

Augmented Reality in the Training Process of Children with Hearing Disorders*

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Abstract. The relevance of the present research stems from the fact that the structure of sports activity of hearing-impaired athletes has objective features and depends on their psychophysiological potential. To modernize educational and training activities, to demonstrate practice exercises in detail, and to intensify the mastering of the movement technique enables the technology of augmented reality (AR). The purpose of this research is to prove the effectiveness of the technology of augmented reality to enhance learning in the educational and training process on track and field athletics by the hearing-impaired children of the basic level. In the course of the writing of the present work the following learning methodological literature, testing, analysis method, data processing, and interpretation. For the processing of quantitative results obtained the methods of mathematical statistics were used. In our research the main tests for the evaluation of the training effect with the use of AR technology are a 20-meters run at flying start, 100-meter race, standing long jump, jumping rope time trial. The effectiveness of the use of AR technology has shown positive dynamics by all criteria of the tests applied in this study. This technology is quite simple in application and use. Apart from the above hearing-impaired athletes, the results of this research can be applied to some other special needs children engaged in sports.

Keywords: education, information technologies, augmented reality, AR technology, hearing-impaired patients, health limitations, deaf and hearing-impaired athletes, educational and training process, sports and game method, training by visual aids, track and field athletics.

1 Introduction

Practical implementation of information technology in human activity is very intensive in today's world. Accordingly, information processes in the field of education are

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tightly connected with the overall computerization of society. It is necessary to emphasize that individual empowerment and realization of human potential is one of the most essential requirements of modern society, especially it concerns disabled people. As evidenced in practice, social integration is more challenging for persons with disabilities due to their physical and mental specifics. It's not uncommon for they have to adapt to social milieu, looking for a place of their own in social life [11]. According to the WHO data, presented in the summary of the World Report on Disability (2011), 10 – 12% of the global population belong to the category of persons with health limitations.

The United Nations specialized agency for Educational, Scientific, and Cultural Organization (UNESCO) has initiated the "Education for All" program in the frame of the world movement. It's purposed to ensure inclusive and quality education for all. Along with inclusive education, UNESCO considers the further extension of social integration; the engagement of adaptive physical education and Paralympic sport to meet the needs of children, youth, and adults [1]. Today in Russia alone there live 1.7 million children related to the category of health limitations, building the higher risk group of various pathologies and complex developmental delays. A large part of these children is deaf and hearing-impaired [2].

Development of the children with hearing disorders cannot be wholesome without physical education and sports. Owing to the introduction of physical activity into various spheres of deaf children, it is possible to correct the hearing disorders, so to improve their physical condition [5].

The potentialities of diverse activities (pedagogic, educational, recreational, sporting, etc.) devoted to such category of children are determined by the extent of disease. Modern researchers in the field of sign language teachers (V.P. Lebedev, D.I. Tarasov, A.N. Nasedkin, et al.) subdivide the reasons for hearing disorders into three groups. The first two groups combine the hereditary and congenital factors leading to deafness or relative deafness. The third group includes hearing-impaired patients with the acquired hearing disorder [9]. This implies that deafness is a biological factor, not a social one. L.S. Vygotsky wrote, – "The fact is that the educator has to deal not so much with these biological factors, but with their social consequences" [3].

Besides, the hearing disorder can cause the associated diseases to have their specifics. To this category belong the persons whose scope of external information is limited, when there is no internal speech and verbal mediation, which causes inhibition in development and a certain decrease in perception, thinking, memory, imagination and the whole cognitive activity at large. This is because the speech is not involved in the solution of evident tasks.

However, there is an area in which children with hearing disorders do not feel restrained when compared to normal people - it is physical education and sport, whose system-oriented character is increasingly important in this context. Sport makes it possible to level the communication between the deaf and the hearing-impaired and the normal people, for both as athletes compete under the same rules.

Functionally, sports activities with the hearing-impaired in terms of their tasks can be divided into two directions: general and specific (correctional). The priorities of the first direction are training basic movement skills and transfer of knowledge connected with sports training. The former direction is focused on the correction of physiological

disturbances and the compensation of body systems, thus defining a selection of pedagogical technologies [4].

To maintain the sports activity of deaf and hearing-impaired children and teenagers we have used information technologies as a management tool for their cognitive activity. In the frame of modern means of communications, information technologies significantly expand the educational opportunities of an individual on basis of free access to information. Being a social, moral, and economic imperative worldwide, information technologies are also an important instrument of social integration of hearing-impaired people [6].

The significance of using information technologies in sport consists in a wide range of possibilities:

- increase the interest in a training process;
- expand communication possibilities;
- form a psychologically acceptable and comfortable work style of a trainer-teacher, allowing to mobilize creative and athletic abilities, activate an intellectual potential of deaf and hearing-impaired athletes;
- improve the trainer teachers strategy in selecting the contents of educational and training programs, as well as means and methods of teaching and training according to the tasks, thus making deaf and hearing-impaired athletes develop independent learning skills, using means of communication with simulated model objects;
- simplify individualization of the training process;
- develop the confidence of hearing-impaired athletes in overcoming information barriers.

Subsequently, the use of information technologies in the educational and training process due to the visual presentation and the involvement of visual memory enables to enhance mastering the movement technique and to hold training at a whole new level, facilitates communication, help achieve autonomy in training and to set individual tasks with the respect to opportunities and abilities of each athlete. It says of the efficient use of information technologies available in sport and emphasizes their advantages, first of all as an aid to maximize the effect of visual presentation.

A significant breakthrough concerning new possibilities as to deliver educational and training material, so to master the movement technique has been made with the introduction of the technology of augmented reality (AR) [14]. On basis of existing scientific analysis on didactic aspects of modern information technologies, means, and considerations on physical and psychomotor development of children, it is the AR technology that allows to considerably expand educational and training process. In this respect, the American philosopher and teacher, John Dewey's words "If we teach today as we taught yesterday, we rob our children of tomorrow", said at the beginning of the XX century, seem even more appropriate today. Therefore, what concerns the educational and training process with deaf and hearing-impaired children the use of new and effective tools enabling better presentation and a more clear demonstration of the sports moving techniques, is a priority to be focused on soon.

2 Goal Setting

The educational process for the hearing-impaired should be built up concerning certain specific characteristics of the nervous system, namely fragmentariness and slowness of acoustical perception, distortion, and incompleteness of verbal representations connected with sensory-sound derivation [10]. In the working process with this category of children, the information on the further movement or action should be transmitted mainly by the means of visualization. Among these are posters, photo, and video displays, etc. For this reason, in training with deaf and hearing-impaired athletes, the applications of visual methods of training and exercising are mainly used, thus facilitating communication, building rapport between trainer and athlete, as well as taking an individual approach to the correction of the faults [15].

Accordingly, the purpose of our research is to prove the use of AR technology to enhance moving technique in educational and training process on track and field for the hearing-impaired children of the basic level [13].

It is because the use of AR technology allows animating images, including digital sound recording and video. In the working process with hearing-impaired athletes, this technology has clear advantages: visualization, involvement, functionality, and other features increasing motivation and interest in sports activities, stimulating ability to master the moving technique, and bridging communication.

On basis of the above, the use of AR technology in the educational and training process for track and field athletics with hearing-impaired children contains a great potential, which might and must be realized in sports practice. This technology is simple in application and it can be used for multi-age audiences. Its appliance enables to meet a wide range of educational and cognitive needs. Moreover, the use of AR technology makes it possible to deliver learning material in a more interesting and accessible form.

3 Development of Method

The AR technology (AR – "augmented reality") is based on the result of the introduction of sensory data into the field of perception, purposing to augment data about the environment and to improve the perception of information [7]. The augmented reality allows imposing images, text, video, and audio components on the existing image or space using computer technologies. Generated this way the augmented information can be read from the marker by various digital devices, such as smartphones, tablets, AR-glasses, and helmets, etc. As a marker any graphic visual object on which can be added multi-format virtual objects by special software tools [8].

The scientific novelty of this work is that at present the technology of augmented reality has not been a topic yet with the education institutions in Russia. It has been practically out of the scope of adaptive physical culture either. This work represents the first case of using AR in sports training with deaf and hearing-impaired children.

The practical importance of this work is that hereby offered methodic can be introduced in educational and training process for more effective work not only for children

with a hearing disorder but also for those physically challenged having other restrictions in health.

The methodic for the use of AR technology offered by has been used in work with hearing-impaired children in the educational and training process on track and field athletics (the group of basic level, age of 7 - 10 years).

The use of the offered technology is reflected in the following principles: individuality, availability, effectiveness. It is presented in forms and methods of training (group and individual training, individual work, participation in competitions); in methods of control and management of the educational and training process (in-training control, testing, and analysis of activity results); in tutorials (use of technical means; smartphones, tablets). Our choice of the training resource is based on the advantages of online access providing AR technology to combine speed and convenience in obtaining the information.

The decisions taken in the course of the movement training should be consecutive and directed to hold the attention of the athletes. At the same time, it is instrumental to set the tasks feasible for the students. The student should realize and clearly understand the training goal.

As a way of the organization of educational and training process, we offer sports and game method, providing a wide use (especially in the first two years of training) of the specialized game complexes and training tasks, which along with comprehensive physical training, allows bringing the athletes to the understanding of the essence of track and field athletics as a sport. The elementary preparation is based on gradual stepping up the training requirements, simultaneously targeting health promotion, development of physical qualities required in the chosen sport. It is also devoted to getting the students acquainted with the technical range of track and field athletics and develop a steady interest in the perspectives of sports activity.

4 Results

At present, the introduction of information technologies in all spheres of human activity shows that common methods of sports training are getting less effective. Augmented reality makes it possible to get sports activity modernized. AR technology enables the involvement of athletes in the educational and training process, to visually illustrate exercises of various characters. At the initial stage of studying and training on track and field athletics of children with the hearing disorder the following methods were used; integral and split skill activity, single motion, and lead-up skills. The basic and the most effective way to reinforce the learning material when working with hearing-impaired children is the sports and game training method.

In our research, the use of AR technology has acted as a didactic tool to create a suitable training environment for children with a hearing disorder, from the State Correctional Boarding School No.36 ("Spetsialnaya (Korreksionnaya) Obshcheobrazovatel'naya boarding school), Stavropol. According to the results, the technology of augmented reality effectively influences the above-mentioned children's training movement technique, as AR can demonstrate it at any level of information. Hearing-

impaired athletes with hearing disorders can see with an equal degree of reliability the reference elements of different exercises in all details. They can compare the technique, identify their errors, and insight into all facets, which in actual practice would hardly be possible to realize.

The educational and training process based on AR technology has its material advantages: there is no need to acquire stands, posters, blackboards, and other visual aids. The two-dimensional marker is placed in front of the camera from which all the information is read out and analyzed, that's all you need to get the effect of augmented reality. However, although AR technology is on the list of the most promising technological trends, it is yet to come and present its use in a sports activity is practically uncommon (table 1).

Table 1. Physical Fitness Index for deaf and hearing-impaired children. The initial and final test measurements

№	Performance	Baseline M ± m	Endpoints M ± m	M1 – M2	P
1	Run 100 m, (s)	16,74±0,06	16,28 ±0,06	0,46	< 0,001
2	Run 20 m, (s)	2,96±0,04	2,66±0,04	0,3	< 0,001
3	Standing long jump (m)	1,65±0,01	1,84 ±0,01	0,19	< 0,001
4	Jump Rope 30 (s)	32,63±0,36	48,75±1,21	16,12	< 0,001

5 Discussion

By reference to the available psychological and pedagogical characteristics of hearing-impaired patients, it follows that disorder of the auditory analyzer leads to the impairment of locomotory memory, thus affecting coordination of movements. The physical development of deaf people yields to normal people. In this relation, in modern society all persons with limited opportunities, notwithstanding their physical, mental, intellectual, cultural and ethnic, language, and other specifics, experience enormous difficulties in their sports activity.

The driving force enabling to optimize educational and training process is the use of information technologies. Provided the correct methodological approach is taken, the implementation of AR technology into a given sports activity will be expedient, opening wide opportunities and initiating new pedagogical approaches to sports training. This transformation is directed at the conditioning of sports accessibility to physically challenged children. The evaluation of the current situation concerning the implementation of augmented reality into the Russian sports training for disabled children indicates that currently there are no elaborations in this direction. We emphasize that the advantages of this technology have a correctional and a compensatory focus.

The revealed contradiction facilitated research purposing to prove the efficiency of information technologies in the sports training of deaf and hearing-impaired children. Children with the hearing disorder from the State Correctional Boarding School No.36 of Stavropol, participated in the research. At the preliminary stage of preparation, the groups were formed from children of 7 - 10 years old. The division of the educational

process into periods is conventional, the emphasis is on the all-around physical and functional training, placing a great deal of focus on general physical conditioning and the development of technique and skills.

Sports activities with this category have specific features. In this connection, the thematic development of each training will be goal-oriented and aimed at either the separate or multi-purposed tasks. The main direction of work is in the training of basic movement skills and transfer of knowledge on the sports training. The key method applied in the working process with children, both with or without health limitations, is sports and games. In the process of the game, motor activity is organized based on a figurative or conditional plot, the character and the ways of the actions are subject to the logic of the game and their choice is up to a changing situation. Training activities comprise relays, outdoor games, repeated tasks, subject game compositions, circuit training, etc. Speech insufficiency of the deaf and hearing-impaired children engaged in track and field athletics influences the perception of the information connected with the description and learning off-track and field exercises. Augmented reality facilitates make young athletes dip into the playing environment to allow them to obtain the necessary information and further to show performance results of the movements they have learned. It is relevant since at the end of the circannual training period the athletes will reach qualifying standards for general physical preparedness.

The use of AR technology promotes mastering sports techniques, stimulation of educational and training process, correction of motor skills disorder, interpretation of motor and speech information, enrichment by target language and phraseology, activation of intellectual activity. It also stimulates the development of spatial thinking and improves the quality of the received information and its assimilation. Concerning sports activity for deaf and hearing-impaired children, the augmented reality makes training more attractive and enjoyable. Using this technology, either trainer or athlete has an opportunity to select an AR-application on a specific subject of the program. AR applications are useful as at an initial approach to the new material, so in further acquiring of it. Athletes either independently or with the trainer control AR-objects: moving, turning, changing scale, studying in a multi-dimensional way, that is interact with different interactive elements. Owing to this they can perceive the reference elements of different exercises observed at a reliable angle, thus enabling them to identify their errors and to correct the execution of the exercises, which in real conditions seems hardly possible to do. Synchronization of visual and auditory information that is happening, in reality, creates full immersion into the information environment and activates the perception, thus making the static content of the application pages animated.

Consequently, AR technology is an actual viable alternative in sports training as compared to the conventional approach to work with deaf and hearing-impaired children. Again, the evident positive aspects are visual presentation, information exhaustiveness, and interactivity. Nowadays, electronic means of information technology are widely used in education and training. However, so far, the technology of augmented reality has not seen its implementation yet, as it is desired. Especially it concerns sports training.

The analysis of existing educational, pedagogical, and scientific literature on this subject, allowed us to conclude that this technology is being a seldom tool in the educational and training process. It is confirmed by Katkhanova I. F. and Bestybayeva K. I., stating that at the moment there is no possibility to apply AR technology in education, for no unified approach to its use has been developed yet in the educational environment [10].

Drawing on the results of sports activity of the hearing-impaired athletes it can be concluded that the technology of augmented reality renders the training a consistent, well-targeted, and motivated character. Its use is most effective for the identification and subsequent correction of errors, in the aspect of motivation, stimulation, and involvement into the training, when there are some difficulties with a concentration of attention and focusing and keen interest is urged. The more evident it is regarding deaf and hearing-impaired athletes, when AR-applications seem a really valuable tool to optimize the organizing of educational and training process, rendering a positive influence both on the athletes (providing better acquisition of the information) and the teacher-trainer (helping optimize the training process).

For the realization of the full-scale implementation of information technologies in Paralympic sport, it is necessary to create and put into practice innovative training methods and adapt the existing approaches according to new opening possibilities to integrate the most advanced technologies into sports.

Despite the recognition of the huge potential of information technologies for education and training in respect of the people with special needs, i.e. limitations of health, their appliance does not always meet the expectations. The reason for such insufficient efficiency might be connected with the uncoordinated functioning of the educational platform with software and hardware aids, incompatibility with the assistive technology to access the Internet. Moreover, there is a certain risk that the first unsuccessful attempt with the assistive technology either by students or by trainers, can result in a negative reaction towards them further on.

However, the systemic use of the technology of augmented reality together with other information technologies required to work out an individual training rule for movement technique in track and field athletics purposed for deaf and hearing-impaired children becomes the desired element of sports activity.

6 Conclusion

Information technologies are the most suitable tool which can help people with special needs in their sports activities. The use of information technologies in the sphere of sports activity increases independence, integration, and equal opportunities for all people with health limitations, and those with hearing disorders in particular.

In our opinion, information technologies in sports offer higher didactic efficiency as compared to conventional methods and means of training, especially at the early stages of preparation. At the same time a keen interest of young athletes, aroused at the start by the technical component of the electronic means used, further grows into a higher interest towards the content of theoretical and methodical aspects of the chosen sport.

The success in the training of deaf and hearing-impaired children with the use of information technologies applied in sports training depends on the choice of technology. Guided by the purpose designated in this research, to solve the tasks, we have made our choice in favor of the technology of augmented reality.

The reason is that the technology of augmented reality that we used in the educational and training process, for the time being, has no solid scientific and methodical base. It is practically simple and available to any trainer-teacher possessing computer skills at the non-programming level. Besides, it allows creating high-quality electronic tools for the didactic support of training in track and field athletics.

The developed training complexes for preliminary exercises in track and field athletics with the use of AR technology have been successfully tested in the conditions of the actual training of the children with the hearing disorder from the State Correctional Boarding School № 36 of Stavropol.

The developed training complexes can be recommended to be introduced into the educational and training process organized in groups of children with hearing disorders and other limitations of health.

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