

INFORMATION TECHNOLOGIES IN THE FORMATION OF CLUSTERS OF PERCEPTION OF INFORMATION IN STUDENTS WITH HEARING IMPAIRMENTS

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Abstract

The article discusses issues with the peculiarity of using information technology to study the features of perception of information in students with hearing impairments. Thanks to the use of information technology, a method for clustering technical science students with hearing disabilities connected with so-called image thinking phenomenon into subgroups with different characteristics of the information perception in the learning process was created.

Employed methods and research strategy of the issue are presented in section 1. Based on the methodology of R. Cattell (form C) and using the modification of the test questionnaire of A. Mehrabian non-metric learning assessment scale using novel clusterization algorithm was proposed. Approbation of the proposed scale was conducted during the survey among the university students of technical specialties. The processing of survey results was conducted in Matlab based software, which was developed as an express method that allows to form personal, intellectual characteristics of hearing impaired students, as well as their motivational basis for learning. Analysis of the results obtained by the software is provided in section 2.

Section 3 of the article includes discussion of the results and recommendations to adopt the real-virtual environment of education, that allows to increase the efficiency of education for students with different types of hearing disabilities. A novel interaction model between teacher and students is also proposed.

Keywords: hearing-impaired students, Matlab based interpretation software, efficiency of education, real-virtual environment, knowledge evaluation system, non-metric evaluation.

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Introduction

One of the key developmental quotients of modern society is provided to invalids the level of conditions allowing the people with disabilities to realize their

potential in variety of fields, including the higher education getting.

By analysed in [1], the largest group of people with disabilities is formed by those who have hearing impairments. It is a significant social problem, since

according to the World Health Organization at least 1.1 billion young people (aged 12–35 years) are at risk of hearing loss due to exposure to noise in places of recreation and entertainment [2]. By official statistics [1] there were about 13 million hearing impaired people, or about 9.1 % of the total population in Russian Federation in 2010.

One of the aspects of the above social problem in Russian Federation is the fact that there is a small amount of higher education among people with hearing impairments. By statistics from the All-Russian Society of the Deaf (RSD) at 01.01.2016 [3] only 3 % of 79 540 RSD members have higher education with other RSD members having: 47 % — incomplete secondary education (basic general education), 36 % — secondary education, 13 % — secondary special, 1 % — incomplete higher.

The aforementioned is due to the fact that at the moment the greatest attention in special pedagogy is paid to the teaching issues of hearing students when they get general and secondary vocational education [4], but limited attention is paid to higher education [5–10]. It should be noted that the results obtained for higher education are contradictory, which leads to instability in the application of modern methodological foundations to improve the hearing students education quality [5, 10] and this is most accurate for technical specialties in higher education for students with hearing disabilities [9].

One of the approaches to overcome this problem is the application of an intellectual approach to hearing students teaching in which the interaction between the teacher and students is based on the appropriate choice of the intellectual learning style [8]. According to [7, 8] a second style of learning prevails among hearing students. It is characterized by a student preference to complete tasks with a high degree of structured input data, which allows students using simpler methods based on traditional approaches. The role of collective thinking is growing in this case. However, despite the significance of the students results, their results are quite general in nature, aimed primarily at obtaining higher humanitarian education. Unfortunately, they do not indicate approaches to their practical implementation [9]. Overcoming this drawback is possible by taking into account the results of [9], which indicates the need to take into account the thinking “images” and further more detailed study of this feature.

Thus, goal of the research is better understanding of such properties as hearing students thinking by “images” with the subsequent development of recommendations for adapting the real-virtual environment of accelerated development.

1. Methods and research strategy

To achieve the formulated goal the MATLAB software was developed, which relies on non-metric learning assessment scale (i. e. personal and intellectual peculiarities of students). The learning assessment

scale is based on the methodology of multivariate personality research of R. Cattell (form C) and the modification of the test questionnaire of A. Mehrabian to measure achievement motivation (MAM), which was proposed by M. Sh. Magomed-Eminov.

The employed methodology as a basis of non-metric learning assessment scale is justified by the fact, that hearing-disabled student are thinking, perceive and process the information by images (so called “image thinking”) that is just external manifestation of a set of personality factors for each hearing student. This, as part of the study group, leads to the formation of the corresponding subgroups, which from the point of view of mathematical statistics represent clusters having common personality traits, which must be taken into account in educational activities.

The Cattell’s methodology is suitable to form such scale because this multivariate personality research model has two advantages over other personality methods. First, it can be used to fairly well cover the personal sphere, and second (and it has been proved by statistical methods), the factors obtained by R. Cattell lack a priori bias characteristic of factors identified on the basis of other theoretical concepts [11]. Moreover, the questionnaire itself allows to describe in detail the personality structure and to reveal the relationship of individual personality characteristics, to reveal hidden personality problems, to find compensatory mechanisms for maintaining mental health. Moreover, one of the most appropriate areas of its application is psychological and pedagogical counseling and professional selection [12]. Thereby the choice of the form C questionnaire is due to the following reasons [11–15]:

- 1) the questionnaire was initially oriented for group testing;
- 2) it was developed for adult persons with at least high school education;
- 3) it is concerned on getting precise assessments, because the questions contained in the questionnaire requires answers that involve self-assessment mechanism and put them into conditional situation from the life;
- 4) it is adapted to native Russian speakers.

The key of non-metric scale is that the employed set of clusterization factors to form subgroups is a block of factors that describes intellectual personal characteristics (B, M, Q1 factors) according to the methodology of R. Cattell [13]. Further characterization of subgroups (tree clustering) is performed with the use of communicational and emotional block of personal factors, as well as factors, responsible for self-assessment [13]. The detailed description of the scale is the following:

- 1) At the first stage, clusterization of students into subgroups is performed according to the set of factors (patterns), that determined intellectual personal characteristics (B, M, Q1) [13]. Here clusterization criterion is student’s attitude to perception of knowledge and its further usage, particularly, presence or lack of pragmatism (focus on accomplishing specific

tasks), difficulties for intellectual tasks, ability or inability to operate with abstract notions.

- 2) Based on the first stage of clusterization, additional tree clusterization is applied using communicational, emotional block of factors, as well as self-assessment, shown in [13]. Thereby patterns close in description are considered as a single whole without using dissimilar features during clusterization and development of description profiles for each subgroup.
- 3) Assessment of motivational part based on MAM, as well as deafness degree is performed after tree clusterization

The abovementioned clustering algorithm using the developed non-metric scale was implemented at the Kazan National Research Technical University named after A. N. Tupolev — KAI (KNRTU-KAI) for educational programs of higher technical education. Approbation was conducted on selected 27 hearing-disabled students. It should be noted that by virtue of the law of large numbers, the use of a sample of such a volume is sufficient to obtain representative results.

2. Algorithm approbation and the analysis of results

The results achieved using the cluster approach are as follows:

1. The considered group of hearing-disabled students is divided into three subgroups based on the intellectual block of factors:

- *Subgroup A (pattern description: $B=0..3, M=0..6, Q1=7..12; B=0..3, M=0..6, Q1=0..6; B=4..8, M=0..6, Q1=7..12; B=4..8, M=0..6, Q1=0..6$).* It includes the majority of students (66.6 %), that are characterized by a focus on thinking, which bears hints of pragmatism, and social dexterity, even if the student has developed analytical thinking, as indicated by the inherent him a concrete imagination, which is an integral part of thinking. It should also be noted that in subgroup A, the majority of students (66.6 %) have persistent hearing impairment (deaf and hard of hearing with only hearing aids, see Fig. 1).
- *Subgroup B (pattern description: $B=0..3, M=7..12, Q1=7..12; B=4..8, M=7..12, Q1=7..12$).* It includes 25.9 % of students from the studied group, is characterized by developed analytic thinking skills, ability to operate with abstract concepts, together with intellectual interest and lack of pragmatism. Decrease in the number of students with persistent hearing impairment (57.14 %) and an increase in the number of hard of hearing students (42.85 %) compared with subgroup A are main features of the *Subgroup B*.
- *Subgroup C (pattern description: $B=0..3, M=7..12, Q1=0..6$).* It includes students with problems to solve intellectual tasks. The size of subgroup is 7.4 % of students from the studied group. The low efficiency of thinking, the

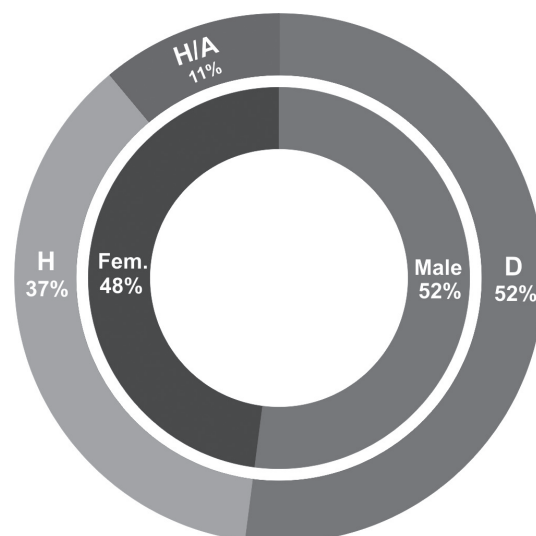


Fig. 1. Composition of students according to gender and degree of deafness

low level of general culture and erudition, the criticality and conservatism in accepting the new, the reduced interest in new intellectual knowledge. Developed imagination, ability to operate with abstractions (see Fig. 2).

2. Tree clusterization of the above mentioned subgroup revealed the following peculiarities:

- *Subgroup A.* The adoption of generally accepted moral rules and norms, submission to the requirements and opinion of the group is observed in 83.3 % of students in this subgroup. The half of the students of subgroup A have difficulty and restraint in establishing social contacts ($A=7..12, F=6..12, H=0..6; A=7..12, F=0..5, H=0..6$), and restraint in interpersonal contacts is observed in 11.1 % of subgroup A ($A=0..6, F=6..12, H=7..12$). It should also be noted that the majority of students (55.55 %) of subgroup A have an overestimated self-esteem, an uncritical attitude towards themselves, as evidenced by overestimated values for the MD factor. The results of tree clusterization in the developed software are shown on Fig. 3.
- *Subgroup B.* A developed sense of duty, responsibility, adherence to generally accepted rules and norms are observed in 42.85 % of students in this subgroup. However, dependence on the opinion of the group is already observed in 85.7 % of students of subgroup B.
- *Subgroup C.* It is characterized by a developed sense of duty and responsibility, the adoption of generally accepted moral rules and norms. There is a certain complacency, but at the same time, students of this group can make their dreams come true, reality-oriented and quite entrepreneurial. Self-esteem is adequate.

3. All students are dominated by the desire to avoid failure. It follows from the analysis of MAM results.

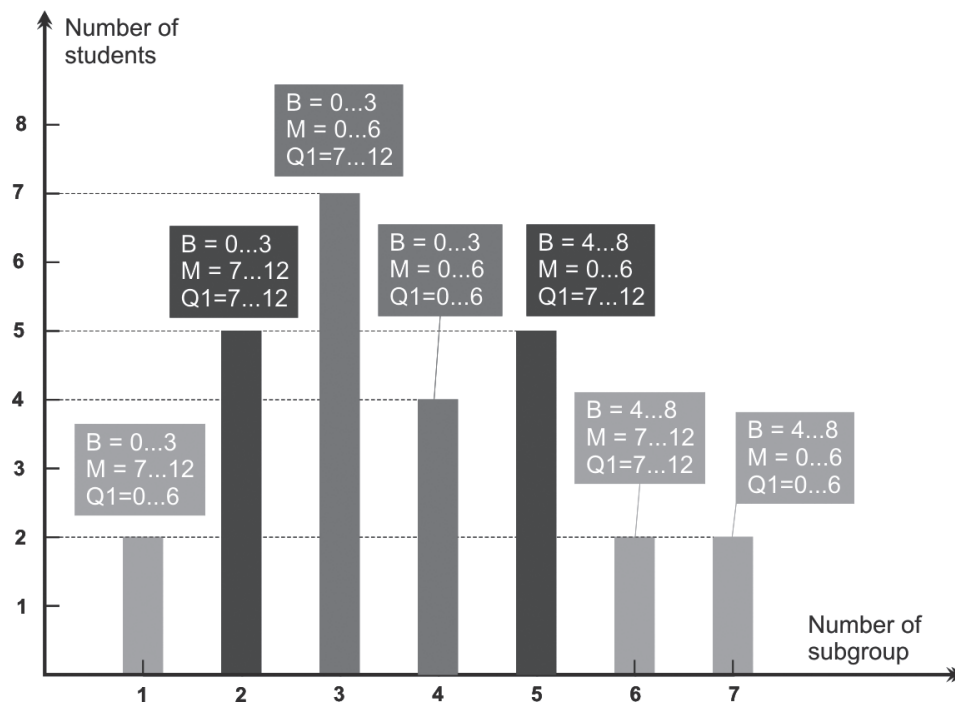


Fig. 2. Students distribution by intellectual subgroups

4. The correctness of the proposed clustering algorithm and non-metric learning assessment scale is confirmed by the results of the analysis of the block of emotional characteristics. So, 88.88 % of students from subgroup A have the following qualities that

follow from the analysis of an emotional characteristics block: pragmatism, following and focusing on material valuables, focus on real activities, prudence. Thereby analysis of emotional factors of subgroup B revealed, that 85.7 % of students in this subgroup have developed

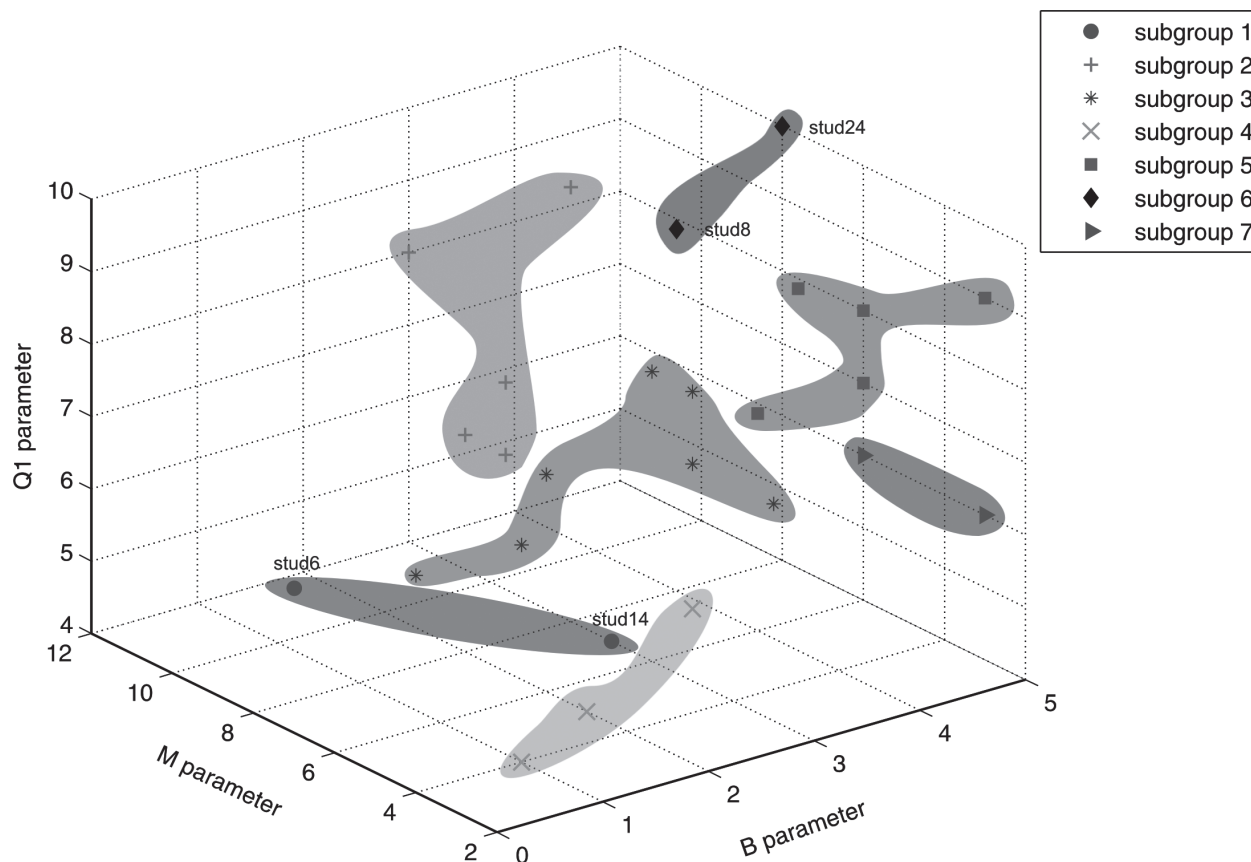


Fig. 3. Results of tree clusterization of hearing-disabled students in the developed software

imagination, low pragmatism in behavior, and the ability to make their dreams come true.

In addition to results obtained from clusterization, the developed software allowed to make the following conclusion for any studied group:

1. Low level of general culture and erudition in 66.67 % of the students; about a third of the studied group (29.63 %) are critical and conservative of accepting new, including novel, intellectual knowledge, in addition, they have a reduced level of analytical thinking; the inability to update the knowledge gained is observed in 14.81 % of students; only a third of the students in the group have the ability to operate with abstractions; and independent third-party intellectual decisions can be made by about a third of all students (29.62 %); it should be noted that difficulties with solving intellectual problems are observed only in 7.4 % of students in the group; low responsiveness is observed in two-thirds of students in the study group.

2. The adoption of generally accepted moral rules and norms, submission to the requirements and opinion of the group is observed in 70.3 % of students.

3. Difficulties and restraints in establishing social contacts is observed in 59.25 % of students in the study group, as evidenced by indicators for factors A, F, H ($A = 0.6$, $F = 0.5$, $H = 0.6$; $A = 7.12$, $F = 6.12$, $H = 0.6$; $A = 7.12$, $F = 0.5$, $H = 0.6$). At the same time, restraint in interpersonal contacts is observed only in 22.2 % of all students, as indicated by indicators for factors A, F, H ($A = 0.6$, $F = 0.5$, $H = 0.6$; $A = 0.6$, $F = 6.12$, $H = 7.12$; $A = 0.6$, $F = 6.12$, $H = 0.6$). Restraint both in interpersonal contacts and difficulties in social communication are observed only in 11.1 % of all students ($A = 0.6$, $F = 0.5$, $H = 0.6$; $A = 0.6$, $F = 6.12$, $H = 0.6$).

4. About a third of students (37 %) are unsatisfied with themselves, lack of self-confidence is inherent in their behavior, about a quarter of all students demonstrate some relaxation in their behavior and complacency (22.22 %).

3. Discussion of the results and recommendations

Based on the approbation results from the presented clusterization method it is possible to propose the following recommendations, which will eventually allow to increase the efficiency of education for hearing-disabled students:

1. Due to the fact that the majority of students with hearing disabilities have difficulty and restraint in establishing social contacts, it leads to a barrier in the interaction between the teacher and the student. It is possible to overcome this barrier through the use of interpersonal contacts, since the establishment of such contacts in the group does not cause problems in most cases. For this, first of all, it is necessary to involve interpersonal contacts between students having a desire for leadership or having leadership qualities, who usually do not have problems in communication

skills and can serve as a mediating leader between the teacher and the rest of the student group. This will allow discipline in the group thereby eliminating the obstacle to learning in the form of relaxation of some students in the group. It should be noted that the teacher, when establishing interaction with the group, should, first of all, seek the role of a mentor, "senior comrade", helping students overcome fear associated with possible failures. In particular, it can be attempted to be achieved by using the interests of the students themselves, related to their future professional activities, helping them to overcome the difficulties associated with learning. It should help to overcome the barrier associated with criticality and conservatism in the adoption of new intellectual knowledge.

In order to accelerate adaptation process it is quite reasonable to form educational groups using the proposed learning assessment scale and clusterization method, particularly the developed software. It useful to select the President of the class and his assistant from persons in subgroup B. Thereby using real-virtual environment can initially significantly accelerate the process of overcoming the barrier, since this reduces fears associated with possible failures, the fear of making mistakes including receiving an unsatisfactory assessment.

2. Since the majority of students observe the adoption of generally accepted moral rules and norms, submission to the requirements and opinion of the group, it is advisable to use the mechanism "teacher — tutor — student", "leader — mediator — student group" to adjust moral rules and standards, which are necessary for socialization, inclusion of students in society including professional. Changes in interaction models are recommended to track with the developed learning assessment scale and clusterization algorithm.

3. Due to the fact that most students have practical thinking, pragmatism, prudence, it is necessary to say that the perception of new intellectual information by people with hearing disabilities always passes an assessment from the point of view of its applicability in practice, including from the point of view of obtaining with its help economic benefits and terms for achieving this. At the same time, the effectiveness of the new information received is evaluated at the expense of the video. Therefore, in order to achieve the greatest efficiency in teaching students with hearing disabilities, it is required to adhere to the following recommendations:

Before submitting lecture material on each topic, it is imperative to show material place in the overall structure of the acquired specialty, as well as the application of the acquired knowledge for the design, maintenance and repair of elements or subsystems of typical systems that are implemented in practice, and it is necessary to indicate the relationship with the previous studied material. Special attention should be paid to the benefits of studying the proposed knowledge, one of the manifestations of which can be professional growth. To achieve the best learning outcome, it is necessary to use deduction with the use of visual

images with an appropriate explanation, which should be distinguished by its logic and simplicity of sentence constructions used for presentation, not allowing their ambiguous interpretation. The easiest way to achieve the result is to use information technologies, that deal with building relations between graphical objects (for example, MS Visio). It is also advisable to use as many household terms that are most often used in everyday life. If the use of household terms or their analogies is difficult or impossible, then a more detailed graphic illustration “in steps” should be used. A story about the relationship with the material previous studied can be conducted in combination with knowledge control by conducting a knowledge survey using a game form, for example, combining questions and answers with students without assessing them using grades. It allows to remove the barrier associated with failures to adjust the learning path. When presenting the lecture material, it is necessary to use a large number of examples demonstrating the material in a visual form.

When setting out mathematical theorems and properties, it is necessary to accompany the material with numerical (practical) examples with graphic material demonstrating a change in its properties or possible practical applications. The presentation of the material itself should resemble in a sense the listing of a PC program, that is, be strict, directive, logical and detailed.

4. Since most students have a low thinking efficiency, it is difficult to switch from one type of work to another. The one of the manifestations of that is the teaching of disciplines that are not close to each other (humanitarian and technical). To reduce the negative manifestations of the low thinking efficiency, it is necessary to group classes in academic disciplines having some commonality (used mathematical apparatus, interdisciplinary relationship) within one school day, while combining lecture and practical classes into a single whole, alternating the presentation of the lecture material in small portions that satisfy the requirement of logical completeness, while the lecture presentation should take place in portions during the time interval not exceeding 30 minutes. After that, the practical component of the discipline should be implemented with the solution of a sufficient number of examples accompanied by a call of each student to the board and with the participation of the rest of the group in solving tasks.

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ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ В ФОРМИРОВАНИИ КЛАСТЕРОВ ВОСПРИЯТИЯ ИНФОРМАЦИИ У СТУДЕНТОВ С НАРУШЕНИЯМИ СЛУХА

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Аннотация

В статье рассматриваются вопросы, связанные с использованием информационных технологий для изучения особенностей восприятия информации у студентов с нарушениями слуха. Благодаря применению информационных технологий был создан метод для кластеризации студентов с нарушениями слуха, обучаемых по техническим специальностям, на основе изучения так называемого феномена «мышления образами» на подгруппы с различными характеристиками восприятия информации в процессе обучения.

Используемые методы и стратегия исследования поставленной задачи представлены в разделе 1. В работе предложена новая неметрическая шкала оценки знаний, реализованная на основе методологии Р. Кеттелла (форма С) и с использованием модификации тестовой анкеты А. Мейерабиана. Результаты, полученные с ее помощью, обрабатываются с помощью нового алгоритма кластеризации. Апробация предлагаемой шкалы проводилась в ходе опроса среди студентов вуза, обучаемых по техническим специальностям. Обработка результатов опроса проводилась в программном обеспечении, разработанном в среде Matlab. Программное обеспечение было создано в виде экспресс-метода. Оно позволяет формировать личностные, интеллектуальные характеристики учащихся с нарушениями слуха, а также их мотивационные основы для обучения. Анализ результатов, полученных с помощью программного обеспечения, приведен в разделе 2.

Раздел 3 статьи включает в себя обсуждение результатов и рекомендации по внедрению реальной виртуальной среды обучения, что позволяет повысить эффективность обучения для учащихся с различными типами нарушений слуха. Также предлагается новая модель взаимодействия между преподавателем и обучаемыми.

Ключевые слова: студенты с нарушениями слуха, программное обеспечение для интерпретации на основе Matlab, эффективность обучения, реальная виртуальная среда, система оценки знаний, неметрическая оценка.

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