extrovert, social, introvert, or autistic. Detecting Autism before birth is impossible. One out of fifty-nine people in the world suffers from autism. In the next era, more than 500,000 autistic teenagers will enter adulthood. Boys are more affected by autism than girls. “Prevention is better than cure” applies well to autistic people. Because anything detected early can be subjected to reduction. The e-learning system developed in this paper helps autistic students to improve their learning, communication, and interaction skills and their underlying brain development. Children affected by autism don’t have a lower IQ [Intelligence Quotient] than most people. The Autism people’s IQ range is tabulated in Table 1.

Table 1.
Autism people’s IQ Range and rate of intelligence.

Autism people (%)	**IQ range**	**Level of intelligence**
32 in 100	IQ<70	Low
26in 100	71-85	Medium
43in 100	86-100	High

The different types of Autism Spectrum Disorder is characterized as follows:

a) Asperger syndrome: Asperger’s syndrome affects a person’s ability for social interaction, speech, and language processing. Individuals affected with this syndrome have repetitive behaviors and interests.
b) Kanner’s syndrome: Individuals who has Kanner's syndrome doesn’t like an environment in which they are subjected to social interaction, they always prefer a non-social(lonely) environment
c) Childhood Disintegrative Disorder(CDD): Regressive autism is also known as CDD. The individual is subjected to hallucinations and loss of speech which affects them as well as their family terribly. They also possess normal autistic symptoms such as low social interaction, repetitive behaviors, and communication problems.
d) Rett syndrome: Rett syndrome is a disease that mainly affects girls in large numbers. The mutation in the MECP2 gene causes this disease which results in the underproduction of an important brain protein. The individuals affected with this disorder find it hard to interact, walk, and use their hands.
e) Pervasive Developmental Disorder(PDD): PDD affects a child’s development capabilities which allows them to interact with the external world around them. The children who have these symptoms find it hard to practice their language skills, initiate an interaction, repetitive behaviour, and change their routine tasks.

This paper mainly focuses on two types of people affected with autism disorders namely Asperger syndrome and Rett syndrome. The core drawback of the traditional e-learning system is the lack of personalization of concepts as per the user’s area of interest. The personalized e-learning system is user-centric and revolves around the need of the user to store and retrieve the information from the concept database [1]. Personalized recommendation learning provides the autistic students a choice of what to learn, when to learn, and how they want to learn. The learning curriculum is customized as per the student’s needs. A personalized e-learning system is developed to cater to the requirements of autistic students using Gene Expression Programming(GEP) and Deep Learning. GEP is used to generate content based on the student’s profile. Deep Convolutional Neural Network(DCNN) is used to identify the student’s reaction and predict whether the student is interested in this course concept or not. If the course concept provided is termed to affect the child in any way means, the course is terminated immediately, and recommended steps are taken to help the student learn in a different mode of teaching.

Therefore, this paper follows the following structure. Section 2 presents the literature review. Section 3 analyses the following concepts in detail: Behavioral Traits of Rett Syndrome and Asperger’s

Syndrome students, GEP algorithm for generating the content in accordance with the user's profile, as well as how DCNN works in detail and how it identifies the student's emotional changes during the class which leads to depression and anxiety. Section 4 presents the extensive experiments conducted using GEP and DCNN to analyse autistic student emotions. Section 5concludes this paper.

2. Literature Review

If a teacher knows what learning style suits the students, they can improve their teaching level. But a single learning style cannot be suited for all. In each class, there will be different students having different learning styles. Learning style varies from visual, verbal, kinesthetic, auditory, etc. To select the ideal learning style for the student, recommendation-based eLearning is used. An eLearning system can be accessed from everywhere without the need for a trainer which terms to be quite effective. The personalized Recommendation approach is a significant solution in the modern days [2]. In these three categories, there are collaborative filtering systems, content-based filtering systems, and hybrid recommendation systems. The resources should be generated based on the context in recommendation-based learning. It shows that there exists a bi-directional relationship between the course content and the learning resource.

eLearning was mainly invented to provide easier access to education for everyone. But making an eLearning system for cognitive impairment [3] students is not an easy task because they have trouble recalling the things they study, concentration problems, decision making, etc. An eLearning system designed should have the following characteristics: (1) Help the students to construct their own learning path; (2) motivation; (3) Encourage Collaboration; and (4) use entertainment features and storytelling concepts to help the students learn concepts outside the classroom. An Intelligent Learning Approach which involves the active participation of students in an eLearning system helps to improve students' academic performance and social interaction [4]. An eLearning system for disabled students has to be designed with proper care. Educational Institutions don't always provide the necessary adjustments to cope with disabled students. Discriminating a student based on their disability is a punishable offense in many countries. Disabled students [5] mainly fall under the following categories: visually impaired, hearing impaired, ASD, Mental health complications, Mobility complications, and Disorders leading to learning difficulties. The technological advancement used in the e-learning system helps students to focus on their studies and forget their weaknesses. The eLearning system uses a screen magnifier, screen readers, screen keyboard, reading software, etc. to fulfill the needs of the disabled student.

The parents of autistic children find it hard to search for a caregiver to provide the appropriate services to their child. The traditional method to train autistic students using a caregiver/trainer is a time-consuming process and an expensive one [6]. A cost-effective and more efficient way of training the autistic student is to develop an eLearning system to satisfy their needs. The parents of autistic students play the main role in improving the child's future which leads to a beneficial outcome if they provide the extra care needed. Computers serve as an aid for providing different types of services to autistic students. But creating an educational eLearning system for an autistic student is not an easier approach, it is quite complex. The autistic students have a psychoeducational profile which is entirely different from the normal children. This is where personalization takes a major troll. The autistic student needs their educational concepts in a personalized manner which will increase their concentration in their studies. A personalized eLearning system was developed using soft semantic web technologies [7]. Soft semantic web technologies allow autistic students to select their own course concepts and control their level of learning.

AARAMBH [8] curriculum uses a hybrid ontology to evaluate the student's performance and their difficulties observed while learning. The methodologies used for training the autistic students is Applied Behavior Analysis(ABA) and Discrete Trials Training (DTT). ABA is a treatment provided for autistic students. Even though the treatment's effectiveness is high there exists a lack of medical professionals for offering this treatment. The staff who practices ABA should have a deep knowledge of the academic program and how to implement the procedures [9]. DTT uses various training approaches like written instruction, lectures, videos, modelling, and feedback to train the teachers. The autistic students tend to obey the computer-based instruction more than the teacher's instruction. The semantically enabled learning evaluates the difficulties possessed by the student in learning a concept by means of intelligent querying. AARAMBH teaches autistic students both the environmental and self-development concepts by means of using various illustrations. HANDS (Helping Autism Diagnosed Teenagers Navigate and Develop Socially) [10] is a computer-based toolbox specially designed to help the students who suffer from autism. The HANDS application in the smartphone is tailored as per the needs of the user both by the student and teacher. This application helps the students to tackle the complex situations that arise in the life of the autistic student. If a student has a particular habit of forgetting his lunch every day at the table, this application helps him to resolve this issue by sending him a reminder.

High Functioning Autism(HFA) is a term used to denote autistic students who have an above-average IQ range. In order to obtain a learning objective, the student's emotion plays a major role. The negative emotions such as anger and anxiety affect the student's learning capacity negatively. Detecting the negative responses of the students in an early stage and providing the necessary therapies to overcome the situation serves as an important factor in the HFA eLearning system [11]. Augmented Reality(AR) [12] is used to teach autistic students with real-time objects they are quite used to because the personal items of the children helps them to identify the concepts even better. The AR uses real-time objects in the environment and adds the student's parents' voice and 3D virtualization to the images by a mobile application to enhance the learning process and interaction. Any smartphone which has an inbuilt camera and speaker can be used to load this application. The lessons are created on the go by the parents and teachers and rendered into the application by the means of a Quick Response (QR) code and displayed on the screen. The modes of teaching for the student are narrating albums, functional reading, and visualization of concepts.

Understanding a mathematics concept is not an easy task for an autistic student. To avoid learning failures by detecting various emotions possessed by the child, an emotional classification system is designed for the maths eLearning system [13]. The student's attributes are measured using various sensors and their emotions are calculated whether they are normal, angry, anxious, or happy. The emotions are analysed by an expert in autism. The results showed that autistic students are mostly affected by anxiety rather than anger. An open source robot LS Maker [14] is used to teach the autistic students how to construct a circuit in a game board. The game can be played by a single player up to two teams in a single session. Four children were involved in the game with the help of the two therapists. The therapists were placed in a supportive role to ensure the active participation and engagement of the students. The students tend to have stable eye contact and enjoyment throughout the session. In the end, the two teams finished the circuit with the help of the robotic system.

To identify an individual's facial expression and emotion is very hard for an autistic student. An application known as Game Book [15] was specially designed for the Autistic students to help them recognize facial expressions using AR. The Game Book has stories that can be both read by text and audio. The interactive environment provided by the application helps the student to identify the correct emotion. Each chapter in the playbook involves a real-time interaction with the fictional contents created. This game's main intention is to promote the child's imagination and engagement. This game has a fictional character known as "Tobias' ' for whom the student has to generate a correct facial emotion related to a particular scenario. SPED (Special Education) involves special classes additional with the regular classes mainly designed for students weak in academic and motor skills. An Interactive eLearning website known as INTERACT is created for autistic students to enroll them in the special classes. The learning pattern for the students is developed by skilled professionals and their academic performance can be viewed both by the teachers and parents.

3. Proposed Framework

The following concepts are discussed in-depth in this section: the behavioral characteristics of Rett syndrome students and Asperger syndrome students in addition to GEP algorithms for the content generated using the user's profile. It also explains how DCNN operates and how it detects the emotional changes of the student during the course that contribute to stress and anxiety.

3.1. Asperger's Syndrome

People with Asperger's syndrome [16] have a problem with nonverbal communication and find it hard to be involved in social interaction. Asperger's syndrome has nothing to do with one's background or the environment in which they grew up. The cure for Asperger's syndrome is not yet found. People with AS tend to possess poor short-term memory and better long-term memory than most people in the world. The Rate of Intelligence categorized for AS syndrome is up to medium and High. Hence, the learning disability is low compared to other types of autism. But they find specific learning methods hard for them such as methods like physical and auditory learning. They find visual, verbal, and pattern-wise learning to be more interesting than the other methods. When it comes to learning, the AS people provide the most honest feedback. This helps to improve the learning system's recommendation based on their needs and taste. The AS people find it very hard to understand and process the language but they can talk fluently. They perform well in maths and language classes. So, the learning system developed keeps these in mind for providing full support, a quality educational plan developed for their learning styles. The poor motor skills are a disability found with the AS people, so they find it hard to write every detail they go through. The learning system provides Asperger's syndrome patients with a visualized learning module to improve their social interaction by observing others on screen. AS people possess the following problems such as repetitive behavior and routines, highly focused interests, and sensory sensitivity which can be described as follows.

i. Repetitive Behavior and Routines: People with Asperger syndrome have a regular daily routine. It can also be essential to use guidelines for them to understand. They prefer the same path from school to home and vice versa. The world seems to be a mysterious place for them and they always prefer the same food for lunch and breakfast. So, the e-learning system developed for them also works on a daily basis at the same time for about 6 hours. From morning 9:30 am to evening 3:30 p.m. If they are asked to do their daily chores in another way, they find it very hard to do, Same as that the AS people are incompatible to change. They always follow a routine in doing things.

ii. Highly Focused Interests: When the AS people are interested in a topic, they tend to learn more about it and excel in that field of interest. If they are interested in anything, they have a keen approach to observe things.

iii. Sensory Sensitivity: The AS people sometimes possess over-sensitivity to certain things, and for certain things, they have no interest or possess low sensitivity. For example, if the classroom is painted in a dark colour means they find it very distracting to observe anything in the class and they will be frightened. These things sometimes lead them to an anxiety attack or physical pain. But some things appear to be fascinating for them such as fairy lights and toys.

3.1.1. Learning Modes for AS

The AS learners like to learn either visually, verbally, or by using patterns. Sometimes by more than two methods, they can learn and sometimes only one approach matches their learning abilities. The three modes of learning are described below:

i. **Visual Learners:** Visual learning is a method of learning by pictures. The people affected by AS like anything to be taught whole rather than taught in a sequential pattern or splitting it into parts. They find it easy to understand the whole concept since they possess a long-term memory. If taught in a sequence or in parts, they find it hard to understand because they are poor in processing everything in the short-term memory. The visual e-learning system designed should provide a full learning system using spatial and visual tasks without omitting any details.

ii. **Verbal Learners:** Verbal learners like to study in a way that includes words and speech. They make their own to-do lists in which they specify the things they want to do in order. They memorize the things they saw on the wall and streets like the number plates, advertisements, bus schedules, etc. All they need is to find a sequence of words in the concepts they study. The verbal learners are good at learning different languages but tend to perform poorly in drawing and visual learning.

iii. **Pattern Learners:** The learners find meaningful patterns from both useful and unimportant data. Music and Maths usually have a pattern deep-lying inside it. These patterns are considered interesting to AS learners. The AS learners can sometimes excel in both(Maths and Music) or either one. Pattern thinking can be also termed as a visual learning concept, but instead of pictures, they think in patterns. Visual arts and Chess mainly involves a pattern learning concept to master the content. Students who are well versed in pattern learning can find it hard to cope with linguistic learning.

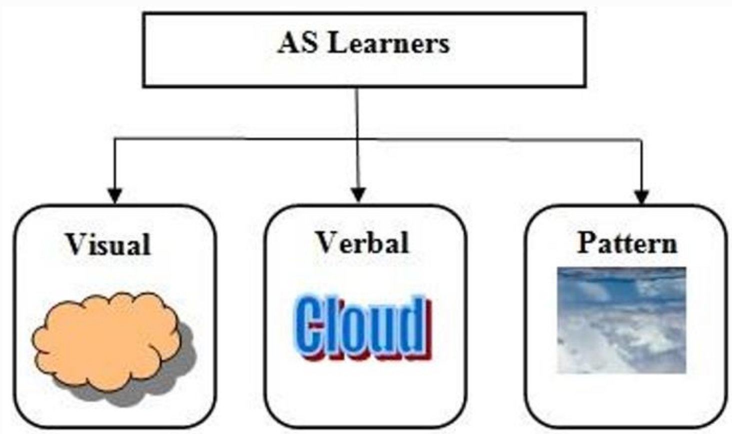

Figure 1.
Different learning modes for AS people

3.2. Rett's Syndrome

Rett's Syndrome [17] is a "full-spectrum" disorder which is based on genetics and the girls affected possess slow growth in development.1 in 10,000 girls are affected by Rett's syndrome every year which is a neurological disorder. The neurological disorder affects the girl's motor controls in many ways, such that they find it hard to do the normal chores every day. In addition to this, they have issues related to heart, breathing, digestion, bone, and muscle problems. The head is small for these people, due to the undeveloped brain. The main difficulties possessed by the people are:

- They find it hard to use their hands and they always wring their hands together
- They have severe social anxiety which results in a decline in language skills.
- Breathing troubles and seizures
- They get tense and feel sad for a long amount of time and the same thing applies to happiness and laughter.
- They find it hard to live independent
- They grieve from severe apraxia issue

3.2.1. Skills of Rett Syndrome People

- They like to interact with others by using touch and interaction which they find to be more comfortable.
- Despite the motor issues from this disease, they have strong eye contact which can be useful in times of interaction and accessing the computer.
- They possess a talent for learning academically and physically.

- We can understand their emotions by noticing their body language and words
- They tend to have a medium level of intelligence and the knowledge of processing the information is high.
- They like to learn by using books and the computer.
- They overcome the defects of apraxia in a place where they are encouraged to do more.

3.2.2. Modes of Learning Suitable for Rett Syndrome

3.2.2.1. Aural (Auditory-Musical) Learning

Children affected by Rett Syndrome likes to be communicated through music and audio. The Aural Form of learning is a boon to them. The proposed system developed involves an audio form of learning for Rett syndrome. Audio is used to describe features such as color, texture, and use. By the use of an audio form of learning, they come to know the different patterns and beats in the sound and tend to process more. From various scenarios that take place in everybody's daily life, it is known that music has a powerful effect on human memory. The music all of us hear has a special place in our memory, that it can be recalled later. The nursery rhymes everyone learned in kindergarten will be still present in our memories. When a favourite song plays in the background, one will automatically go to the place they heard it in the past. Music is a form that helps to recall one's past. Some students tend to get more interested in an activity when there is music playing in the background. So, for these types of student's certain music running in the background will help them to recall things. Students are given the music they enjoy when learning or doing other activities to lead to an increase in their efforts.

3.2.2.2. Physical (Kinesthetic) Learning

The second mode that is compatible with the Rett syndrome is learning through the sense of touch by using their body and hands to interact with the world. By using this mode of learning, these increase the girl's ability to think and work better. People affected with autism are mainly physical learners. Physical learning helps them by learning physically instead of focusing on reading the book and memorizing it. People affected by Rete syndrome like to communicate by moving their body and hands in the form of dance, sports, yoga, and other activities that involve movement. If they sit idle for a long time, they will become depressed or this behavior leads to anxiety. The movements used for training should be no means to disturb others. Each position shown should be related to a concept. The student can practice in various positions such as up, down, above, below, behind, and front. For example, to create a dance pattern, a sequence of color squares placed on the mat is developed and the student is ordered to step on the color shown in front of them. If the color shown is red, then the student is ordered to step on the red square. Hence, they can learn the shapes and colors from the real sequence of events. A projector is used to project some learning books and with the help of laser light or another form of input, the important words are pointed using the laser pointer or highlighted on screen. With the help of the laser light also they can learn to draw pictures in Real Time.

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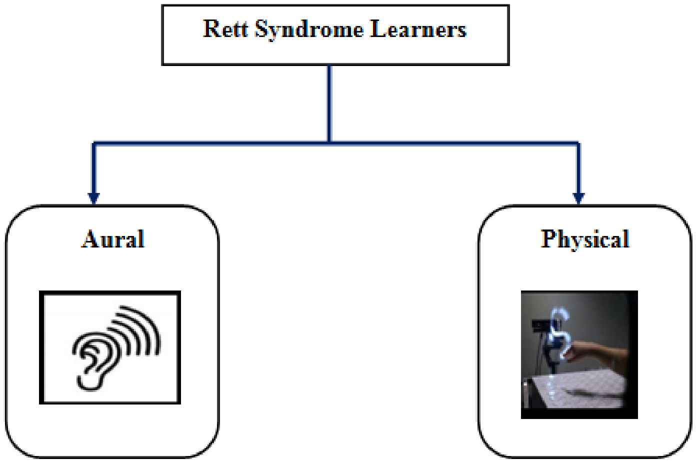

Figure 2.
Different Learning Modes for Rett Syndrome people.

3.3. Personalized Learning Tactic Using Gene Expression Programming

The personalized approach gives the specified materials according to the learning needs of the autistic student. A curriculum sequencing is used by the learning system in which concepts are grouped in a sequencing order of the materials by the specified student's grade and subject. Curriculum sequencing is used here because when a Rett syndrome student is provided with various materials with visual learning concepts instead of Aural methods, they find the course very uninteresting which leads to disorientation. The disorientation caused leads to a reduced performance of the students in their academics, which should be overcome at any cost. In order to prevent this disorientation, a genetic algorithm called Gene expression programming is used. Gene Expression Programming (GEP) [7, 18] identifies the users profile and generates content based on their profile and preferred ways of teaching. The GEP algorithm used considers teaching activity as an optimization problem and presents the learner with the prescribed style of teaching and learning methods. The problem to be optimized is finding the right kind of teaching mode for the autism people. The two major elements in GEP algorithms are the chromosomes and fitness function. This leads to a fully personalized learning system varying the learning modes and content based on the user request.

There are two parameters for each course concept for people with autism:(i) Taking into account the relationship between autism and modes of learning, and (ii) the difficulty level in understanding the concept. The concept can be considered as a vector representation in a Multidimensional Euclidean space The genetic element in the multidimensional Euclidean space is represented by $r_{j,n}$ which can be described in equation (1) as follows

$$r_{j,n} = tf_{j,n} x \log \frac{k}{df_n} = tf_{j,n} x IDF \quad (1)$$

where$_{,represents}$the significance of the nth term in the j^{th} concept, $,tf_{j,represents}$ the term frequency of the n^{th} term in j^{th}concept,k denotes total concepts in database, $,df_n$ represents the document frequency of the nth term, *IDF* defines the Inverse Document Frequency logarithm. Consider the case where there are s conditions combining the j^{th} and k^{th} concept. The concept relationship between the j^{th} and k^{th} concept can be designed using a cosine transform in equation (2)

$$m_{i,j} = \frac{\sum_{h=1}^{s} (r_{j,n})(r_{k,n})}{\sqrt{\sum_{h=1}^{s} (r_j^2, n)(v_k^2, n)}} \quad (2)$$

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The concept C_j and C_k is represented as $C_j=\{r_{j,1}, r_{j,2}, \dots\dots\dots.., r_{j,s})$ and $C_k=\{r_{k,1}, r_{k,2}, \dots\dots\dots.., r_{k,s})$, where $rd_{j,k}$ represents the relationship degree between two concepts. The course concept database consists of y course concepts and relation matrix M is described as shown in the equation (3).

$$M = \begin{matrix} \\ C_1 \\ C_2 \\ . \\ . \\ \\ C_y \end{matrix} \begin{bmatrix} C_1 & C_2 & \cdot & \cdot & \cdot & C_y \\ rd_{1,1} & rd_{1,2} & \cdot & \cdot & \cdot & rd_{1,y} \\ . & . & & & & . \\ . & . & & & & . \\ . & . & & & & . \\ rd_{y,1} & rd_{y,1} & \cdot & \cdot & \cdot & rd_{y,y} \end{bmatrix} \quad (3)$$

The difficulty parameter(D_i)for the autistic student for each course is calculated using a 5-point scale concept which is described in table 2. The average difficulty derived from the learners and expert's collaborative response is depicted as follows

$$\text{Average } Difficulty_{k}(collaborative\ response) = \sum_{i=1}^{5} \frac{nr_{i,k}}{NR_k} D_i \quad (4)$$

Where$nr_{i,k}$ represents the number of experts and learners who rated the ith difficulty for the kth course concept.NR_krepresents the total number of learners and experts who rated the course concept.

Table 2.
Difficulty parameters for autistic students.

Difficulty parameter (Di)	Numerical value	Description
D1	2	The session is very interesting
D2	1	Session is interesting
D3	0	The session is not fitting
D4	-1	Session is difficult
D5	-2	Session causes disorientation

The GEP algorithm generates a personalized path for the autism e-learning system based on seven stages:

i. Chromosome String(Solution)
The Individual Autistic Student Education Plan(IASEP) is derived based on the type of autistic disorder and to select which mode of learning will suit them. IASEP is assigned a serial number from 1 to n to create the learning path generation. Each IASEP generated is known as the chromosome in the GEP algorithm.

ii. Initialization of Population Parameter
Population size is set based on the complexity of the problem to be solved. Having a large population size will reduce the speed at which the correct course concept can be found in time, but the learner has a better chance of finding a high-quality course concept.

iii. Selecting Fitness Function
To calculate the effectiveness of a customized e-learning system, the fitness function is used. Two parameters can be calculated to generate it
   1) Concept relation of the IASEP
   2) Difficulty parameter of IASEP

iv. Reproduction
In this operation, the chromosome(solution) with a high fitness value is allowed to reproduce new course concepts. This reproductive operation aims to find an optimal solution for an individual autistic student. This operation is performed by a mechanism known as a weighted roulette

solution which calculates the probability of the selected solution shown in equation (5). The accurate course is selected for the individual learner whose probability value equals 1.

$$Probability\ of\ selection = \frac{Fitness\ of\ the\ selection}{Total\ Fitness\ of\ the\ selection} = 1 \quad (5)$$

v. Crossover

Two-parent chromosomes are combined to form two-child chromosomes by using the probability decision. The total number of IASEP is initially fixed, which cannot be exceeded later. To avoid duplicate paths and duplicate IASEP serial numbers which increases IASEP usage, it is necessary to perform a crossover operation. As a result of the uniform crossover operation, the likelihood of creating duplicate learning paths is minimized by exchanging the whole chromosome using the probability of selection calculated

vi. Mutation

The chromosomes that are not created using the reproduction and crossover operations are created in the mutation operation.

vii. Termination

After identifying the appropriate solution (a correct form of teaching given to the two different types of autistic people) for the problem the GEP algorithm is terminated. Figure 3 illustrates the workflow of the GEP process.

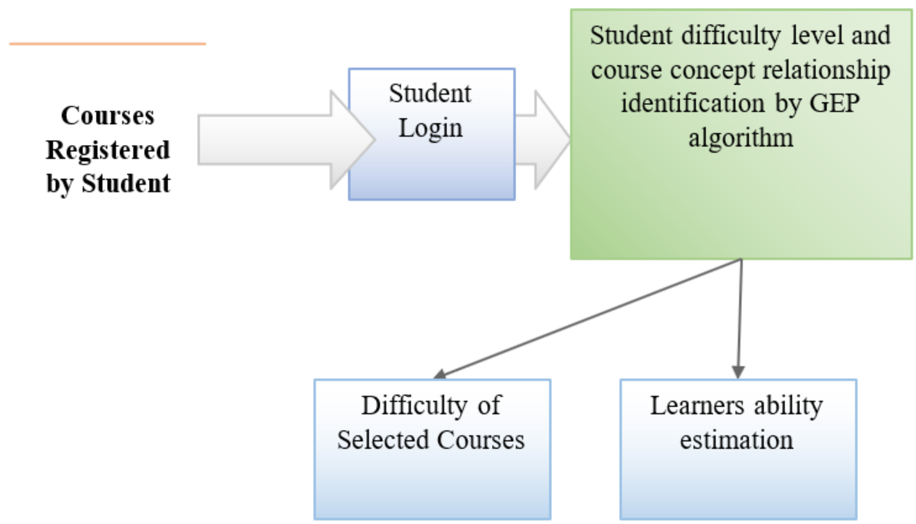

Figure 3.
Workflow of the GEP process.

3.4. DCNN for Emotion Identification of Autistic Students

In deep learning, artificial intelligence neural networks are used for the processing, which are mainly based on how the human brain functions. It has multiple layers for extracting the higher-level features from the raw input data obtained. Deep learning can be termed as unsupervised learning which predicts the features without manual intervention using a neural network. In contrast to a normal neural network, a deep neural network is more complex, and it has many numbers of layers. In order to process the complicated input data obtained it uses sophisticated mathematical models. The input layer, output layer, and hidden layer are the three layers of a neural network. Neural networks receive input through the input layer. The output layer predicts the correct class or type to which a given input belongs. The hidden layer serves as the intermediate layer between the input and output layers. Neurons constitute the chief component in a neural network in which the information processing takes place and they are connected to the adjacent layers. The pixels from the input image are obtained and sent to the first layer of the neural networks input layer. A unique number is associated with each neuron known as the bias. Inputs reaching a neuron are weighted with bias. The hidden layers also act as the activation nodes. Information is forwarded to the output layer by the activation neurons/nodes. Layers are added by using their outputs as inputs. Figure-4 illustrates the DNN architecture.

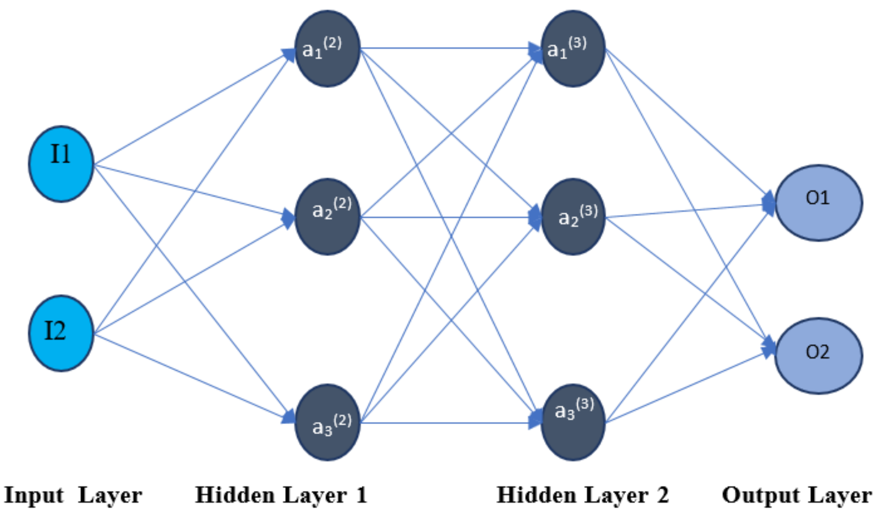

Figure 4.
Deep neural network

In equation (6), a deep neural network consists of two matrices, I and A, representing the input and hidden layers, respectively.

$$I = \begin{bmatrix} I0 \\ I1 \\ I2 \end{bmatrix} A = \begin{bmatrix} a_0(2) \\ a_1(2) \\ a_2(2) \\ a_3(2) \end{bmatrix} \quad (6)$$

In a deep neural network, weights are represented by 'w'. Below is a matrix showing how the input layer and hidden layer are weighted.

$$w^{(1)} = \begin{bmatrix} w_{10} & w_{11} & w_{12} & w_{13} \\ w_{20} & w_{21} & w_{22} & w_{23} \\ w_{30} & w_{31} & w_{32} & w_{33} \end{bmatrix} \quad (7)$$

If The dimension value of a neural network with x units in layer n and y units in layer n+1 is x*(y+1). The activation function activates hidden layers. As a result of multiplying the input vector (I) with the weight matrix (W), the activation function is applied.

$$I_1^{(2)} = \Gamma(w_{10}^{(1)}{}_{a0} + w_{11}^{(1)}{}_{a1} + w_{12}^{(1)}{}_{a2} + w_{13}^{(1)}{}_{a3})$$
$$I_1^{(2)} = \Gamma(w_{20}^{(1)}{}_{a0} + w_{21}^{(1)}{}_{a1} + w_{22}^{(1)}{}_{a2} + w_{23}^{(1)}{}_{a3})$$
$$I_1^{(2)} = \Gamma(w_{30}^{(1)}{}_{a0} + w_{31}^{(1)}{}_{a1} + w_{32}^{(1)}{}_{a2} + w_{33}^{(1)}{}_{a3}) \quad (8)$$

Equation (9), showing the computation for a deep neural network with multiple hidden layers and neurons, is as follows:

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$$a_n^L = [\sigma(\sum_m w_{nm} L[....[\sigma(\sum_j w_{kj} 1 l_j + b_j^1)] + b_k^2)].....]_m + b_n^L]_n \quad (9)$$

A neural network's output error rate is reduced by adjusting weights and biases are adjusted in the neural network. To perform this function, gradient descent can be used for both weights and biases in equation (10,11)).

$$w_{ij}(l) = w_{ij}(l) - \omega \frac{\partial E}{\partial wij(l)} \quad (10)$$

$$b_i(l) = b_i(l) - \omega \frac{\partial E}{\partial bi(l)} \quad (11)$$

A Convolutional Neural Network is mainly used in image processing, data analysis, classification problems, and pattern detection applications. CNN has ten to a hundred hidden layers for processing the input data. As each hidden layer passes, the complexity level increases. The first hidden layer detects the edges and the last hidden layer examines the most complex detail in the image face. The input layer neuron is connected to the hidden layer neuron in a traditional neural network. The input layer neurons in a CNN are only connected to the hidden layer neurons by a small layer. An array of image pixels is filtered by the convolutional layer in order to produce a convolved feature map. Observing an image through a window allows you to see certain features that aren't visible during certain times of the day. Local Receptive Fields are sometimes referred to as LRFs (Local Receptive Fields). Transmitted from the input layer to the hidden layer neurons, the LRF translated across an image. A description of the convolution operation can be found in equation (12)

$$\text{Convolution}(x,y) = \sum_n \quad w_n i_n \quad (12)$$

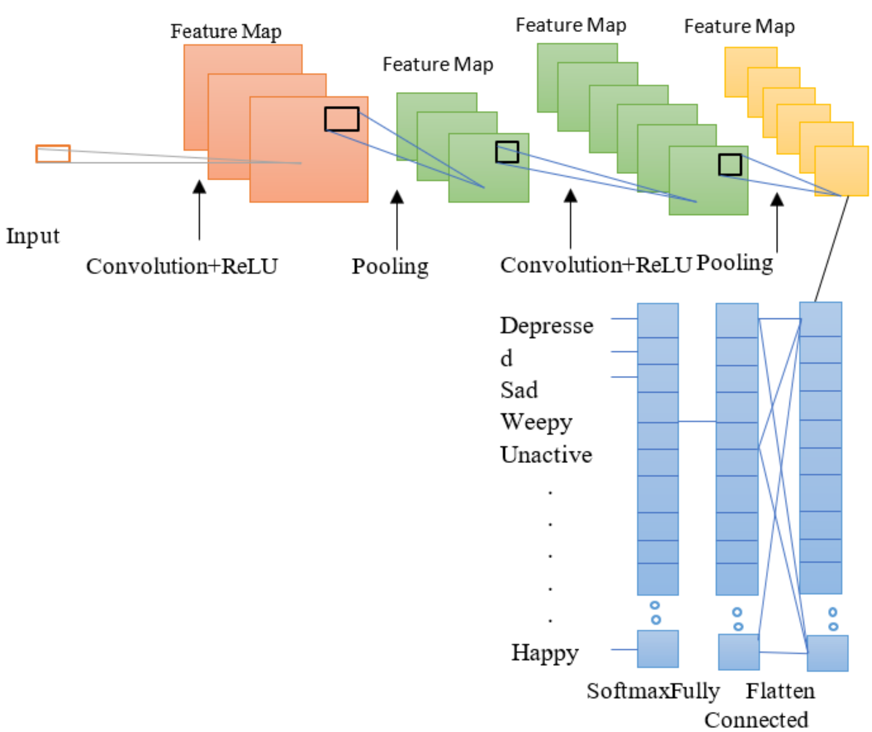

Figure 5.
Architecture of DCNN.

In this paper, DCNN is used to identify the student's emotions in a video sequence to find whether they are under any anxiety attack, physical pain, mental breakdown, breathing problems, seizures, etc. The working of DCNN is presented in Figure 5. Students' edges are identified by lower level layers, while their emotions are identified by higher level layers. This process is efficiently implemented using convolution. Weights and biases are continuously updated based on the new examples of training.

All hidden neurons in the same layer, CNN uses the same weights and bias values. Each underlying layer neuron detects the same edge or blob on the image in different regions. This allows the network to tolerate object translation in a picture.

A neuron's output is transformed by an activation function. ReLU (Rectified Linear Unit) is a common activation function that ensures nonlinearity throughout the network.

As a result of ReLU, convolutional networks include non-linearity since, in reality, negative values serve no purpose. By omitting it, the data fed through each layer loses its dimensionality.

In the case of a negative answer, the neuron output is mapped to the highest value possible. This paper uses ReLU to achieve better performance. This paper uses ReLU to achieve better performance. Figure 6 illustrates the graphic representation of the output of equation (13) from the ReLU function.

$$f(a) = \max(0,a) \tag{13}$$

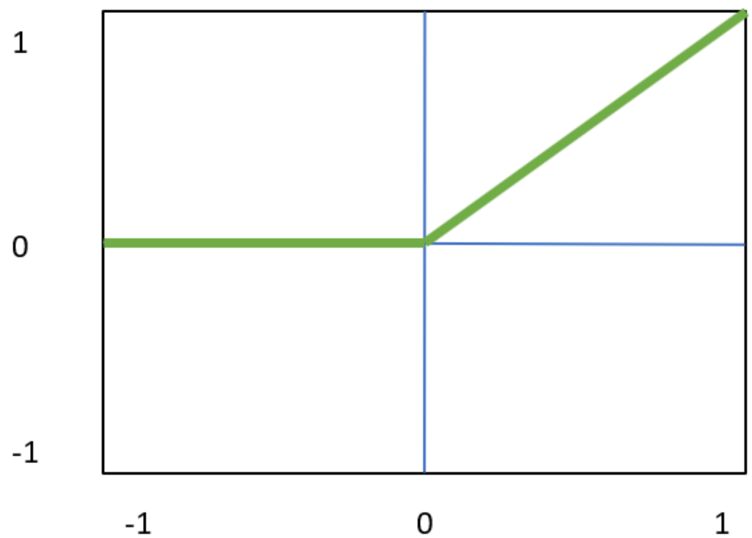

Figure 6.
ReLU representation in graphic form.

In pooling, each small region of neurons is condensed into a single value, reducing the dimensionality of the feature map. The feature map is down sampled as a result. Down sampling parameters results in much more efficient processing of parameters by the network. Feature maps are produced as a result of this process. Using MAX pooling, a particular convolved feature can have the maximum input possible, given by equation (14).

$$\text{Output}=\max(a_i) \tag{14}$$

The maximum pooling for a two-by-two filter is shown in Figure 7.

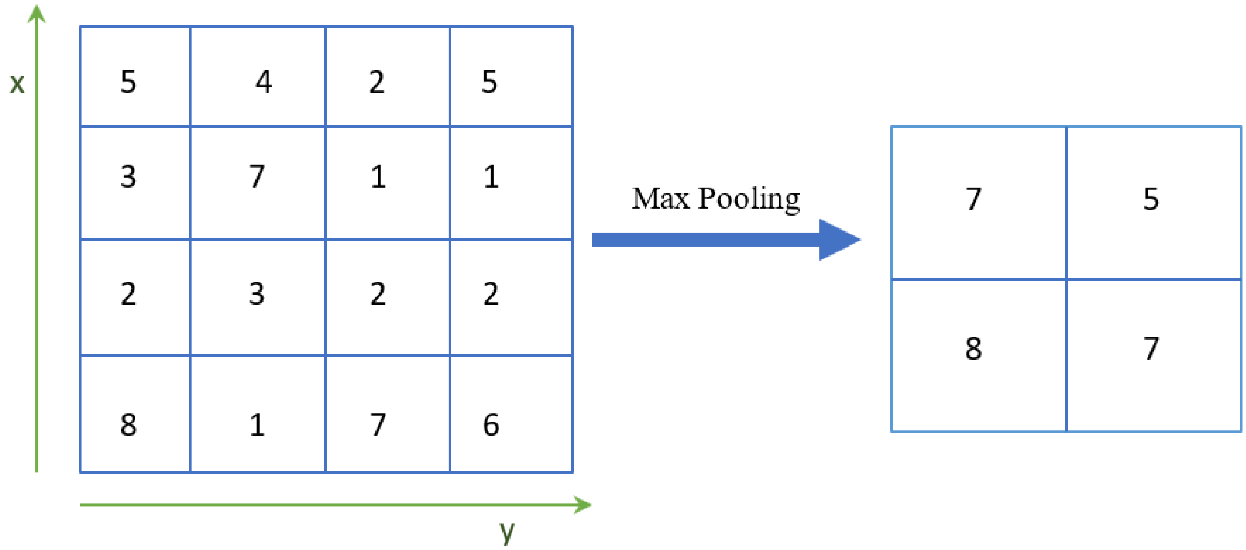

Figure 7.
Maximum pooling.

As shown in equation (15), average pooling simplifies input values to averages.

$$\text{Output}=\text{mean}(a_i) \quad (15)$$

As a result, the following layers are simplified, and the model has fewer parameters to learn. After applying the activation function, a pooling step can further transform the output.

$$\begin{bmatrix} -5 & 4 & 9 & -7 \\ -8 & -8 & 5 & 4 \\ 4 & 12 & -5 & 2 \\ 5 & 3 & -2 & 7 \end{bmatrix} \xrightarrow[\text{Re}\,LU]{} \begin{bmatrix} 0 & 4 & 9 & 0 \\ 0 & 0 & 5 & 4 \\ 4 & 12 & 0 & 2 \\ 5 & 3 & 0 & 7 \end{bmatrix} \xrightarrow[Pooling]{} \begin{bmatrix} 4 & 9 \\ 12 & 7 \end{bmatrix} \quad (16)$$

This layer is responsible for generating the final output and performing classification on the dataset. The training samples are m (x i,y i).There are (n+1) dimensions to the input vectors. DCNNs train their output layers using Batch Gradient Descent (BGD)). Using BGD, DCNNs can be optimized. According to statistics, a batch-based learning algorithm divides a training set into multiple batches. Students' emotions are captured in each batch during their learning sessions. Once the loss has been computed, the parameters are updated. Based on the n input values, the SoftMax function normalizes the n input values into n probability distributions.

Softmax hypotheses are as follows:

$$h\theta_j(x_i) = \frac{exp\ (\theta_j^T x_i)}{\sum_{i=1}^{k} \ exp\ (\theta_i^T x_i)} \quad (j=1,2,\ldots,k), \quad (17)$$

This variable where θj is used to indicate the weights and bias that occur for the jth output. When there is a regularization term in a loss function, it can be represented as cross-entropy:

$$j(\theta) = -\frac{1}{m}[\sum_{i=1}^{m}\sum_{j=1}^{k} 1\{y_j = j\} \log \frac{\exp(\theta_j^T)}{\sum^k \exp(\theta^T)}] + \frac{\lambda}{2} j = \sum_{i=1}^{k}\sum_{j=0}^{n} \theta_y^2 \quad (18)$$

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This Partial derivative (also known as the "error term") for θj is calculated as follows:

$$\nabla\theta_i J(\theta) = \frac{1}{m}\sum_{i=1}^{m} \quad [x_i(1\{y_i = j\} - p(y_i = j|x_i;\theta))] + \lambda\theta_j, \tag{19}$$

There are three functions in this equation: p represents the distribution of the SoftMax outputs, 1 {·} represents the indicator function, and λ is a penalty factor. In one gradient descent iteration, the following parameters are updated:

$$\theta_j := \theta_j - \alpha\nabla\theta_j J(\theta)(\text{ j=1,2,…,k}), \tag{20}$$

In other words, this is how fast the parameters are learning.

Based on the SoftMax output, it is possible to divide the error term into three groups. Pi is the probability that a sample will belong to a particular class based on its prediction.

It is assumed that T1 and T2 correspond to thresholds that divide m training samples into well-recognized, confusing, and noisy groups, which correspond to the well-recognized, confusing, and noisy groups, respectively.

Thus, (3) is equivalent to,

$$\nabla\theta_j j(\theta) = E_1 + E_2 + E_3 + \lambda_{\theta_J} \tag{21}$$

$$= -\frac{1}{m}\{\sum_{i_1 \in M_1} \quad [x_{i_1}\left(1\{y_{i_1} = j\} - p(x_{i_1};\theta)\right)]$$

$$+ \sum_{i_2 \in M_2} \quad [x_{i_2}(1\{y_{i_2} = j\} - p(y_{i_2} = j|x_{i_2};\theta))]$$

$$+ \sum_{i_2 \in M_2} \quad [x_{i_3}(1\{y_{i_3} = j\} - p(y_{i_3} = j|x_{i_3};\theta))]\} + \lambda\theta_{j,} \tag{22}$$

where*E1*, *E2*, and *E3* represent the sub-error terms corresponding to the three above-mentioned sample groups, respectively. The proposed approach which involves DCNN captures the video footage and images of the students during their e-learning session. The data is collected and stored in the databases. The collected data is cleaned and only reasonable frames are filtered and the set of appropriate frames is processed. DCNN can accurately identify the features of the image and it can classify the images based on their emotions. The images are classified based on the emotional aspects of the students. The system identifies the emotions to understand whether the course is boring or interesting based on the student's reaction. The main aim of this DCNN is to identify emotions correctly. If a student is subjected to panic or anxiety attack the course is terminated immediately. The working of the DCNN is shown in figure 8.

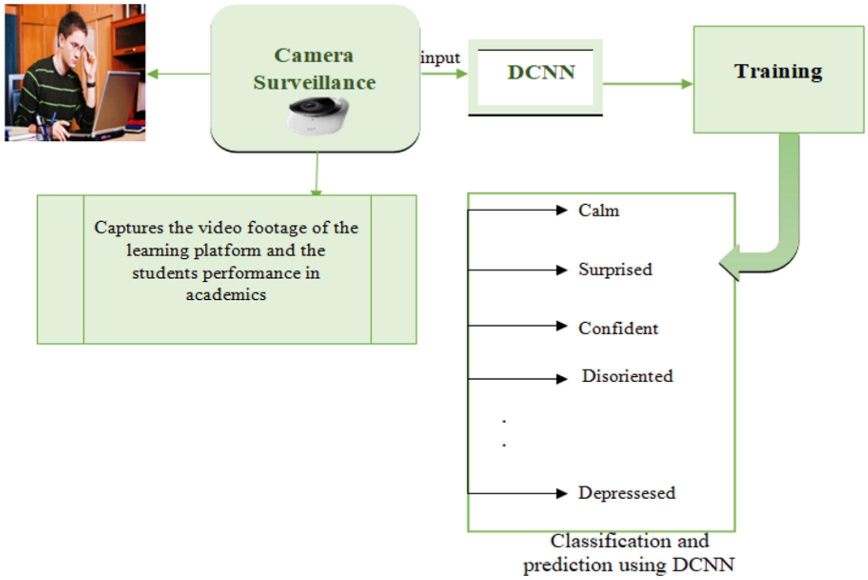

Figure 8.
Working of the DCNN.

4. Experimental Analysis and Design

The system prototype was successfully implemented using GEP and students with HTML programming skills were invited to test this method in order to evaluate the effectiveness and efficiency of a customized curriculum sequencing approach for learning. The following are detailed functions and experimental results.

4.1. Terminology Training

Different terminology training related to courses in the field of design is first explained for the description of the experimental results. The teacher's course can be classified as "Artificial Intelligence" and "HTML Program" titles. In addition, the analysis of the contents of the courses can further split a course into several sections. In fact, other relevant course materials containing similar concepts have been included as part of the course unit, but there are varying levels of difficulty associated with these courses.

Modelling determines every aspect of the material, so a single web page with course material is the smallest component. The course class, 'Attribute' for example, contains several specific course materials with varying degrees of complexity to express the definition of the 'Attribute' in the course division, 'HTML programming.'

4.2. Simulation Environment

The latest version is actually deployed on the IIS 8 Web server Windows framework. In fact, the PHP 7.4.8 and Python application front-end script language is used for the implementation of this program. Based on the student/user the course unit will be selected, when a learner logs into this program. The program displays the grades, the class divisions, and the list of all courses in the HTML class database in the left frame. When a student/user clicks on an HTML-course, the contents of the chosen HTML-course are displayed. There is also a recommendation interface at the bottom of the right window.

As shown in Figure 13, the proposed system will receive recommendation acknowledgment through the recommendation agent's link to two questionnaires. 13. This question can be used to determine whether or not the student has successfully completed the HTML course.

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The system difficulty is measured by a scale of five values. This study uses a scale in a standard variation, with -2 meaning 'Very Easy', -1 meaning 'Easy', 0 meaning 'Moderate', 1 meaning 'Hard', and 2 meaning 'Very Easy'. Students/users who feel that the suggested HTML-course is suitable for them should have average answers very close to zero, i.e. moderate. The response to question two aims to get a HTML-course for the student's understanding.

In order to determine the performance of students, the program transmits these two recommendations to the HTML-course recommendation agent. Based on a student's current ability, a list of recommended HTML-courses will appear after pressing the review key. The following table illustrates an HTML course recommendation based on a student's ability when the student offers an acknowledgment and an HTML course based on the data values provided by the student.

This title refers to the subject of the HTML course and the value indicates the recommended HTML course description. The value in the recommendation column indicates the corresponding HTML-course information value. A large value indicates that an HTML-course is best suited for the student/user. A low value, however, suggests an improper HTML-course for the student/user. The study frequency indicates the performance of the student from past to present who has acquired an HTML course level. In addition, the degree of understanding shows the response of the student to the second questionnaire. Table-3 shows the HTML course management agent interface for teachers, in a course unit, to define difficult parameters for the HTML course.

Table 3.
Ranking of the course information level

Course heading	**Recommendation level**	**Description**	**Understanding level**	**Study frequency**
href Attribute	8	Adding Hyperlink in web pages	1	1
src Attribute	9	Adding source attribute in web pages	0.8	0
style Attribute	8	Style tags to enhance the web pages	0.9	0
width and height Attributes	9	width and height Attributes for web pages	0.7	1
lang Attribute	8	Selecting the language of the web pages	1	0
title Attribute	9	Setting the title of the web pages	0.6	0
alt Attribute	8	Provides the alternate text for an image	0.8	1

4.3. Analysis of Students Learning Capacity

The experimental analysis is conducted by providing the students with a list of HTML concepts. The attribute course is a part of the 'HTML Programming' course unit which provides the test results of the personalized sequencing of the curriculum. The 'Attribute course' actually includes a minimum of 7 sections in which each section has a different level of difficulty associated with it. Three hundred students are taking down the program and 330 courses are found in the student profile folder. Currently, this system contains only a little HTML coding, as it requires a lot of work to engage in this work to produce a high-quality HTML-course. Our projects require customized sequencing services, which is why we chose HTML programming as the teaching unit. Table 4 lists all planned HTML programming courses and their corresponding difficulties decided by the proposed HTML method and Table-5 lists the attribute course added. In order to extend the database of the HTML course and to provide HTML content to students more efficiently. In this framework, the HTML course has a limited range of student capability and complexity parameters from -1 (that is, the lowest capacity and easiest HTML class) to +1 (that is, the maximum capacity and the most complicated HTML level).). Once a student enters into this program, if there is no historical record in this user account database in that student's chosen course class, his original skill would be rated as 0. This means that the program considers the power of the student to be reasonable. As a student clicks on the suggested HTML learning course, the student's skills are reassessed by his / her answers as well as the difficulty/complexity parameter of the HTML course they took.

Table 4.
The HTML courses for the students along with the difficulty parameter

HTML courses	Difficulty parameter
Elements	1.0
Attributes	0.9
Heading	1.0
Paragraph	0.9
Styles	2.0
Cascading style sheet	2.0
Comments	0.5
Links	2.0
Images	2.0
Tables	1.5
Frames	1.9
JavaScript	2.0
Head	0.9
Layout	2.0
File Path	2.0

Table 5.
The attribute study materials and difficulty related to the attribute course.

Course heading	Difficulty level
href attribute	0.8
src attribute	1
style attribute	0.9
width and height attributes	0.7
lang attribute	0.1
title attribute	0.3
alt attribute	0.4

Figures. The graphs in 9 and 10 show the relationship between the parameters of the complexity of the course materials and student ability changes. The course is recommended to the student based on their suggestion. Using the GEP algorithm based on the difficulty level of the learning course, these two experimental findings show that the proposed system is capable of properly assessing the learner's ability. Figure 11 shows how the suggestion is received from the students. It asks the student to rate the course provided to them and seeks whether they are comfortable with the course. After the suggestion is obtained from the student, the result is evaluated. The balanced importance of the learning skill is better if students understand the tougher materials suggested.

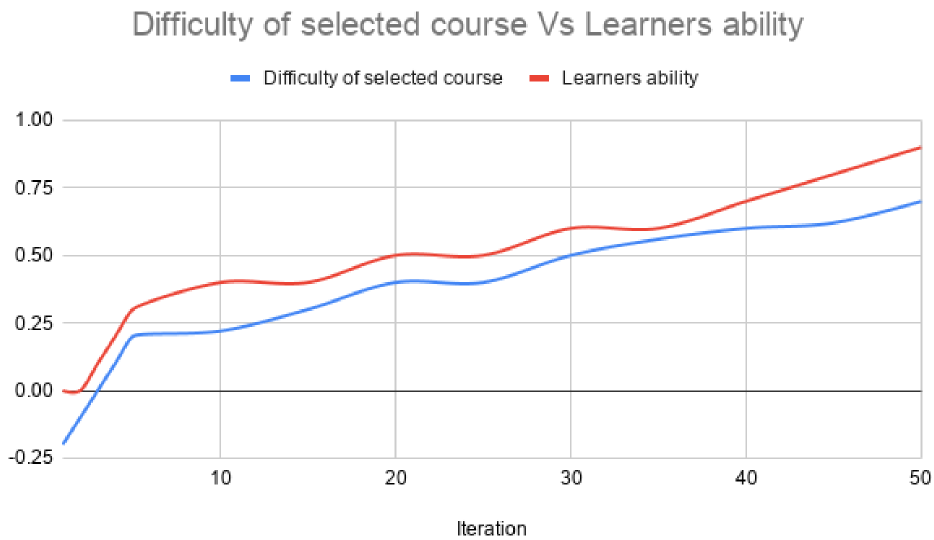

Figure 9.
Comparison of the learner's ability with the difficulty of the chosen course.

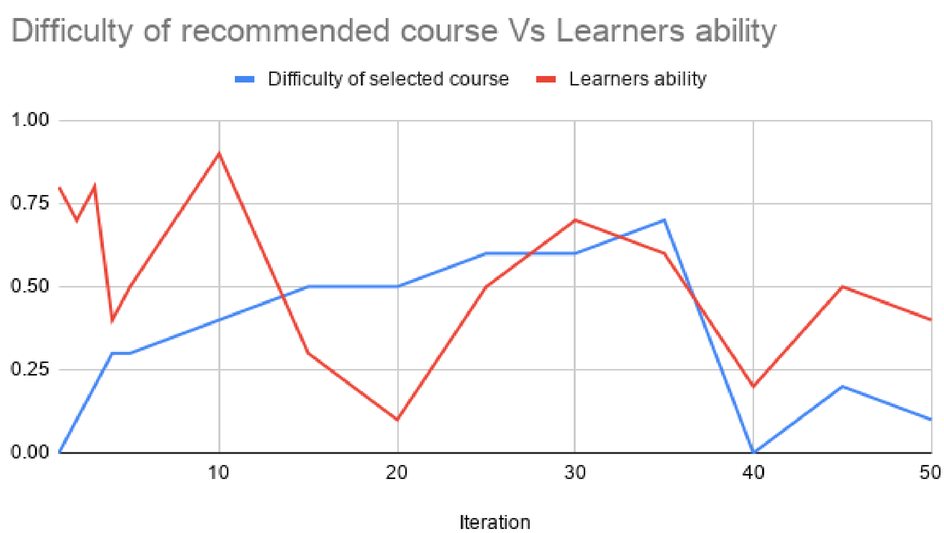

Figure 10.
Compared to the recommended course difficulty, the learner's ability.

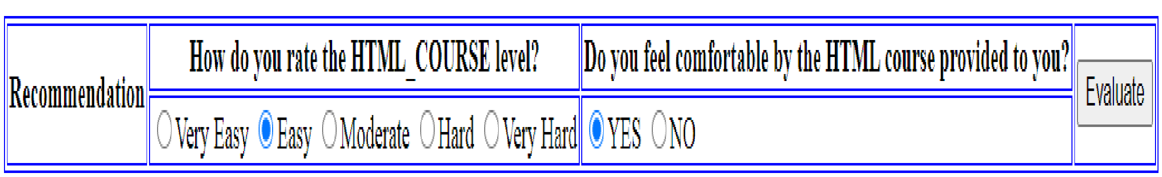

Figure 11.
Collecting suggestion from the students related to the course.

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4.4. Curriculum Sequencing Using Actual Information

Initially, the original information function is used to perform the curriculum sequencing service in order to observe the effect of personalized curriculum sequencing. In Figs. 9 and 10, we show the relationship between the student's ability and the difficulty parameter for students with diverse abilities. According to the experimental results, the suggested course material's difficulty parameter is closely related to the student's ability. This results in the proposed system will prescribe appropriate learning material according to its abilities. This occurrence is logical since the src Attribute is the most complicated and simplistic HTML course in the lang Attribute with difficulty values such as 1.0 and 0.1.

Next, to evaluate the learning path prescribed by the initial actual information method, the learning process analysis is carried out in order to achieve the learning path sequence for the students of specific skills. Tables 6–8 demonstrate the associated teaching technique prescribed for students of high, low, and intermediate abilities by the initial knowledge feature, respectively. In our simulation results, presume that if the prescribed HTML-course has not been studied by the student, the student agrees to learn the HTML-course according to the rating order of HTML-course suggested by our method. In this way, once a student has learned the recommended top 1 HTML course, a student can pick the recommended top 2 HTML course for studying and so on. Additionally, Tables 6–8 show that student ability to analyse the experimental results is strongly correlated with the complexity value of a proposed HTML course of top 1.According to such results, students will select HTML courses based on their abilities by utilizing the original information.

Table 6.
Students with high learning abilities are given curriculum information based on the original information.

Iteration	Selected course	Recommended course	Concept relationship degree	Difficulty parameter of the selected course	Students learning ability	Do you feel comfortable by the HTML course provided to you
1	href Attribute	Example 1-5	0.7	0.8565	0.8987	Yes
5	src Attribute	Definition 1-5	0.8	1.0000	0.9874	Yes
10	style Attribute	Example 1-5	0.58	0.9544	0.8978	Yes
15	width and height Attributes	Sample programs 1-2	0.6	0.7454	0.7895	Yes
20	lang Attribute	Sample programs 1-3	0.9	0.1425	0.8975	Yes
25	title Attribute	Definition 1-5	0.8	0.3451	0.8548	Yes
30	alt Attribute	Example 1-5	0.9	0.4545	0.8578	Yes

Table 7.
Curriculum information provided to students using the original information for students with moderate learning ability

Iteration	Selected course	Recommended course	Concept relationship degree	Difficulty parameter of the selected course	Students learning ability	Do you feel comfortable by the HTML course provided to you
1	href Attribute	Example 1-5	0.5	0.8565	-0.1	No
5	src Attribute	Definition 1-5	0.4	1.0000	-0.1	No
10	style Attribute	Example 1-5	0.38	0.9544	-0.2	No
15	width and height Attributes	Sample programs 1-2	0.6	0.7454	1	Yes
20	lang Attribute	Sample programs 1-3	0.9	0.1425	0.9858	Yes
25	title Attribute	Definition 1-5	0.8	0.3451	0.9857	Yes
30	alt Attribute	Example 1-5	0.9	0.4545	0.8125	Yes

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Table 8.
Curriculum information provided to students using the original information for students with low learning ability.

Iteration	Selected course	Recommended course	Concept relationship degree	Difficulty parameter of the selected course	Students learning ability	Do you feel comfortable by the HTML course provided to you
1	href Attribute	Example 1-5	0.35	0.8565	-0.1	No
5	src Attribute	Definition 1-5	0.48	1.0000	-0.1	No
10	style Attribute	Example 1-5	0.28	0.9544	-0.2	No
15	width and height Attributes	Sample programs 1-2	0.3	0.7454	1	No
20	lang Attribute	Sample programs 1-3	0.4	0.1425	0.0587	No
25	title Attribute	Definition 1-5	0.2	0.3451	0.1578	No
30	alt Attribute	Example 1-5	0.3	0.4545	0.3657	No

4.5. Curriculum sequencing incorporating Modified Information (MI)

Following is the procedure for retrieving MI. In the example provided, let us assume that the student has learned the nth course. To identify the next course suitable to the user the MI function is estimated as follows:

$$MI_i^{`}(\emptyset) = (1-k) \times \left[\frac{(1.69)^2}{[e^{1.69}(\emptyset - d_i)][1+e^{-1.69}(\emptyset - d_i)]^2}\right] + k \times c_{nj} \quad (23)$$

In the above equation, $MI_i^{`}$ represents the modified information value of the i^{th} course learned. The students learning ability is represented as $\emptyset$ and the value *k* represents the adjustable weight. The difficulty parameter and concept relation degree is estimated as d_i and c_{nj}.

It is recommended to use the modified information function to achieve the study path sequences for students with different skills in order to improve the disadvantage of curriculum sequences.

Additionally, the sequences of the programs are recommended. A weight value of 0.7 is set to 0.7 in the modified knowledge function experiment, highlighting concept of relationship intensity. In accordance with

Using the modified information function, a suitable HTML course recommendation can be recommended based on the individual student's skill level, according to the experimental analysis.

Accordingly, figure 11 shows an analysis of the definition relation rates in comparison to the modified information function resulting from the original information function.

Compared to the actual information function, the modified approach provides students with better learning paths. Accordingly, concepts with a high degree of concept relation are introduced successively according to student abilities and levels of complexity in HTML during the learning process. As a result, these students will achieve tremendous benefits, since they will be directed to learn more effectively.

Depending on the complexity of the course material, the adjusted weight k is set as a small value, and continuity in the learning pathway is ignored. According to the experimental findings indicate that, while modified weight *k* is set as a higher value, as a result of the prescribed course materials having a complexity value that is less interrelated to the student's ability, related learning concepts are prescribed successively during the neighborhood learning process. This research recommends that the dynamic weight *k* is set to 0.6 to fulfil the program series specifications and receive high-quality HTML course advice.

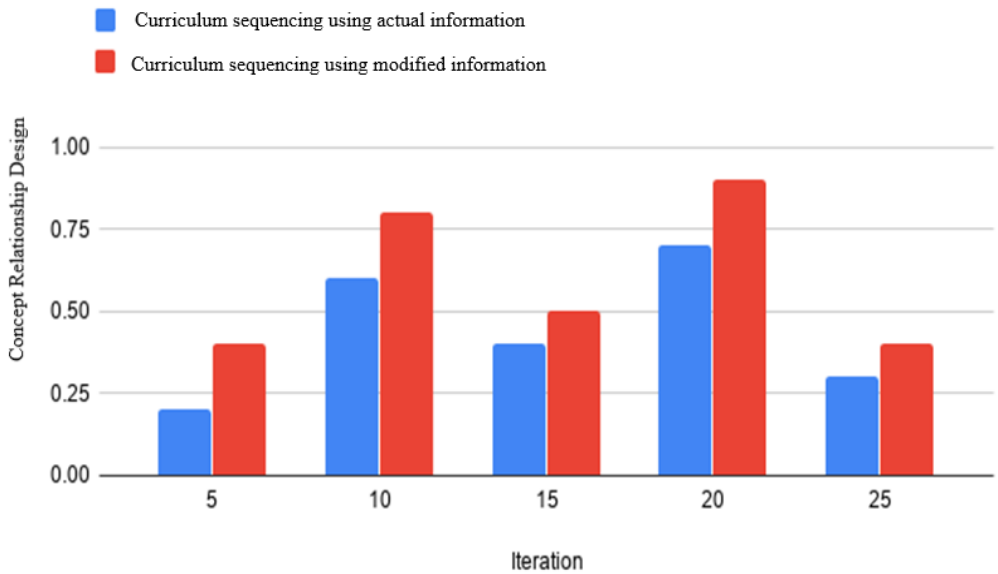

Figure 12.
Comparative analysis of the efficiency of curriculum analysis using actual and modified information

4.6. Evaluation of the Prediction Performance of DCNN In Terms of Classification Accuracy

A DCNN is used in this world to recognize facial expressions. The data consists of color images of faces with 48x48 pixels obtained using the surveillance cameras. The goal is to classify each face into one of seven categories (0 = Calm, 1 = Suprised, 2 = Happy, 3 = Disoriented, 4 = Sad, 5 = Weepy, 6 = Depressed) based on the emotion displayed in the facial expression. Using OpenCV you can automatically detect faces in photographs and draw boundary boxes around them. After the CNN has been trained, saved, and exported, the trained model is sent directly to a web interface, and performs face expression recognition on video and image data in real-time. To verify whether the prediction model by our DCNN is accurate it is compared with three other models such as Artificial Neural Network(ANN) [19] Multilayer Perceptron Network(MPN) [20] and Deep Belief Network(DBN) [21]. The Classification Accuracy of the models is derived using the following equation.

$$CA = \frac{Number\ of\ accurate\ predictions\ made\ by\ the\ system}{Total\ Number\ of\ predictions\ made} \quad (24)$$

In Figure, the classification accuracy is plotted against the number of approaches. The graphical analysis reveals that the proposed DCNN approach provides maximum classification when compared with all other approaches as shown in Figure-13. The classification accuracy obtained for different images is presented in Table 9.

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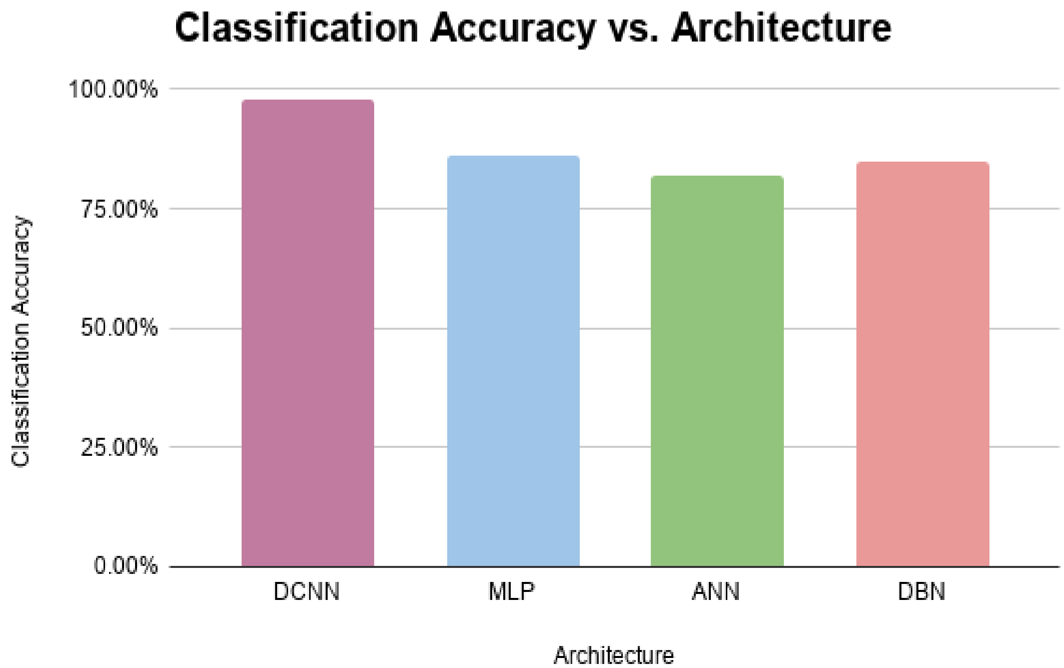

Figure 13.
Comparison of Classification Accuracy with different approaches.

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Table 9.
Facial expression of images categorized based on CNN.

Images	**Classification accuracy and expression detected**
	Identified Emotion: Weepy Classification Accuracy:100%
	Identified Emotion: Depressed Classification Accuracy:97%
	Identified Emotion: Calm Classification Accuracy:99%
	Identified Emotion: Happy Classification Accuracy:98%
	Identified Emotion: Disoriented Classification Accuracy:99%
	Identified Emotion: Sad Classification Accuracy:98%

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5. Conclusion

Autism is a chronic condition that has an early effect on children and their day-to-day experiences in life. Autistic children avoid social interaction, communication, and possess repetitive behaviours. A personalized learning system modifies the academic subject, education program, and learning environment according to the student's learning style and interests. The paper develops a personalized recommendation training framework employing Gene Expression Programming and DCNN for Autistic students with Rete's and Asperger's Syndrome. DCNN classifies the facial emotions of the student and considers the disorientation to the subject. The Gene Express Program determines the user's profile and produces content on the basis of their profile and preferred teaching methods. When disorientation is detected, the course is automatically terminated and an alternating learning style that reduces disorientation is given. The GEP algorithm considers teaching operation a question of optimization and offers the student the prescribed methods of teaching and learning. The challenge to be solved is to find the best teaching tool for people with autism. In the simulation part, a modified information function is used that can estimate student's skills on-line and suggest HTML courses to students across suitable and easier learning pathways. Simulation results demonstrate that, depending on students' skill and concept continuity in successive HTML-course, the program can specifically include a personalized curriculum sequencing approach using GEP and can also increase the learning effectiveness in students. Importantly, students just need to respond to two basic curriculum sequencing questionnaires. The Classification Accuracy of the proposed DCNN technique in predicting the student's emotions for discontinuing the difficult courses is 98%. In addition, our future work will provide certain assisted teaching materials such as personalized learning and diagnostics to include customized e-learning services in greater depth.

6. Future Work

One of the most important uses of Assistive Technology is in providing the Autism people to communicate their thoughts and needs. According to the latest surveys, nearly 40% of Autism people are non-verbal. A very large proportion of Autism people are facing problems in verbal communication as well as social communication. Hence the most suggested way of assisting the Autism patients is to enhance their communicative skills. For a patient with nonverbal skills, a tool or an App can be designed. On the other hand, social cues can be used to help the patients with strong verbal skills. Technology can be utilized to hear the voices of Autism patients which can help them make decisions. Special speech therapy tools are required instead of human voices to develop speech and language skills among them. Hence the future scope of the research work mainly concerned with creating an interactive AI tool which can replace human beings. It is proposed that a comprehensive system could be developed to improve learning skills, social skills, and linguistic abilities for people with autism spectrum disorders. Future research will examine the performance of different types of recommendation systems across all age groups with ASD

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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References

[1] M. Lina, *Personalized e-learning system based on multi-layer architecture. In 2009 International Forum on Information Technology and Applications*. Chengdu. https://doi.org/10.1109/IFITA.2009.245, 2009.

[2] H. Li, L. Wang, X. Du, and M. Zhang, "Research on the strategy of E-Learning resources recommendation based on learning context," in *2017 International Conference of Educational Innovation through Technology (EITT)*, 2017: IEEE, pp. 209-213.

[3] P.-A. Cinquin, "Online e-learning and cognitive disabilities: A systematic review," *Computers & Education*, vol. 130, pp. 152–167, 2019. https://doi.org/10.1016/j.compedu.2018.11.010

[4] D. A. Huffaker and S. L. Calvert, "The new science of learning: Active learning, metacognition, and transfer of knowledge in e-learning applications," *Journal of Educational Computing Research*, vol. 29, no. 3, pp. 325-334, 2003. https://doi.org/10.2190/5p79-pvkw-0ww7-3x06

[5] J. T. Nganji, "Designing disability-aware e-learning systems: disabled students' recommendations," *International Journal of Advanced Science and Technology*, vol. 48, no. 6, pp. 1-70, 2012.

[6] J. Jang, D. R. Dixon, J. Tarbox, D. Granpeesheh, J. Kornack, and Y. de Nocker, "Randomized trial of an eLearning program for training family members of children with autism in the principles and procedures of applied behavior analysis," *Research in Autism Spectrum Disorders*, vol. 6, no. 2, pp. 852-856, 2012. https://doi.org/10.1016/j.rasd.2011.11.004

[7] M. Judy, U. Krishnakumar, and A. H. Narayanan, "Constructing a personalized e-learning system for students with autism based on soft semantic web technologies," in *2012 IEEE International Conference on Technology Enhanced Education (ICTEE)*, 2012: IEEE, pp. 1-5.

[8] K. Venkatesan, S. Nelaturu, A. J. Vullamparthi, and S. Rao, "Hybrid ontology based e-Learning expert system for children with Autism," in *2013 International Conference of Information and Communication Technology (ICoICT)*, 2013: IEEE, pp. 93-98.

[9] D. Granpeesheh, J. Tarbox, D. Dixon, C. Peters, K. Thompson, and A. Kenzer, "Evaluation of an eLearning tool for training behavioral therapists in academic knowledge of applied behavior analysis," *Research in Autism Spectrum Disorders*, vol. 4, pp. 11-17, 2010. https://doi.org/10.1016/j.rasd.2009.09.004

[10] P. Øhrstrøm, "Helping autism-diagnosed teenagers navigate and develop socially using e-learning based on mobile persuasion," *The International Review of Research in Open and Distributed Learning*, vol. 12, no. 4, pp. 54-71, 2011. https://doi.org/10.19173/irrodl.v12i4.878

[11] H.-C. Chu, W. W.-J. Tsai, M.-J. Liao, and Y.-M. Chen, "Facial emotion recognition with transition detection for students with high-functioning autism in adaptive e-learning," *Soft Computing*, vol. 22, pp. 2973-2999, 2018. https://doi.org/10.1007/s00542-017-3415-2

[12] A. J. Vullamparthi, S. C. B. Nelaturu, D. D. Mallaya, and S. Chandrasekhar, "Assistive learning for children with autism using augmented reality," in *2013 IEEE Fifth International Conference on Technology for Education (t4e 2013)*, 2013: IEEE, pp. 43-46.

[13] H.-C. Chu, M.-J. Liao, W.-K. Cheng, W. W.-J. Tsai, and Y.-M. Chen, "Emotion classification for students with autism in mathematics E-learning using physiological and facial expression measures," *International Journal of Information and Communication Engineering*, vol. 6, no. 6, pp. 1660-1669, 2012.

[14] S. Thill, C. A. Pop, T. Belpaeme, T. Ziemke, and B. Vanderborght, "Robot-assisted therapy for autism spectrum disorders with (partially) autonomous control: Challenges and outlook," *Paladyn*, vol. 3, pp. 209-217, 2012. https://doi.org/10.2478/s13230-012-0041-9

[15] J. Brandão, P. Cunha, J. Vasconcelos, V. Carvalho, and F. Soares, "An augmented reality gamebook for children with autism spectrum disorders," in *The International Conference on E-Learning in the Workplace 2015*, 2015, pp. 1-6.

[16] S. Brighenti, S. Schintu, D. Liloia, and R. Keller, "Neuropsychological aspects of Asperger Syndrome in adults: a review," *Neuropsychological Trends*, vol. 24, pp. 63-95, 2018. https://doi.org/10.7358/neut.2018.24.2492

[17] J. L. Neul *et al.*, "Rett syndrome: Revised diagnostic criteria and nomenclature," *Annals of Neurology*, vol. 68, no. 6, pp. 944–950, 2010. https://doi.org/10.1002/ana.22124

[18] C.-a. Yuan, C.-j. Tang, J. Zuo, A.-l. Chen, and Y.-g. Wen, "Attribute reduction function mining algorithm based on gene expression programming," in *2006 International Conference on Machine Learning and Cybernetics*, 2006: IEEE, pp. 1007-1012.

[19] E. Mese and D. A. Torrey, "An approach for sensorless position estimation for switched reluctance motors using artifical neural networks," *IEEE Transactions on Power Electronics*, vol. 17, no. 1, pp. 66-75, 2002. https://doi.org/10.1109/63.988671

[20] H.-C. Fu, Y.-P. Lee, C.-C. Chiang, and H.-T. Pao, "Divide-and-conquer learning and modular perceptron networks," *IEEE Transactions on Neural Networks*, vol. 12, no. 2, pp. 250-263, 2001. https://doi.org/10.1109/72.911939

[21] Q. Dong *et al.*, "Modeling hierarchical brain networks via volumetric sparse deep belief network," *IEEE Transactions on Biomedical Engineering*, vol. 67, no. 6, pp. 1739-1748, 2019. https://doi.org/10.1109/TBME.2019.2945231