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Decision Support in the Automated Compilation of Individual Training Module Based on the Emotional State of Students

Adelina Iulamanova*. Diana Bogdanova**. Vitaliy Kotelnikov ***

* Ufa State Aviation Technical University (USATU)
Ufa, Russia, (e-mail: adel551155@mail.ru)

** Ufa State Aviation Technical University (USATU)
Ufa, Russia, (e-mail: dianochka7bog@mail.ru)

*** Ufa State Aviation Technical University (USATU)
Ufa, Russia, (e-mail: vit_kot@mail.ru)

Abstract: Distance education has become very relevant in the context of the global coronavirus pandemic. There is an acute issue of increasing the efficiency of this process. Students face problems of self-organization and lack of motivation to learn. Considering their emotional state and individual characteristics let create a system that adapts to each student and make education more individual. In this work, the problem of decision support is described in the automated compilation of an individual training module in distance education based on considering the emotional states of students. The work formulates the existing problems of distance education. An overview of existing research in the field of accounting and recognition of emotions in education is given. The problem of managing the process of distance learning, considering the emotional states of students and their individual characteristics, is given. It is proposed to introduce emotional support in the learning process and select the form of presentation of the material adequate to the student's state. The results of an experiment on 80 students with different personality types are presented. The analysis of the results showed that the emotional state of the students, who used the developed decision support system in teaching, became much better. After training, the level of knowledge of students, who used the developed decision support system, became higher.

Keywords: affective computing, student emotional state, distance learning, fuzzy decision trees, Nearest Neighbors algorithm

1. INTRODUCTION

Distance learning has been talked about a lot and for a long time, it was considered as the future of education. The period of the pandemic showed that this is not the future, but a necessity, and people had to teach and study remotely here and now. The distance learning skills, that we have acquired, need to be developed. The modern economy dictates the need for constant improvement of their knowledge from workers in any field of activity. There is a need to constantly study, study on the job – that is, remotely. People differ in their cognitive, psychological abilities and individual characteristics. The task of increasing the effectiveness of distance education through its personalization and adaptation to individual characteristics and emotional states of students is very relevant.

This article proposes an approach to managing the learning process in distance education based on the student's emotional state. In the first section, the problem of considering the individual characteristics and emotional state of students in distance education is formulated. This is followed by an overview of research on the issue under consideration. After that, the proposed approach to managing the distance learning process is revealed and the results of the experiment are presented.

2. FORMULATION OF THE PROBLEM

Currently, distance learning is one of the main ways of acquiring knowledge for the majority of students and schoolchildren around the world. But distance learning has a serious drawback. This is the lack of live communication between the teacher and the students. Because of this, the teacher cannot find an approach to a specific student and affect his emotional state.

Emotion is the body's response to external or internal stimuli. The right emotions motivate students, increase attention, and help make learning easier. If the student is experiencing emotional discomfort or has no emotions at the moment, then he will not pay due attention to the study of the subject. The emotions experienced depend on many factors, internal and external. One of the internal factors is the psychological type of the student's personality.

Increasing the efficiency of the distance education process is the aim of the research. This goal can be achieved by improving the mechanisms for managing this process by introducing decision support based on considering the individual characteristics of students and the emotional state. This problem is multidisciplinary, at the intersection of artificial intelligence, psychology and affective computing.

The main tasks on the way to achieve this goal are, firstly, formalizing the individual characteristics of students and their emotional states in the distance learning process; secondly, classifying students by their individual characteristics and emotional states; thirdly, considering these factors when organizing distance learning through the selection of emotional support and form of presentation adequate to the individual characteristics of the student.

3. RELATED WORK

Many scientists are studying the influence of emotions on the learning process. The work (Theobald et al., 2021) investigates the dependence of the emotional reaction for failure to achieve the set goal of learning and motivation to learn. The study involved 344 medical students who used LMS (learning management systems). Before teaching students reported their learning goals and after teaching they described their emotions (anger, tension, joy and pride) each day for 40 days. Daily goal achievement was assessed objectively using log files. The results show that the motivation to learn, in the form of adjusting the learning goal, depends not only on the previous achievement of the goal, but also on the students' emotions after success or failure.

The work (Horovitz et al., 2021) examines the influence of the emotional state of the teacher on various learning processes and its results. The work analyzes both the process of full-time and distance education and considers the binary emotional state of happiness and boredom. The study puts forward 5 hypotheses. The first hypothesis says that the emotional state of the teacher is recognized by the students; the second hypothesis is that this state affects the emotional condition of the students. The third hypothesis is that the state of the teacher affects the motivation of students, and the fourth hypothesis is that it affects the learning outcomes. The fifth hypothesis tests that students will respond in the same way to the teacher and to the computerized screen agents in distance education. A statistical experiment was carried out. The experimental results confirmed the first, second and third hypotheses completely, rejected the fourth hypothesis (possibly because the direct test was not sensitive enough) and partially confirmed the fifth hypothesis, recognition of the teacher's emotions in full-time education was higher. It can be concluded that students become happier and more motivated when they learn from happy teachers than from bored ones.

In (Arguedas et al., 2016), the influence of emotion management on time and management itself in e-learning is considered. Time is an important factor in the analysis of learning processes and the success of e-learning often depends on good time management. For the analysis, an experiment was conducted with high school students, which showed that improving the ability to manage emotions increases the ability to productively manage time, which increases the academic performance of students.

In (Gartmeier et al., 2016), the ways of presenting material and their ability to transmit emotions are analyzed. The role of emotions in learning with the help of training video-cases is considered. It describes how video recordings can adequately reflect the emotions of people participating in scenes, and how

this can affect professional-oriented education. The ability to respond professionally and recognize emotions affects the development of professional competencies.

In (Finch et al., 2015), experience-based learning in management education and the impact of emotional involvement on the learning process are considered. An experiment conducted in the research shows that student goal orientation plays an important role in predicting emotional response, which leads to improved learning performance. The research also showed that in the process of performing practical tasks, the interdependence inherent in team learning is a critical trigger of negative emotions. From this it is concluded, that in this type of learning it is important to learn how to regulate and adapt to negative emotions, while maintaining a focus on performance.

The research (Whiteside et al., 2016) examines how the relationship between students and teachers is realized in online and blended learning. The power of emotions in learning is analyzed, the concepts of social presence are defined and the social presence model (SPM) is described and explained. Researches confirm the importance of the role of teacher leaders who personalize blended learning and help students with emotion and innovative learning strategies. Social presence enhances the overall learning experience.

In (Heidig et al., 2015) multimedia teaching is considered and the influence of emotional design of multimedia educational material on the learning process is analyzed. The research attempts to deduce emotionally significant features of multimedia design, considering negative emotional states. The experiment was carried out on German college students. It consisted of nine conditions, two types of design with two levels of emotionality, and a usability factor with different levels of practicality. The research did not reveal objective differences in aesthetics or practicality, and did not affect the emotional state of the students. However, the perceived aesthetics and practicality had a positive effect on the emotional state of the students, which ultimately influenced the motivation of the students.

In (Feidakis, 2016) the problems of e-education are analyzed. These include students' self-doubt, high dropout rates, low motivation and engagement, self-regulation, and task performance. It is proposed to create such learning systems that would be adaptive, emotionally oriented, and personalized, adequate to the inner world of each student. The creation of such systems will expand the boundaries of educational distance technologies and implement cost-effective training programs.

The work (Khuri, 2004) deals with intergroup dialogue. This form of education a priori causes emotional reactions that are not universally analyzed. The work examines the role of emotions in intergroup contact and proposes a set of principles for working with emotions in intergroup dialogue.

The authors (Lackéus, 2014) propose a new approach to organizing business education based on real practice. The work examines the influence of experienced emotional events in the learning process on the development of entrepreneurial

competencies. The experiment was carried out for 9 months on engineering students. The students were equipped with a mobile application used to report emotional events and critical learning events. The reports were accompanied by quarterly semi-structured interviews. The results obtained indicate a large number of connections between emotional events and developed entrepreneurial competencies, such as interaction with the outside world, working in uncertainty, and experience of teamwork.

The main task of affective computation in education remains the task of recognizing the emotions of participants in the learning process. For this, various technical and intellectual means are used. The question of the modality of measuring emotions is equally acute. The work (Yang et al., 2018) proposes an approach based on face recognition to identify students' understanding of the entire distance learning process. It consists of three stages: feature extraction, feature subset collection, and emotion classification. The Haar Cascades method is used to detect the input image, then a characteristic emotion value is obtained using Sobel edge detection. By training a neural network classifier, six types of different emotional categories are obtained. The experiment was carried out on data from the JAFF database. The results show that the proposed method has high classification efficiency. Recognizing facial expressions in real time allows you to identify the student's learning status in distance education.

In e-learning systems, considering the emotions of students is extremely important. Emotion recognition can be organized in a variety of ways. Emotions can be requested from the user, can be recognized by voice, facial expressions, gestures, or by tracking implicit parameters. The authors (Imani et al., 2019) consider the methods of recognizing emotions in the best way, suitable for e-education, analyze their advantages and disadvantages. According to the results of this research, multimodal emotion recognition systems by fusing information in the form of facial expressions, body gestures and user messages provide better performance than unimodal systems.

Emotions play an essential role in cognitive processes that are responsible for the assimilation of new information. The teacher cannot always control the emotions of students, therefore, a system, that supports the teacher's work and is capable of tracking all the hidden indicators of students' internal emotions, is needed. In the article (Bouhlal et al., 2020), the authors reveal the value of emotional recognition for both students and teachers. The phases of face recognition are considered, educational approaches that integrate various types of face recognition techniques are proposed.

In work (Krithika et al., 2016), a tracker of activity of pupil movements and movements of the student's head during classes is used for the recognition of emotions in an electronic learning environment. The authors propose a system that can identify and control student emotions in an e-learning environment and provide a real-time feedback mechanism to improve e-learning tools for better content delivery. The activity tracker for pupil movement and head movement can provide an assessment of the student's level of concentration.

The article (Tian et al., 2014) presents an approach to emotion recognition based on textual interaction in Chinese with students in e-learning. For the analysis, the categories of emotions that are adequate for learning are determined. The semantics and syntax of the Chinese language and its features for recognizing emotions are evaluated. As a toolkit, applicability to Support Vector Machines (SVM), Naive Bayes, LogitBoost, Bagging, multiclass classifier, RBFnetwork algorithm, J48, Random forest is evaluated. An experiment, that uses the weighted sum method to calculate the similarity of Chinese sentences, is conducted. The result shows that the effective case ratio is 68%.

In (Cen et al., 2016), the recognition of emotions by continuous speech is investigated and a system for the recognition of speech emotions in real time is proposed. The proposed approach consists of voice activity detection, speech segmentation, signal preprocessing, feature extraction, emotion classification, and statistical analysis of emotion frequencies. Experiments were carried out on recorded datasets and on real-time data with recognition of four emotions. The average measurement accuracy in both experiments was 90% and 78%, respectively. An experiment in a simulated online learning environment showed that the developed system effectively recognizes the student's response to the course, which helps students achieve optimal learning performance.

The article presents an analysis of 16 studies related to the organization of distance education through information systems with the recognition and consideration of emotionally colored information of students in the learning process. The analysis showed that various methods of emotion recognition with different effectiveness are used in distance education. Much depends on the tasks set for researchers. Also, the articles under consideration show the dependence of learning outcomes on the emotional state of students.

4. PROPOSED APPROACH

The proposed approach to the management of the distance learning process consists in the formation of an individual training module adapting to the characteristics of the student and his emotional state. To solve this problem, 5 basic emotions that must be taken into account in distance education are considered. It is joy, interest, fear, sadness, and anger. Emotions depend on the type of person. Knowing the student's psychotype, one can assume what emotions he will experience and how he will behave in a given situation. Psychological verbal and communicative methods are used to determine the psycho-type of personality and emotional state of students. The psychological type of a student's personality is determined using the Eysenck questionnaire. Students' personality types can be sanguine, phlegmatic, choleric or melancholic. At the end of the test, each student has a profile that stores information about the student and his or her motivation to learn, initial training, speed of perception, representative system and his or her personality type. To determine the emotional state of students, the modernized Karelin questionnaire, which is part of the recommendations of the psychological support service in higher educational institutions in Russia, was used.

Figure 1 shows the developed structure of the control scheme for the distance learning process based on the individual characteristics and emotional state of students taking into account.

The object of management is the learning process, which consists of the following stages. After registration, the student passes a questionnaire, where his main characteristics of the profile are ascertained (motivation for learning, representative system, personality type, etc.). Then the student chooses a subject of study and undergoes an assessment of his level of knowledge in the chosen subject. Based on the data obtained, a student's profile is formed.

Testing is carried out to identify emotions. Then the identified emotions are formalized. In this way, the student's emotion is determined before the start of training. The classification of students according to their emotional state is carried out. To improve the effectiveness of training, the emotional state of the student is corrected by providing him with emotional support. The Nearest Neighbor Method is used to select emotional support. This method determines the degree of similarity between the new observation and the rest of the observations. And then it assigns the new observation to the class with the greatest similarity. Each student is assessed according to the parameters of his emotional state and personality psycho-type.

For emotional support it is suggested to form a limited set of activities, for example to praise the student, show a joke or a short inspirational video, etc. For each class of the student's emotional state, expert psychologists have chosen their own emotional support activities. The classes consist of a number of students with the same characteristics and are based on a training sample. For each class, the appropriate emotional support has already been selected by certified psychologists.

The next step is the selection of the form of material presentation. The method of fuzzy decision trees is used to select the level of complexity and form of material presentation. Each student is characterized by the following parameters: motivation to learn, speed of information perception, level of initial training, representative system and emotional state. In this method, a decision tree is initially built using a training sample of students. After that, new students are classified using the already built tree. Fuzzy decision trees allow you to find out not just the class membership, but the degree of membership. That is, a student can belong to different classes with varying degrees. In such trees, the degree of their belonging is grouped, but not the number of observations of a particular node. Then training is carried out and the final testing is performed after the student has fully studied the program of the chosen subject.
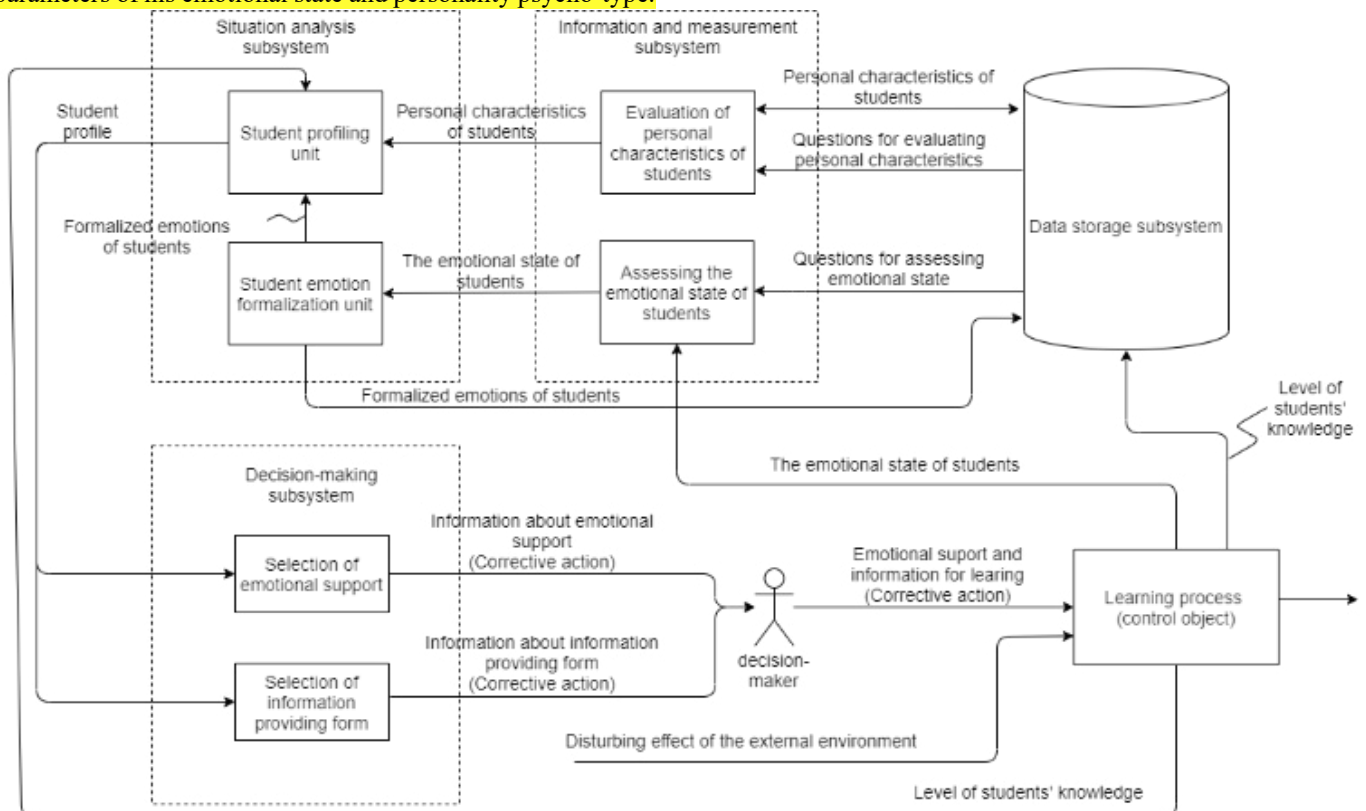

Figure 1. The structure of the control scheme for the distance learning process

5. ANALYSIS OF EXPERIMENTAL RESULTS

To assess the effectiveness of the proposed approach, a decision support system was developed in the formation of an individual training module, considering the individual characteristics and emotional state of students. For the experiment were selected 120 students of the Law College, studying the "Psychology" discipline. The training set consisted of 50 students with a random set of personality types. The experimental set consisted of 80 students, divided into 2 groups. Students of the first group were trained using a decision support system. During the training, they were provided with emotional support, and the material was selected based on their personal characteristics. Students of the second group were trained without using a decision support system.

For the purity of the experiment, each of these groups included 10 sanguine, 10 phlegmatic, 10 choleric and 10 melancholic.

After the experiment, the indicators of the emotional state of students after training and the level of knowledge of students after training were monitored.

The analysis of the experimental results is shown in Figures 2-4. The emotional state of the students who used the developed decision support system in teaching was much better. The number of experienced positive emotions increased by 20%. After training, the level of knowledge of students who used the developed decision support system was higher. The number of students who passed the test increased by 12.5%.
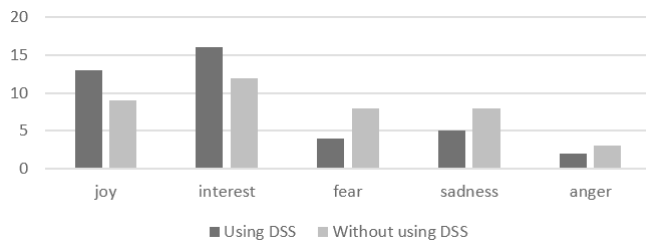

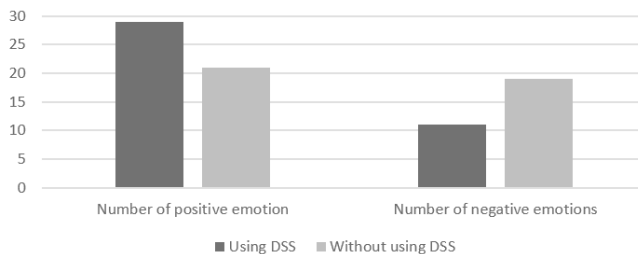Figure 2. The level of students' emotional state after training

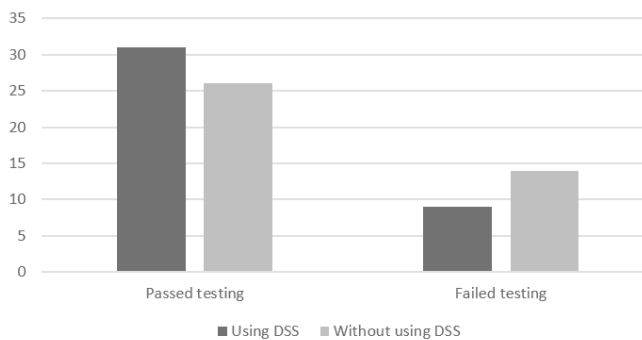Figure 3. The level of students' emotional state after training

Figure 4. The level of students' knowledge after training

6.   CONCLUSIONS

Evaluating and accounting for students' emotions in distance education is a major challenge. It is sometimes difficult for a student to manage his emotions when he is alone with the teaching system. Emotional support is designed to improve motivation for learning, increase self-confidence and help cope with the volume of knowledge being mastered.

In this work, the problem of decision support is considered in the automatic compilation of an individual learning module in distance education based on the emotional states of students

taking into account. The work formulates the existing problems of distance education. This is the lack of live communication between the teacher and students, which is why the teacher cannot find an approach to a specific student and affect his emotional state.

A review of existing research in the field of accounting and recognition of emotions in education showed the relevance of the problem and the high activity of researchers in this area.

The task is to manage the distance learning process, taking into account the emotional states of students and their individual characteristics. It is proposed to introduce emotional support into the learning process and select the form of presentation of the material adequate to the student's condition. To improve the effectiveness of training, the emotional state of the student is corrected by providing him with emotional support. The Nearest Neighbor Method is used to select emotional support. The method of fuzzy decision trees is used to select the level of complexity and form of material presentation.

To analyze the performance of the proposed approach, an experiment was carried out on 80 students with different psychotypes of personality. The analysis of the results showed that the emotional state of the students who used the developed decision support system in teaching became much better. The number of experienced positive emotions increased by 20%. After training, the level of knowledge of students who used the developed decision support system was higher. The number of students who passed the test increased by 12.5%.

A prototype of a decision support system was developed to test the proposed approach. In the future, it is planned to expand the functionality of the developed software product with the possibility of integration into existing learning management systems (LMS). To improve the accuracy of students' emotional state assessment, it is planned to implement the recognition of students' emotions during training by analyzing facial expressions from videos.

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