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## **Development of support software for inclusive online education**

Situation with corona virus has demonstrated that online education is a compulsory measure in arrangement of education for children with disabilities. Learners with disabilities cannot capture educational programs without use of dedicated (adapted) educational programs, methods of teaching and upbringing, and also their software support. This article covers issues of arrangement of an educational process for learners with mental retardation with the use of online educational technologies and also describes experience of creation of "InclusiveEdu – Information Science 7" software within principal educational school program. It offers maximally available and efficient educational space, arrangement of which takes into account individual characteristics of learners. This educational space can involve all the participants in educational relations: learners, their parents (legal representatives), teachers, special community helpers. It has been found that mentally-retarded children prefer to watch and listen to information instead of reading. That is why the developed software product offers an opportunity to listen to important information. In order to test efficiency of the developed software, a pedagogical experiment was carried out in four schools of Almaty City in conditions of online education which produced positive results in favor of the offered teaching methodology.

**Keywords:** online education, inclusive education, inclusive online education, software, disabilities, mental retardation, dedicated educational programs, special educational needs.

### *Introduction*

Online education enables all students, irrespective of their level of education and health status, to receive quality self-education and training throughout their lives. It provides for remote interaction between a teacher and pupils that represent all the elements inherent in the educational process (objectives, content, methods, organizational forms, training aids).

Therefore, opportunity for studies is provided to those who cannot or does not want to participate in classroom studies. These may include children with special educational needs who receive inclusive online education.

Contemporary concept of inclusive education provides for its interpretation as an educational process designed to overcome any restrictions in obtaining of knowledge, which is significant for full adaptation in a modern society.

Therefore, any system of education and vocational training must meet challenges of justice and development, which have crucial significance for life quality of all the people.

Available data in [1–3] demonstrates that within inclusive education pupils are treated as self-sufficient persons regardless of the scale of their achievements and abilities.

In his article Ismar Frango Silveira has demonstrated that everybody must be entitled to education with no discrimination. Thus, the United Nations Convention on the Rights of Persons with Disabilities recognizes it as a human right (this is especially relevant because according to estimates today 15% of the global population has some form of disability) [4].

Academic studies have proved efficiency of use of information technologies, in particular creation of software for inclusive education [5–8]. With booming spread and availability of mobile cellular devices it also becomes urgent to develop software support for inclusive education with their use [9–12].

Tatiana Shestakevych in her paper states that upgraded support for people with special needs' education will contribute to social integration of such population. Efforts to develop mathematical and software methods and tools imply the creation of a scientific base of information technologies, which pursue support of inclusive education. Model of inclusive education thoroughly covering all the stages of such process has been designed based on analysis of present-day support of inclusive education with information technologies. Model of information and technology support for inclusive education has been employed to determine functions of software for a system to support such program. On the basis of the developed models method to verify education format was offered as an element of a program system of inclusive education support [5].

This paper of Kumar Mandula discusses the challenges faced by special educators in this regard and proposes an ICT based educational assessment framework for planning and executing individualized education for children with mild mental retardation. It explains various interfaces that can be provided through this framework to parents and special educators for assessing, planning, teaching and measuring child's progress [6].

An educational assistive technology Luciana C. L. F. Borges was developed to support the child in the literacy process. It's intended to enable that HATS in educational context, as on the Computer Science and Engineering learning, can be developed in a participatory way including educators on the design process in order to facilitate the PwD learning in several knowledge areas [7].

Research by Angel Jaramillo-Alcázar comes up with a serious mobile game that targets some basic principles of electrical circuits. Moreover, it covers accessibility features for students suffering from hearing or visual disabilities [9].

Jaramillo-Alcázar also offers to set out a compilation and analysis of different access guidelines that allow to engineer serious mobile games for students suffering from cognitive disabilities. Moreover, he gives a model to evaluate accessibility of serious games for people with cognitive disabilities. He also applies it in a case study. In the end, the author offers an evaluation tool for developers of mobile serious games, which zeroes in on students with cognitive disabilities [10].

Edilson Arenas in his research indicates that boosted spread and availability of mobile cellular devices across developing countries has enabled development of a global platform for connected learning – a software and data infrastructure that will underlie a lot of systems we build to put into action the concept of equal access to educational services. In his article the author argues that a key challenge for deployment of that platform is development and introduction of an engineering standard specification rooted in breakthrough learning theories and principles [11].

In conditions of Kazakhstan's inclusive education, children with special educational needs have home schooling and study only a limited number of disciplines. Amid the pandemic, ORLEU National Center of Advanced Training developed video lessons covering the entire school syllabus from the first to the eleventh grade. There is also "OnlineMektep-BilimLand" portal that offers online lessons. Algorithm of actions is very simple and allows pupils to easily surf the website.

Therefore, it enables inclusion of children with special educational needs into the existing online educational environment of pupils who are free from health limitations.

Such developments have resulted in a concept that highlights normalization of development of pupils, with its focus to offer pupils with health limitations generally accepted learning standards.

Inclusive online education (IOE) must be implemented with the aid of specific Internet resources or other tools that provide for interactivity. Contraindication between a need to apply IOE opportunities and incomplete development of portals that employ required information technologies made the author choose the following objective.

Analyzing different scientific papers, we have drawn conclusion that it is necessary to carry out research of online inclusive education. Purpose of our study is to demonstrate requirements that have been taken into account for children with developmental delays within development of educational environment software, and obtained results for pedagogical experiment which demonstrate efficiency of its employment in Kazakhstan.

### *Experimental*

The notion of "mental retardation" is used with respect to children with minimal organic or functional damage to the central nervous system and those who stayed in conditions of social deprivation (in an unfavorable social environment) for a long time. They are distinguished by immature emotional-volitional sphere and underdevelopment of cognitive activity. Insufficient expression of cognitive interests in children with mental retardation is combined with memory impairments, functional insufficiency of visual and auditory perception, and poor coordination of movements [13].

Children with mental retardation of constitutional origin have the following specific features:

- unstable attention;
- low cognitive activity and performance;
- prevalence of visual-effective, concrete-figurative thinking over abstract-logical one;
- insufficient verbal and semantic memory;

– increased exhaustion and satiety of active attention. Children are tireless in a game but they are quickly bored with intellectual activities [14].

It is recommended to develop their independence, self-regulation, play activities, responsibility.

Providing quality learning opportunities involves focus on four key areas, namely Process, Pupil, Personnel and Resources.

The process involves content and instructions and takes into account that the standard curriculum of the Republic of Kazakhstan for such child is broad and balanced.

Teachers adapt content of the standard curriculum (curricula) by drawing up a course schedule so as to make topics relevant and functional for such pupils. In doing so, teachers set appropriate, achievable goals for their pupils ensuring that pupils can meet a level set for them.

Considering all these factors, the article covers some aspects of developed software designed to teach children with special educational needs and allows it to be used in inclusive online education.

Software content (Figure 1) includes relevant and functional topics in accordance with the standard curriculum of the Republic of Kazakhstan in Information Science, grade 7.



Figure 1. Content of Software “Inclusive Edu – Information Science, Grade 7”

With the use of the offered software teachers can employ various teaching strategies. For example, multi sensory approaches, demonstration, project, guided video tours, direct learning, differentiated learning, one-to-one learning, peer learning, small group learning. And teachers are provided with an opportunity to carry out joint learning.

In the course of teaching with the use of our software a suitable pace for pupils is taken into account, it is not slowed down and at the same time does not allow to rush some pupils to meet the compiled course schedule of the curriculum.

In the process of teaching children with mental retardation it was found that they would prefer to watch and listen to information rather than to read. Therefore, given their wishes, the software enables to listen to important information, in Fig. 1 this can be seen in the form of a metaphor “Golden Bell”. Such metaphor is used because of predominance of concrete-figurative thinking over abstract-logical thinking in such children, and their unstable attention. When a pupil sees the Golden Bell, they understand that they have important information in front of them and must listen to it carefully. Due to insufficiency of verbal-semantic memory,

which features in children with mental retardation of constitutional origin, indicated in [5], the software has a video tab that explains theoretical and practical material for each topic in Information Science (Figure 2).

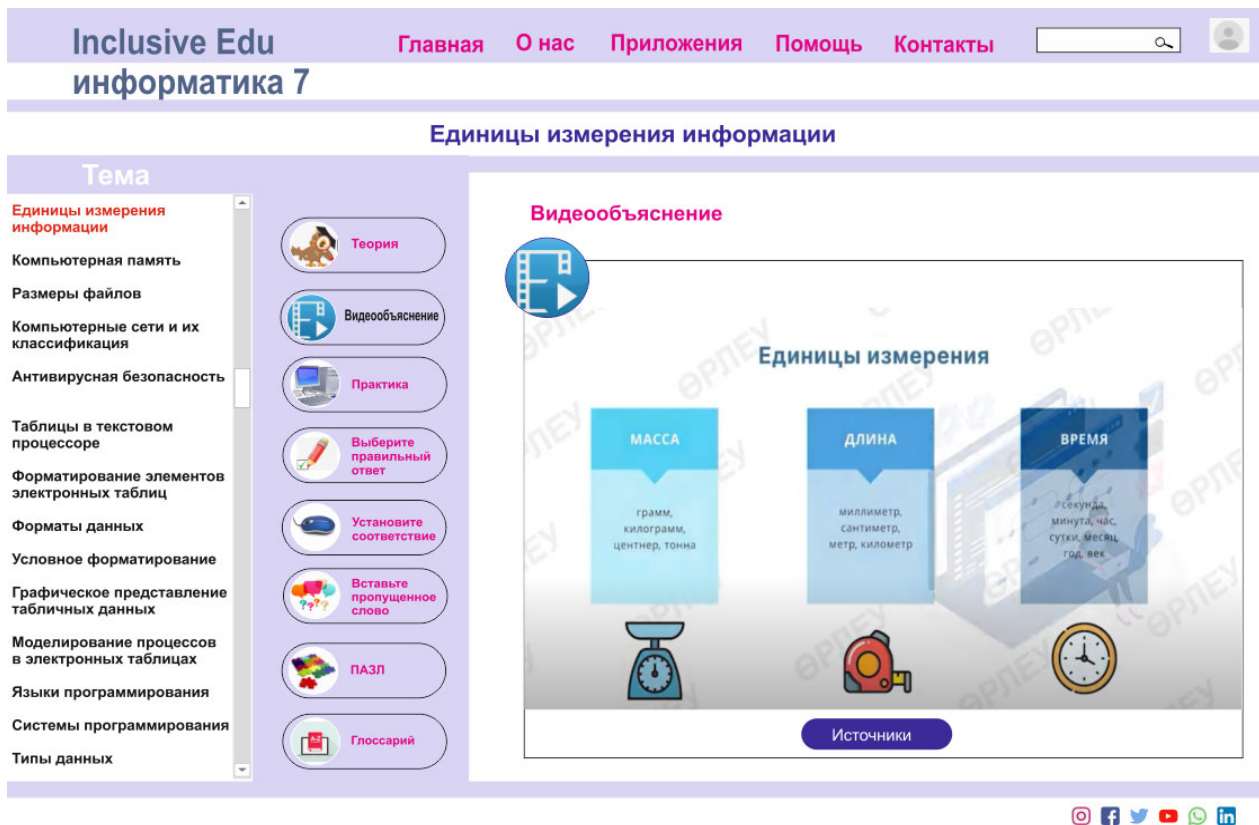


Figure 2. Video explanation

Users of the offered software may have an immature motor sphere, which manifests itself in the form of impulsive movements, insufficient coordination of movements, presence of unnecessary movements, insufficient fine movements of fingers and hands, therefore choice of objects is possible using a keyboard and not just a mouse. Also, any transition action requires confirmation in the form of the question “Are you sure...?”

From our own teaching experience, we have found out that children with mental retardation are different, some need a repeated explanation several times, while others need help in using the mouse and the keyboard.

Responsibility, independence, self-regulation should be developed in such children, therefore, thanks to the offered software, pupils can study lesson material at their own pace and repeat it a sufficient number of times. A number of tasks for independent work is also offered, which allows self-control of the covered material.

During the learning process pupils with mental retardation have revealed that they are often distracted, get tired and find it difficult to concentrate. Therefore we believe that predominance of a game form of study and consolidation of material will kindle interest and bring pleasure from the game to children with emotional and volitional immaturity. For example, there is a puzzle game in the software, where a part of the puzzle is opened for pupils with the correct answer to an asked question.

Children with mental retardation experience learning difficulties as they make a large number of mistakes due to the state of increased fatigue. In order for them not to get a feeling of inability, not to increase a painful attitude towards their failures, not to develop neurotic reactions, in the software, when completing a task, they can use a “Hint” button any time. By clicking it, the child sees an animated object in front of them, which is happy to help in solving the problem.

When evaluating knowledge in the software all types of tests are used [15], such as choose a correct answer, insert a missing word, put in a correct order, puzzle.

### Results and Discussion

For an objective and evidence-based verification of a pedagogical hypothesis, a pedagogical experiment was carried out, which was held in two stages: ascertaining and teaching experiments.

Experimental training was carried out in four schools in Almaty City in conditions of online learning. Pupils were divided into experimental and control groups.

Purpose of the training experiment was to test efficiency of the developed software and offered methodology for teaching children with mental retardation in online inclusive education.

In order to verify reliability of experimental teaching we have used the method of comparing a level of capturing of educational material by pupils in control and experimental classes and a probabilistic method – a criterion. For this purpose control tests were carried out, results of which were subject to a qualitative analysis. Each pupil was asked 10 questions in 3 variants.

Method -  $\chi$  criterion is most often used in pedagogical research [16] to compare distribution of objects of two populations by the state of a certain property based on changes in a name scale of this property in two independent samples from the considered populations. Value of statistics of  $\chi^2$  criterion to compare results of a control work is calculated by the formula

$$\chi^2 = \frac{1}{l_1 l_2} \sum_{i=1}^k \left[ \frac{(l_1 R_{2i} - l_2 R_{1i})^2}{R_{1i} + R_{2i}} \right],$$

where  $l_1$  is a number of reviewed works in the first sample;  $l_2$  is a number of reviewed works in the second sample;  $R_{1i}$  is a number of relative assessments of the  $i$ -category in the first sample;  $R_{2i}$  is a number of relative assessments of the  $i$ -category in the second sample.

If  $\chi^2 > \chi_{kr}^2$ , then difference between the two distributions is significant; if  $\chi^2 < \chi_{kr}^2$ , it is insignificant.

We have randomly selected 20 works (answers to tests) in the control and experimental classes.

The first sample is answers to tests performed by the pupils of the control classes, the second – by the experimental classes. Test results are recorded in Table 1 and are graphically shown in the diagram (Figure 3).

Table 1

#### Experiment results

Relative assessment	Control classes	Experimental classes
$R \leq 50\%$	4	0
$50\% < R \leq 70\%$	12	3
$70\% < R \leq 80\%$	3	12
$80\% > R$	1	5

Given that in the covered case  $l_1 = l_2$ , it is possible to make calculations according to the formula:

$$\chi_i^2 = \sum_{i=1}^k \left[ \frac{(R_{2i} - R_{1i})^2}{R_{1i} + R_{2i}} \right].$$

Notations are the same as in the previous formula. Then we have:

$$\chi^2 = \frac{(4-0)^2}{4+0} + \frac{(12-3)^2}{12+3} + \frac{(3-12)^2}{3+12} + \frac{(1-5)^2}{1+5} \approx 14,5.$$

As it follows from the table, compliance with three degrees of freedom values  $\chi_{kr}^2$  is 95% at the level of probability – 7.81. Since  $14,5 > 7,81$ , we can discard the zero hypothesis and consider that there are significant differences in results of the control test held in the experimental and control classes.

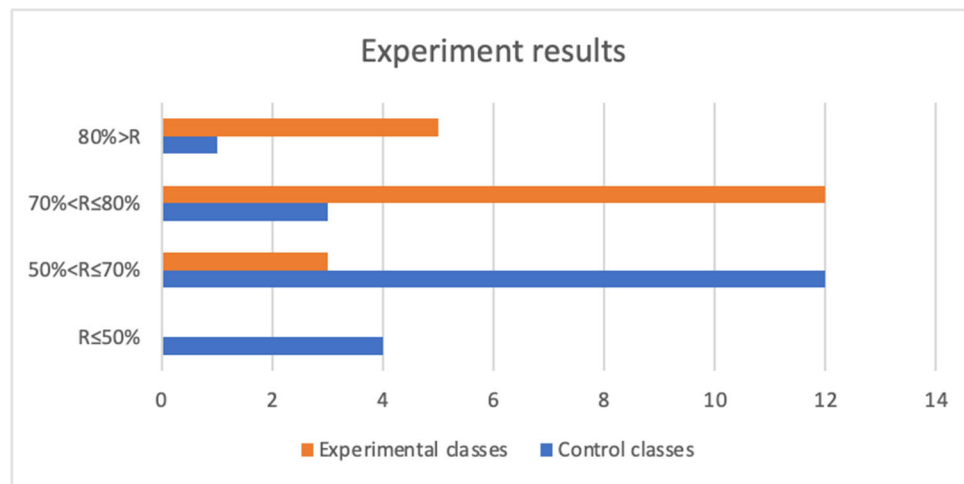


Figure 3. Diagram of the experiment results

Clearly indicate advantages, limitations and possible applications. Thus, based on findings of the experiment, it can be argued with certainty that the proposed arrangement of teaching discipline Information Science to pupils with mental retardation using software in inclusive online education is effective.

### Conclusion

Ultimate objectives of teaching with the use of the offered software are determined by significant changes in theory and practice of pedagogical science associated with introduction of adjustments in content of learning technologies that contribute to provision of a qualitatively new model of training children with mental retardation in inclusive distance education.

In the course of the research the following results were obtained:

1. Regulatory documents and requirements for arrangement of education for children with mental retardation have been reviewed.
2. Software for teaching children with mental retardation in inclusive online education has been developed.
3. A complex of educational and applied tasks in Information Science has been developed based on our own experience of teaching pupils with mental retardation.
4. To test research results and obtain effective results of the use of the offered methods, an experiment was carried out in schools.

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### **Инклюзивті қашықтықтан білім беруде бағдарламалық қолдауды әзірлеу**

Коронавируста қатысты жағдай мүмкіндігі шектеулі балалардың білім алуын ұйымдастырудағы мәжбүрлі шара қашықтықтан оқыту болып табылатынын көрсетті. Мүмкіндігі шектеулі білім алушылардың арнайы (бейімделген) білім беру бағдарламалары мен оқыту және тәрбиелеу әдістерін, сондай-ақ оларды бағдарламалық қолдауды пайдаланбай, білім беру бағдарламаларын меңгеруі мүмкін емес. Мақалада қашықтықтан білім беру технологияларын қолдана отырып, психикалық дамуы тежелген оқушылардың білім беру процесін ұйымдастыру мәселелері қарастырылған, сонымен қатар, мектептің негізгі білім беру бағдарламасы аясында «InclusiveEdu – информатика 7» бағдарламалық жасақтама-сын құру тәжірибесі сипатталған. Барынша қолжетімді және тиімді білім беру кеңістігі ұсынылады, оны ұйымдастыру кезінде білім алушылардың жеке ерекшеліктері ескеріледі және осы білім беру кеңістігіне білім беру қатынастарының барлық қатысушылары: білім алушылар, олардың ата-аналары (занды өкілдері), педагогтар, көмекші бейіннің мамандары қосыла алады. Психикалық дамуы тежелген балалар оқығаннан гөрі ақпаратты көбірек қарап, тыңдағысы келетіні анықталды, сондықтан әзірленген бағдарламалық өнімде маңызды ақпаратты тыңдауға мүмкіндік бар. Әзірленген бағдарламалық жасақтаманың тиімділігін тексеру үшін Алматы қаласының төрт мектебінде қашықтықтан оқыту жағдайында педагогикалық эксперимент жүргізілді, онда ұсынылған оқыту әдістемесінің пайдасына оң нәтижелер алынды.

*Кілт сөздер:* онлайн білім беру, инклюзивті білім беру, инклюзивті онлайн білім беру, бағдарламалық жасақтама, мүмкіндігі шектеулі, психикалық дамуы тежелген, арнайы білім беру бағдарламалары, ерекше білім беру қажеттіліктері.

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### **Разработка программной поддержки для инклюзивного дистанционного образования**

Ситуация с коронавирусом показала, что вынужденной мерой в организации получения образования детьми с ограниченными возможностями здоровья является дистанционное обучение. Невозможно освоение образовательных программ обучающимися с ограниченными возможностями здоровья без использования специальных (адаптированных) образовательных программ и методов обучения и воспитания, а также их программной поддержки. В статье рассмотрены вопросы организации образовательного процесса обучающихся с задержкой психического развития с применением дистанционных образовательных технологий, а также описан опыт создания программного обеспечения «InclusiveEdu – Информатика 7» в рамках основной образовательной программы школы. Предложено максимально



доступное и эффективное образовательное пространство, при организации которого учитываются индивидуальные особенности обучающихся, и в это образовательное пространство могут включаться все участники образовательных отношений: обучающиеся, их родители (законные представители), педагоги, специалисты помогающего профиля. Выявлено, что детям с задержкой психического развития хочется больше смотреть и слушать информацию, нежели читать, поэтому в разработанном программном продукте есть возможность прослушать важную информацию. Для проверки эффективности разработанного программного обеспечения был проведен педагогический эксперимент в четырех школах города Алматы в условиях дистанционного обучения, где были получены положительные результаты в пользу предложенной методики обучения.

**Ключевые слова:** онлайн образование, инклюзивное образование, инклюзивное онлайн образование, программное обеспечение, с ограниченными возможностями, задержка психического развития, специальные образовательные программы, особые образовательные потребности.

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