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## AUDITORY SYSTEM AIDING DEVICES AND SCHOOL ENVIRONMENT

## *ДОПОМІЖНІ ПРИСТРОЇ СЛУХОВОЇ СИСТЕМИ ТА ШКІЛЬНЕ СЕРЕДОВИЩЕ*

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***Urgency of the research****. The research under the support of disabled children in educational and bringing process are the condition of the subjects life quality. Undertaking in disfunction context they show the direction of proceedings, and help to develop appropriate solutions. In the age of inclusion pedagogy, it is important to widely discuss difficult topics regarding the creation of specialized environments in mainstream school to ensure equal educational for all children. Special attention should be paid on disabled child, where the existing developmental potential can be inhibited by i.a. by perceptual and communication constraints.*

***Target setting.****The purpose of this paper is to highlight the situation of a child with a hearing impairment in school environment. We paid attention to the problems of sound reception in unfavorable conditions and to contemporary means of supporting of hearing. Another goal was to make*

***Актуальність дослідження****. Дослідження щодо до підтримки дітей-інвалідів у навчально-виховному процесі є умовою якості життя суб'єктів. У контексті дисфункцій вони показують напрямок роботи і допомагають розробити відповідні рішення. В епоху педагогічної інтеграції важливо широко обговорювати складні теми, що стосуються створення спеціалізованих середовищ в загальноосвітній школі для забезпечення однакового рівня освіти для всіх дітей. Особливу увагу слід звернути на дитину-інваліда, де існуючий потенціал розвитку може бути пригнічений щодо сприйняття і комунікаційних обмежень.*

***Постановка проблеми****. Метою цієї роботи є висвітлення ситуації щодо дитиною з порушенням слуху в шкільному середовищі. Ми звернули увагу на проблеми прийому звуку в несприятливих умовах і до сучасних засобів підтримки слуху. Іншою метою було зробити педагога більш*

*educator more conscious of how they should work with deaf persons. We introduced teachers to problems of hypoacoustic pupils and showed some methods of making their life at school easier, e.g. by creating adjustments of the acoustic environment or application of relevant accessories to enhance the verbal message.*

***усвідомленим, так як вони повинні працювати з глухими. Ми познайомили викладачів з проблемами гіпоакустичних учнів і показали деякі способи полегшення їхнього життя в школі, напр. шляхом створення коригувань акустичного середовища або застосування відповідних аксесуарів для підвищення вербального повідомлення.***

***Actual scientific researches and issues analysis.*** *Technological support, analysis of environmental conditions in the education of children with hearing impairment is undertaken by many researchers. In this work we indicated, among others, such authors as: Marangos, Miquel, Novaes, Manrique, Talaska, Schach, Mildner, Kochkin, Diller, Laske, Veraguth, Dillier, Binkert, Holzmann, Huber, Stecker, Sollmann, Laszig, Sindija, Zrinski.*

*Their research work allowed to determine the impact of acoustic conditions on the signal perception process, including speech.*

***Аналіз останніх досліджень і публікацій****. Багато дослідників займаються технологічним забезпеченням та аналізом стану навколишнього середовища при навчанні дітей з порушенням слуху. У цій роботі ми вказали, серед іншого, на таких авторів, як: Марангос, Мікель, Новес, Манріке, Таласка, Шах, Мілднер, Кочкін, Діллер, Ласке, Верагут, Ділліер, Бінкерт, Хольцманн, Хубер, Штекер, Солманн, Лазіг, Сіндія, Зріньскі.*

*Їх науково-дослідні роботи дозволили визначити вплив акустичних умов на процес сприйняття сигналу, включаючи мовлення.*

***The research objective****. The study is focused on pupils with hearing impairment and some aspects of acoustic environment. We analyze means of modern hearing prosthetics for speech understanding. We show the solutions used to improve the quality of hearing. The main goal of the work is support the idea of inclusion development, raising the awareness level of people associated with the process of education and therapy.*

***Постановка завдання****. Дослідження зосереджено на учнях з порушеннями слуху та деяких аспектах акустичного середовища. Проаналізовано засоби сучасного слухового протезування для мовного розуміння. Продемонстровано рішення, які використовуються для поліпшення якості слуху. Основною метою роботи є підтримка розвитку ідеї інклюзивності, підвищення рівня обізнаності людей, пов'язаних з процесом навчання і терапії.*

***The statement of basic materials****. The paper deals with the problem of hearing loss in the context of condition of society and statistics determining the need for a discussion regarding the school functioning hard of heaaring people. The conditions of the acoustic environment were analyzed, including the impact of: noise, reverberation, volume and*

***Виклад основного матеріалу****. У статті розглядається проблема втрати слуху в контексті умов суспільства і статистики, що визначає необхідність обговорення питання про функціонування слабочуючих людей в школі. Проаналізовано умови акустичного середовища, в тому числі вплив:*

*absorbency of school rooms, on the communication proces. Means of modern hearing devices have been analyzed in context of the speach perception supporting.*

***Conclusions.*** *The research under the situation of disabled children in mainstream schools are highly connected, even more, are the part of policy of pedagogical inclusion. The special attention should be paid on children with hearing disorders. From one side, there is a technical progress and hearing devices' support of hearing function allows to achieve high level of verbal communication skills, from the other hand, therapists, teachers or pedagogues, cannot forget that those children still require special methods and special environment, in particular, the acoustic environment of school facilities.*

***Keywords:*** *audiology, cochlear implant, hearing aids, school environment, auditory system, hearing loss, hearing impairment*

*шуму, реверберація, об'єм і ступінь поглинання звуку стінами шкільних кімнат, на процес спілкування. Проаналізовано засоби сучасних слухових апаратів у контексті підтримки сприйняття слова.*

***Висновки.*** *Дослідження становища дітей-інвалідів у загальноосвітніх школах тісно пов'язані, навіть більш того, є частиною політики педагогічної інтеграції. Особливу увагу слід звернути на дітей із порушеннями слуху. З одного боку, технічний прогрес і підтримка слухових апаратів дозволяє досягти високого рівня навичок усного спілкування, з іншого боку, терапевти, вчителі або педагоги не можуть забути, що цим дітям все ще потрібні спеціальні методи і особливе середовище. Зокрема, акустичне середовище шкільних приміщень.*

***Ключові слова:*** *аудіологія, кохлеарний імплантат, слухові апарати, шкільне середовище, слуховий апарат, втрата слуху, порушення слуху*

*Urgency of the research*. There has been a major change in how people with damage of the organ of hearing function within the society. The struggle for human dignity held in the '70s (including fighting racial and sexual prejudices, homophobia etc.) resulted also in a great turn in perception of and attitude to disabled people, including deaf persons as well[1]. In the '80s and '90s many European countries introduced acts which allowed to set up integral schools and classes, although the first attempts to educate well-hearing and deaf children together were reported as early as in 1826 (Bavarian experiment). The turn of the centuries brought in completely new educational opportunities for deaf people. Thanks to intense medical development and progressing advancement of

[1] Selected acts and resolutions aimed at spreading social equality in years 1970-1990:

- Declaration on the Rights of Mentally Retarded Persons, United Nations General Assembly, resolution 28/56 (XXVI) of December 20, 1971,
- Declaration on the Rights of Disabled Persons, United Nations General Assembly, resolution 34/37 (XXX) of December 9, 1975,
- The World Programme of Action for Disabled Persons, United Nations General Assembly, resolution 37/52 of December 3, 1982,
- Convention on the Rights of the Child, UN Assembly in New York, November 20, 1989, Journal of Laws of 1991, No. 120, Item 1673.

hearing aids we could obtain maximum results and inclusion in community of the hearing ones[2]. Intensive and long-term works on electro-stimulation of the cranial nerve, which allowed to „restore" individuals suffering from damages to the organ of hearing to the world of sounds, as well as creation of systems that support hearing (including hearing aids, BAHA implant, middle ear implant etc.) made it possible to deaf people to use the sound speech that still is the basic way of interpersonal communication all over the world[3]. As a result of technological and medical progress, teachers more and more often face children of special educational needs, in this case the deaf or hypoacoustic children [1, 2]. Educational success of these children depends not only on application of specialist therapy, but also on whether the teacher is able to make appropriate selection of accessories or knows how to prepare the environment in terms of acoustics so that it met the needs of such highly demanding listener [3].

*Actual scientific researches and issues analysis*. According to WHO 1 to 1000 babies is born with a bilateral hearing loss. American and European research prove that the rate may reach even 2 to 5 per 1000 births, if we take into account all babies, regardless of the degree of hearing disorder. A major increase of inter- and post-lingual hearing losses has been reported [4]. Genetic and perinatal factors are accompanied by other, environmental ones such as: physical damage to the organ of hearing, drugs and ototoxic substances, illnesses related to the organ of hearing or resulting in damages to the acoustic analyzer. It has been estimated that 3 to 13 (out of 1000) school-aged children suffer from hearing loss which exceeds the edge of 45 dB [5].

The number of individuals who are hard of hearing increases systematically year by year. This fact seems to be reflected in the data provided by WHO which in 1986 reported that around 42 million people all over the world suffer from hearing disorders, including 12 million of those who have been diagnosed a bilateral deafness or profound hypoacusia. Now the same organization estimates that these numbers could be even seven times as big. In 2005 WHO published a report which provided that 278 million people from all over the world suffer from moderate or severe hearing loss, whereas 80% of them are citizens of developing countries – with low or average income, and 45 million of them live in Europe only [4]. According to Hear-it [6], Poland is the sixth European country in terms of people with hearing disorders population. The number or deaf or hypoacoustic people accounts to 4.7 million. It allows to

[2] Selected acts and resolutions aimed at spreading social equality:

- The Standard Rules on the Equalization of Opportunities for Persons with Disabilities, United Nations General Assembly, resolution 48/96 of December 20, 1993,
- 1997 Amsterdam Treaty, Art. 13, provision on prohibition to discriminate disabled persons,
- Charter of Fundamental Rights of the European Union, Nice, December 7, 2000, as amended,
- 2002 Madrid Declaration,
- The Treaty establishing a Constitution for Europe of June 18, 2004, as amended, including among others the Charter of Fundamental Rights,
- 2001-2006 Community Action Programme to Combat Discrimination, Member States of the EU.

[3] Deaf persons may use two legally equal (1980 after establishments made by members of the International Congress of Deaf Education in Hamburg) systems of communication: the first one based on linguistic system of particular country and its verbal expression and the other one based on natural gestures (which looks different in various countries).

conclude that the main risk factors are social and technological development. Environmental factors, including noise, are the cause of about 40% of all hearing losses [7]. Noise, regardless of its contribution to hearing disabilities, constitutes the main obstacle in perception and reception of speech. At the same time, it stimulates development of auditory prosthetics. Technological and medical progress imply more effective ways of dealing with insufficient acoustic perception, and especially with failure to understand speech at unfavorable conditions [8].

Results of the research show that noise is the main disturbance in everyday life of people who are hard of hearing. 82% of respondents with hearing loss reported that hearing aids should be improved in this aspect [9]. The same conclusion could be drawn from the own research of 71 young and active users of hearing aids and cochlear implants [10]. What received the lowest grade in evaluation was the operation in a noisy environment, including the level of speech understanding under noise and reaction of the devices to loud sounds.

Noise is a multidimensional phenomenon and can be considered as: purely physical subject of analysis consisting of constitutional elements, duration, amplitude etc. or, in terms of health (e.g. influence of exposure to noises on human health), as a result of influence measurements it has if considered in relation to the environment, either objectively or subjectively. In the present paper noise will be referred to as a noise level, a set of disturbances that constitute background for signals of speech which directly influence on quality and effectiveness of communication.

The course of sound speech involves two specific structures:

– Temporal Fine Structure
– Signal envelope amplitude

Complete and proper reception of a verbal message requires fluency in both structures. If we rely on nothing more than the information provided by the envelope amplitude, which reflects only the variations in loudness, we are able to understand speech in quiet environment. Reception of speech in noisy conditions is determined more by the time structure which provides data on quickly alternating frequencies and minor variations within component frequencies of particular time section [11].

Dependent on kind and extent of hearing defect the noise will more or less affect correctness of speech recognition.

Individuals with a normal range of hearing understand very well a common speech (100% discrimination) which oscillates from 65-70 dB, when the average signal level exceeds the noise level by about 6 dB – the S/N (speak-noise) quotient is +6dB. 50% speech understanding can be reached by well-functioning acoustic analyzed at the S/N quotient “0”, that is when the levels of speech and noise are equal. Well-hearing people are able to understand verbal message also in case of negative S/N value when some additional conditions are met, e.g. when the content of message is known, reception is supported with visual stimulations or speech and noise reach the receiver from opposite directions [12]. Diller provides that S/N value for such instances can be even “-15 dB” [13].

The thing is, however, different for people whose organ of hearing is damaged. The optimum S/N value which allows reception and understanding of speech is about 20 dB. Under 15 dB S/N value perception of speech becomes severely disturbed or even impossible.

Another meaningful determinant of speech perception is the frequency range of received sounds. A healthy individual is able to receive signals ranging between 16-20 Hz and 16-20 kHz [14, 15]. Correct reception of messages in a quiet environment requires such band of acoustic transmission that consists of frequencies of at least 4 kHz. Under this value acoustic perception is severely limited (usually to simple sounds only), even if the dB norm is met.

***The research objective.*** The situation of a child with hearing loss in public school was analyzed by reference to the information on noises and perception of speech. It was estimated that the level of teacher's speech is about 70 dB. Thus the level of acoustic background shall not exceed 45 dB (to meet the desired S/N value) so that a student with hearing loss could understand his or her teacher. Suggested norms[4] provide that the noise level shall not exceed the safe threshold of 30-35 dB (which not only affects condition of hearing but also results in tiredness, decreased concentration and lowering mental abilities etc.). The point is that results of measurements made in public schools show that the noise level is highly above the suggested norms: during lessons (silence) it is about 60 to 80 dB, whereas during breaks it can reach even 120 dB [13]. Therefore the S/N value during the lesson is "0" and during breaks "-50". There is no doubt that in such conditions a hypoacoustic child is not able to receive verbal messages in convenient way.

Apart from that, the child with a hearing loss has to deal with other distracting agents that are present in the classroom and result from acoustic properties of school premises. These include mainly shape and volume of the room, its absorbing properties, distance from the source of sound. All these factors affect the dispersal of acoustic energy and arrangement of frequencies. Another remarkable agents include lighting, teacher's and student's personality or applied accessories.

Reverberation – the time required to reduce intensity/energy of acoustic wave of 60 dB – is the crucial determinant of effective communication. Optimum reverberation for the premise where conversation takes place is 0.3-0.4 s. In the classroom, where verbal communication takes place nearly all the time, reverberation shall not exceed 0.75 s [13]. Having no regard to the situation of children with hypoacusis many countries, including Poland, lack regulations concerning acceptable reverberation parameters for school classrooms. According to the British data it can be noticed that reverberation

[4] Selected directives concerning norms for noise in the European Union:

- Directive 2002/49/EC of the European Parliament and the Council relating to the assessment and management of environment noise of June 25, 2002,
- Directive 2003/4/EC of the European Parliament and of the Council on public access to environmental information of 28 January 2003,
- Directive 2003/10/EC of the European Parliament and of the Council concerning noise of February 6, 2003. It determines minimum requirements for health protection and safety in terms of employees' exposition to physical agents.

norms should be adjusted to how the group of pupils in question functions. To compare, British regulations provide norms both for well-hearing and hypoacoustic children which are accordingly 0.5-0.8 s and 0.3 – 0.6 s [16].

Polish research on reverberation in school premises (measurements for frequencies ranging between 100 Hz to 5 kHz) show unambiguously that they are not adjusted to work with children suffering from hypoacusis. In school buildings from the 70's time of reverberation ranges from 0.75 s (high tones), 1.15 s (medium tones) to 1.36 s (low tones). This time is even longer in school buildings erected after 2000 – from 1.2 s (low tones), 2.83 (medium tones) to 1.62 (high tones). Another thing to worry about is the frequency line which should run flat with slight deflection of 5-10% and a drop of reverberation time towards lower frequencies (below 300 Hz). In fact, it more reminds a curve dropping towards the high frequencies (school buildings from the 70's) or is bell-shaped (school buildings erected after 2000). This results in major distortion of speech, e.g. advantage of vowels in received message. Longer reverberation results in interference of sounds, vowels start to dominate the message. When signal in such premise is enhanced, reverberation increases and reception of speech becomes even more difficult. This may cause misunderstanding between student and a teacher.

The aforementioned research show also other abnormalities in acoustic features of school buildings which are caused by disturbed proportions, shape and volume of the premises. Classrooms are longer and wider than recommended. Those built in the 70's are wider by 60% and longer by 90%, whereas the ones that were erected after 2000 are wider by 35% and longer by 13% [16].

Because we cannot influence dimensions of school premises, other measures should be taken to improve acoustics during the lesson. It is recommended to use sound-absorbing and dispersing materials with special attention paid to how they are arranged. At the same time, some rules must be obeyed while working with hypoacoustic students. We must be aware of direction and distance between interlocutors and remember that doubling of the distance damps the sound by 6 dB. According to this, a child who sits at the first desk would hear 80% of message whereas the one at the end of the classroom is able to receive only 40-50%. Therefore, work stands must be arranged in such way that the child with a hearing loss was always closest to the teacher and in front of him or her, and had appropriate lighting provided.

Other determinants of speech audibility:

- teacher's voice emission skills: pace of speech, loudness, color, defects in articulation etc.
- pace of work and stress,
- student's personal features including problem solving strategies,
- cognitive development, fluency in communication,
- supporting persons – integral classes,
- presence of supportive accessories, including acoustic aids.

***The statement of basic materials***. Technological advancement of the present hearing aids allow effective compensation of more and more

complicated damages to the hearing organ. Deaf individuals often owe their opportunity of living in the world of sounds to combination of various therapies and appropriate adjustment of hearing aids. Appropriately selected and adjusted device allows to receive signals even in unfavorable acoustic conditions such as reverberation, noise, presence of loud and sudden sounds, instable acoustics and others. The most common technical solutions include hearing aids, cochlear implants and their variations such as BICROS systems, hybrid implants, BAHA implants. Middle ear and stem implants are less frequently used and/or less effective. In order to increase acoustic comfort of the listener, these systems are accompanied by supportive devices such as FM systems, inductive loops and charging mats or other wireless systems.

The most commonly used compensating devices are hearing aids. They are easily accessible and require no surgeries. They are dedicated to individuals with hypoacusis of various extent but in case of severe damages to the organ of hearing which result in nearly complete loss of hearing they may be insufficient. Well-selected hearing aid which is consistent with the qualification framework allows [17-19] to obtain satisfactory level of well-being in each aspect of human life. This became possible thanks to better enhance and direction of sound with an opportunity to reduce unwanted signals, even noise as the most disturbing agent. Contemporary devices are extremely powerful and manufacturers[5] introduce numerous solutions to improve perception of sound:

– digital processing of signal – reduction of noises and distortions,
– automation and adjustment to current acoustic conditions,
– wide band of signal transmission from 60 Hz to 10000 Hz (for advanced devices),
– acoustic signal converters and integrators,
– systems of microphones (to determine directions),
– silencers – adaptive reducers,
– systems of speech location, selection and enhancement,
– application of multiple channels and bands,
– reducers of after-sound and wind (air) noise,
– anti-coupling systems,
– acoustic programs,
– systems for high-tone compression and/or phase shifting in order to improve reception of high tones or compensate dead areas,
– dynamic contrast regulators,
– possibility to connect external devices including FM systems.

The way hearing aids work and look and what we currently know about hearing defects allow to select appropriate system for even most demanding user. It also became possible to support asymmetrical hearing losses or unilateral deafness. The latter, however, provokes discussion on whether we should develop hearing aids for those patients whose one ear is fully efficient. Nevertheless, research show that supporting these controversial incidences is

[5] Data acquired from training materials of Phonak, Widex, Oticon, Bernafon, Siemens, Audio Serwis.

needed and effective [10, 19]. What is extremely important in the aforementioned case is that the child may become able to receive sounds that come from various directions. In order to provide patient with acoustic comfort and possibility to receive sounds on the side of damaged organ, the CROS system has been invented. Standard CROS was first constructed in 1965 by Hanford and Barry. It is based on the division of subsets in regular hearing aid (thus the CROS system is considered a type of the hearing aid). The deaf ear is supported with a microphone, whereas the other ear is equipped with an earpiece and amplifier. Both devices are connected with a special wire which allows transmission of sounds, or alternately, they are equipped with transmitter and receiver for wireless signal transmission. Devices are set in place with individual, open inserts which results in no occlusion, and most of all, allows ventilation of auditory meatus and natural reception of sound by the healthy ear. Thanks to such solution it is possible to avoid the wall of "head's shade" which stops signals (mainly the high-tone ones) from reaching the hearing ear. It becomes easier for the patient to identify source of sound, to receive complete acoustic image and to communicate in unfavorable conditions – noise, after-sound, chat with numerous interlocutors [20].

The CROS system was introduced with some modifications to create the BICROS system. It is applied to such hearing damages where on the one side there is deafness, residual hearing or profound hypoacusis and on the other side either slight or moderate hypoacusis. What makes it different from the standard CROS system is that the side of more severe hypoacusis is equipped with microphone placed on an open insert, whereas on the other side there is a complete hearing aid (equipped with all necessary subsets: earpiece, amplifier and microphone or combination of microphones) mounted to a ventilated insert dependent on the extent of hypoacusis. The name is commonly simplified to CROS.

Cochlear implants systems, as another example of how we are now able to support hearing, are dedicated mainly to people with profound, bilateral cochlear hearing loss. Due to the opportunity of rehabilitation they are more often used for small children before they develop speaking skills. They require specialist surgery to be implanted. They are highly complicated technological solutions which allow to achieve excellent therapy results. At the moment they are equipped with a range of functions which made it possible to restore audition to completely deaf people (cochlear hypoacusis which is hardly ever located on some other section of the auditory path). Contemporary devices are multielectrode cochlear implants systems, which provide additional solutions to make hearing highly precise even in most complicated acoustic conditions. Suggested and applied solutions include as follows[6]:

– simultaneous stimulation with no interaction of channels
- channel interaction compensation,
- sign-correlated simulation,
- triphasic pulses,

[6] Data obtained from training materials of Med – El, Cochlear, Bionic.

– precise determination of processor parameters thanks to NRT measurements (responses from the cranial nerve during surgery),

– microphone systems for determining direction – single and omni-directional,

– selective perception in noise – reduction of distracting signals,

– deep location of the bunch of electrodes so that all synapses of the cranial nerve were stimulated in order to maximize the signal transmission band,

– precise stimulation at optimum frequency thanks to which the system works in the same way as a healthy organ,

– making it possible to users of the cochlear implant to receive time dependencies within a sound that is the information included in signal's time structure,

– automatic adjustment of hearing dynamics separately for all channels,

– automatic reduction of useless/loud/uncomfortable sounds in order to emphasize the crucial part of information within channels,

– multiple bands – e.g. turning down the bands with recognized noise, turning up the quiet ones,

– automation and adjustment to current acoustic conditions,

– application of auditory software,

– opportunity to connect external devices including FM systems.

Additional tool to support most of available hearing aids are so called wireless sound transmission systems which take advantage of radio waves. These are referred to as FM systems. They are intended to enhance functions of the hearing aid and cannot be used independently.

They are used primarily to make hearing easier to people with profound, or most of all with difficult hearing losses – the ones where even little noise results in major decrease in perception of speech (e.g. auditory neuropathy, cochlear damages). These devices transmit signal directly from the speaker to receiver's hearing aid or implant and allow to adjust directions of microphones and reduce the acoustic background completely. Therefore, pure signal with no disturbances can be received no matter where the act of communication takes place. Unfortunately, despite obvious benefits from using the FM system, it is introduced in relatively rare cases. Gaps in knowledge of specialists, limited access to information for affected persons and prices deter potential buyers. Apart from that, survey which covered 17 individuals with severe hypoacusis that had purchased FM system showed that even those who are equipped with it tend to use it rather rarely: 7 respondents use it often, but not always (adults), 5 – only at home and another 5 – rarely or hardly ever. 7 out of 10 home or occasional users are school-aged children. Reported reasons for not using the FM system were mainly: fear that it might be damaged, lack of knowledge on how to use it (refers mostly to the teachers) and doubts on whether the system works at all *„I'm not sure if it works at all and if my child uses it correctly*[7].

***Conclusions.*** This paper highlights the situation of a child with damaged

[7] A. Czyż, research conducted in 2009, not published work

organ of hearing in school environment with special attention paid to perception of speech. Data analysis provides valuable information on negative influence of a noisy environment and additional agents which disturb reception of speech on the act of communication which constitutes a crucial part of school education. Another issue to mention was how present hearing aids can be supported to improve reception of sound in unfavorable acoustic conditions.

To conclude, the only possible way of improving situation of children with hypoacusis is to spread knowledge on nature of the defect, application of hearing aids and to pay more attention to acoustic comfort of the environment which is the primary source of school failure of deaf or hypoacoustic children.

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# ДІАГНОСТИКА РІВНЯ РОЗВИТКУ ТВОРЧИХ ЗІБНОСТЕЙ УЧНІВ ШКІЛ МИСТЕЦТВ В ПРОЦЕСІ НАВЧАННЯ З ВИКОРИСТАНЯМ ЕЛЕКТРОННОГО МУЗИЧНОГО ІНСТРУМЕНАТРІЮ

*DIAGNOSTICS OF THE DEVELOPMENT LEVEL OF ART SCHOOL STUDENT’S CREATIVE ABILITIES IN THE LEARNING PROCESS WITH ELECTRONIC MUSICAL INSTRUMENTS USING*

**В. В. Марцинів**

***Актуальність теми дослідження.*** *Цифрові технології у сучасному світі широко використовуються у різних областях людської діяльності. У навчальному процесі мистецьких закладів освіти застосовуються як віртуальні, так і фізичні електронні музичні інструменти. В школах мистецтв впровадження електронного музичного інструментарію пов’язане із використанням у навчальному процесі електронного клавішного синтезатора. Значною перевагою цього музичного інструмента є широкі можливості для якісного та ефективного розвитку творчих*

***Urgency of the research.*** *Digital technology in the modern world is widely used in various fields of human activity. There are virtual and electronic musical instruments, which can be used in the educational process of art schools. The implementation of the electronic musical instruments associated with using in educational process of electronic digital keyboard. Advantages of this musical instrument there are many big opportunities for qualitative and effective development of creative abilities of students.*