The Concept of Fine Motor Skills Development of Preschool Children Using Haptic Gloves

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Abstract

The fine motor skills development of preschool children is an important factor in creative, verbal, and cogitative development. The modern development of information and robotic technologies allows the use of virtual reality in conjunction with haptic gloves for the development of fine motor skills of preschool children. A special advantage of haptic gloves using for the development of fine motor skills is the possibility of remote control of the children's exercise during their absence in preschool. Remote connection of the teacher to the virtual model will allow monitoring and giving recommendations to the child during exercises online, and the presence of the virtual model of the game form will increase the child's interest in learning. The purpose of this article is to develop the concept of fine motor skills development of preschool children using haptic gloves and virtual reality technologies. The existing prototypes of haptic gloves are considered. The technique of the haptic gloves using for pre-school educational institutions. The advantages and disadvantages of using virtual reality technologies in the educational process of preschool institutions are considered. The study concluded that the relevance of this technology for the development of fine motor skills of preschool children who are away from kindergarten. The prospects for the development of the subject are considered. Keywords: preschool child, fine motor skills of hands, haptic gloves, virtual reality.

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1 Introduction

is known that the improvement of fine motor skills plays an important role in the overall development of the child, especially his speech abilities. This is due to the fact that the motor and speech centers in the brain are close, and therefore, the better developed fine motor skills, the more successful will develop speech [Lob19]. On the basis of the development of tactile sensations in children formed creative imagination, thinking, memory, attention, coherent speech, the ability to retell.

Modern technologies for the development of fine motor skills of preschool children often include a variety of games for the development of tactile perception, games with water and sand, folk finger games, exercise with objects, games for laying out, games for stringing, games with construction kits, etc. Almost all types of these games are implemented in preschool institutions, the purpose of which is to develop the communicative and intellectual competencies of the child, which necessarily includes the development of fine motor skills. But in practice, there are often cases when a child can not go to kindergarten. This may be due to frequent diseases that form the child's immunity or special circumstances of the parents. At the same time, parents do not always have the opportunity to conduct classes on the development of fine motor skills with the child at home because of their workload or lack of experience in educational activities. The article proposes the use of information technology for virtual development of exercises for the development of fine motor skills of the child at home under the supervision of educational institutions educators.

To realize this remote possibility of teaching a child is offered with the use of haptic gloves and virtual reality technologies.

Haptic gloves are devices that look like mechanized gloves worn on the hands of a child (hereinafter the operator), which can transmit information about the position of the hands (including the position of the fingers) in space, and transmit this data to the software virtual model. The relevance of the use of haptic gloves in the development of virtual reality technology is confirmed by numerous publications on this topic [Per18, Tat15, Pop99, Udd16, Cho03, Hoa13, Kun97]. Educational opportunities for the use of haptic gloves are considered in publications [Sul15, Ash18, Kah09].

Existing implemented prototypes of haptic gloves for working in a virtual environment are shown in figure 1: Sapsan glove CT (Fig. 1A) [Per19], Manus VR (Fig. 1b) [Man19], Plexus VR glove (Fig. 1C) [Ple19], CaptoGlove (Fig. 1d) [Cap19], Avatar VR (Fig. 1e) [Ava19], Noitom Hi5 VR glove (Fig. 1f) [Noi19], Senso glove (Fig. 1g) [Sen19], VRfree by Sensoryx (Fig. 1h) [Vrf19], VRgluv (Fig. 1i) [Vrg19].

Figure 1: Prototypes of haptic gloves for work in virtual environment

Haptic gloves have tactile sensors responsible for the feedback between the operator and the virtual model. Vibration sensors are most often used for this purpose, which inform the operator about the interaction of the virtual model of the operator's hand with other objects of the virtual environment.

A General view of the haptic gloves work in virtual reality glasses is given on the example of work in HaptX Gloves (Fig. 2A) [Hap19] and the example of the children's game Job Simulator (Fig. 2b) [Job19].

The advantage of using haptic gloves in the development of fine motor skills of children is the possibility of remote control by the teacher of the child's exercises and the child's play form of interaction with the virtual

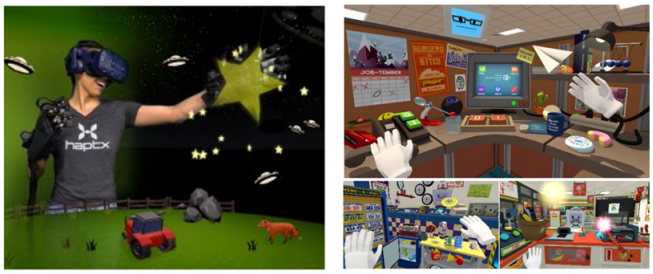

Figure 2: General view of the haptic gloves work in virtual reality glasses

environment.

2 Task

The concept of fine motor skills development of preschool children using haptic gloves and virtual reality technologies includes 3 stages:

- at the first stage, it is necessary to consider the scheme of interaction between the teacher and the child with the remote development of fine motor skills using haptic gloves and virtual reality glasses;
- at the second stage it is necessary to describe the method of games in a virtual environment and their possible variations;
- the third step is to consider the advantages, disadvantages and limitations of the proposed technology for preschool children.

Let's take a closer look at each stage.

3 Development Of Methodology

3.1 Scheme Of Interaction Between Teacher And Child

Man is distinguished from other living beings by the use of the hand as the leading tool of mental development. Hand – a thin complex organ that allows the mind to enter into relations with the world. Hand movements and developing speech of the child are closely linked. The child's need for intensive development of fine motor skills falls on the age of 1.5 – 5.5 years [Bel18]. Since the average age of the child's stay in kindergarten begins from 3 years, the proposed concept will be relevant for children of preschool age from 3 to 5.5 years. The time of the proposed classes is 15-20 minutes a day, depending on the individual characteristics of the child.

For remote education of a child in a virtual environment, parents' permission to conduct classes is required. It is also necessary the presence of adults for the period of the lesson, which is associated with the need for proper connection of the required equipment, connection with the teacher, monitoring the condition and convenience of the child, monitoring the interaction of the child with small voltage electrical appliances, etc.

Interaction of the teacher and the child according to the offered concept is made in the virtual environment, with specially picked up color scale. The scheme of interaction between the teacher and the child is shown in figure 3.

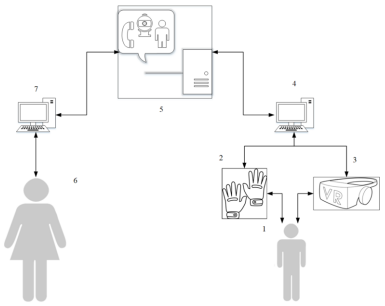

Figure 3: Scheme of interaction between the teacher and the child in the remote development of fine motor skills using haptic gloves and virtual reality technology

The child (1) connects to the system through controllers (haptic gloves) (2) and virtual reality glasses (3) while outside the kindergarten under the supervision of parents. A virtual reality simulation program with the necessary developmental exercises is run on a personal computer (4). The personal computer (4) receives data on the operator's hand movements from the haptic gloves (2) and transmits back the interaction signals to the vibration sensors, which inform the operator about the interactions in the virtual environment. The image from the simulation program is transmitted to the virtual reality glasses (3) to demonstrate the video images.

3.2 Methods Of Games In A Virtual Environment And Their Possible Variations

Exercises and games for the development of fine motor skills in preschoolers with the use of haptic gloves and virtual reality glasses can be divided into several groups [Gal18]:

- developing programs;
- training program;
- program of experimentation;
- computer diagnostic programs.

All presented groups of games and exercises have their potential for the development of the child, their formation and use in the correct sequence should be regulated by proven research methods. In this article the technique of game exercises with the use of developing, training and emotionally unloading programs for the development of fine motor skills is considered.

The methodology of the games in a virtual environment for the development of fine motor skills of the child can be divided into 6 stages, in which, in parallel with the development of fine motor skills, it is possible to introduce exercises to get acquainted with the colors, letters, numbers, seasons, animals, transport, space and other surrounding world.

1. At the first introductory stage, it is necessary to acquaint the child with the proposed technology of training. The full-time presence of the teacher and the child is necessary. The child should examine and examine the haptic gloves. The teacher can demonstrate how to use haptic gloves and virtual reality glasses on a personal example. The simulation model in this case should be displayed on both virtual glasses and a large screen. When putting gloves on the child's need to familiarize him with tactile feedback system – a vibration sensor. It is necessary to explain and make it clear to the child in which cases the vibration signal is triggered. Familiarization with virtual reality glasses should take place after studying the picture on the big screen. The chosen scene of the virtual environment should be coordinated with the child psychologist. Audio communication of the teacher and the child should be provided manually. It is possible to consider the variation of joint children's play on a large monitor at the same time between the child and the teacher. At all stages, it is possible to place a visual model instruction for performing a game exercise.

2. At the second stage, it is possible to start studying the work with stationary objects of medium and large size: folding towers of cubes of different colors, adding the cubes to the basket, playing on matching shapes and holes, etc. To interact with large objects, it is possible to create scenes in which the child must coordinate the action of two hands. Possible variations of games with a ball, books, large virtual toys or toy animals, etc.

3. In the third stage, it is proposed to complicate the elements of the game by entering smaller stationary parts. The child should study the virtual interaction of small and medium objects in a virtual environment. The introduction of exercises in which you want to draw in a virtual environment, to push different buttons to play musical instruments, use baby utensils, stringing the small items on the thread, collect mosaic, etc. The game Difficulty will increase with the decrease of virtual items, which will engage a child and increase their number.

4. At the fourth stage, it is possible to introduce handcrafting: virtual modeling, cutting, weaving, etc.

5. At the fifth stage, the introduction of dynamic objects should be carried out. This will develop the child's attention, observation, hand coordination and precise finger movements. Games with dynamic objects can be divided into two groups. In the first group, the child will need to interact with slowly moving objects, Dodge them, catch with one and two hands, fold. The second group should be used games with throwing, pressing the moving buttons, moving objects to the desired position. The second group is a particularly mobile method of learning, so it is necessary to closely monitor the game of the child. Long-term influence of highly mobile games can affect the excitability of the Central nervous system of the child.

6. At the sixth stage, when the child is fully adapted to the exercises in virtual reality, it is possible to introduce simulation games that will immerse the child in fairy tales and fantasy worlds. Perhaps the use of arcade scenario games. Thus, it is possible to study road safety techniques, behavior in public transport, etc.

Thus, the use of game forms in virtual reality allows you to develop a variety of competencies of the child. At the same time, real physical games are especially important.

3.3 Advantages, Disadvantages And Limitations Of The Proposed Technology For Preschool Children

The benefits of using haptic gloves and virtual reality technology can be attributed, first and foremost, the remote nature of the training and control of implementation of the child tasks. The possibility of variation of exercises variety will develop an interest in learning, make it colorful, memorable and fantastic. It is possible to develop various competencies of the child, hand coordination, fine motor skills, attentiveness, logical and creative thinking, memory. In the future, it is possible to conduct group classes in a virtual environment with the supervision of a teacher. This will allow to develop communication skills and coordinated work of the group on common tasks. Augmented reality is a very useful tool in the hands of a professional teacher, but if used improperly, this technology can bring negative effects.

The negative effects include, first of all, the rejection of simple and classical methods of learning. The child's interest in developing fine motor skills through simple games and exercises may fall. To solve this problem, the teaching staff, including psychologists and sociologists, should be directly involved in the development of a specialized simulation environment. The method of training and a set of exercises for the development of the child's competencies should be clearly indicated. If this technology will be used for remote education of children who for some reason are absent in kindergarten, it is necessary to consider their skills when choosing an exercise.

The second important negative effect is the high load on the child's vision, because virtual reality glasses are very close to the eyes. To solve this problem, it is necessary to perform a complex of visual gymnastics before and after the exercise and not to overload the child with more normative indicators. Dishonesty of parents can also serve as a factor that the child will stay in the virtual world longer than the allotted time. Exercises in virtual reality glasses should be strictly regulated and controlled by the parent.

Disorientation. In virtual reality, there may be a disorder of synchronization of the organ senses, which can negatively affect the well-being of the child. Careful preparation of the child for the use of virtual reality glasses is necessary.

Stress on the nervous system. Using virtual reality glasses with the wrong selection of exercises can increase the load on the child nervous system, resulting in increased excitation of the nervous system or a strong decline. The use of too bright tones will irritate the child's Central nervous system, and quick visuals will cause overstrain for visual information processing. It is necessary to use high-quality software products for the implementation of remote virtual learning.

The high cost of virtual reality glasses and haptic gloves will not allow mass introduction of this technology in the educational process, and fragile materials require careful care and careful handling.

Do not forget about the use of classical methods of teaching and development of fine motor skills. Haptic gloves and virtual reality glasses should be only a small part of the educational program. This technology should complement the classical teaching methods, but not replace them. This fact must first be understood by parents, because sometimes due to lack of time, many parents forget to pay full attention to the development of the child.

Insufficient research of technology. Virtual reality technology is a new round of information technologies. As a result, its impact on children is little known and its impact on preschoolers is especially little known. Development of methods of conducting classes for children should be thoroughly investigated before introduction into the educational process. The use of virtual reality in inclusive education also requires additional research. As a result, it can be concluded that the need for funding research in this area.

4 Results

The results of this study is the presented concept of fine motor skills development of preschool children using haptic gloves. The scheme of interaction between the teacher and the child allows remote control over the training and development of fine motor skills of preschool children. The proposed structure implies the sound interaction of the teacher with the student, while the teacher can view the visual images that the child creates in the interaction of objects in a virtual model.

The proposed method of games in a virtual environment involves the use of educational, training and emotional unloading programs for the development of fine motor skills in a playful way. The technique has 6 conditional levels of complexity, depending on the complexity of the manipulation object and its characteristics.

The advantages, disadvantages and limitations of the use of the proposed technology for preschool children implies that it is possible to develop the competencies of the child with the use of proven techniques developed by experts from different fields. The presented negative effects of the proposed training technology implementation are not critical if a number of simple but important rules are observed, the number of which may increase in the future, but affect the quality of training.

5 Discussion

The proposed technologies for the development of fine motor skills of preschool children using haptic gloves and virtual reality technology are new information educational technologies. As a result, their full impact on preschool children has not yet been fully understood. In the prospects of development of this subject, it is necessary to conduct additional experimental studies of the impact of the proposed technologies on the psycho-emotional, speech and creative-mental development of the child.

It is also necessary to study the possibility of using virtual reality technologies in inclusive education, which is an important topic for modern society. It is necessary to develop strategies and methods for the application of the proposed concept of distance learning for group classes with children on intramural and on remote education.

To implement the proposed concept, it is necessary to carry out joint work of scientists and researchers from different fields, including engineers, mathematicians, programmers, psychologists, teachers, doctors, sociologists, defectologists, etc.

To implement the proposed concept, it is necessary to conduct joint work of scientists and researchers from various fields, including engineers, mathematicians, programmers, psychologists, educators, doctors, sociologists, defectologists, etc.

It should be noted that the proposed concept can carry out education in the formats of full-time studies, distance, mixed, as well as self-education. This allows you to visually, safely, focused and involved to teach children and develop their competencies.

6 Conclusion

This article proposes the concept of remote learning and development of fine motor skills of preschool children using haptic gloves and virtual reality technology.

According to the results of the study, it should be concluded about the possibility and prospects of using haptic gloves and virtual reality technology for the fine motor skills development of children from 3 to 5.5 years. The paper focuses on the remote education of children who do not have the opportunity to attend classes in preschool institutions. In the proposed concept of development of fine motor skills of preschool children using haptic gloves the scheme of interaction between the teacher and the child is considered. This scheme allows you to control the learning process in real time. Taking into account this interaction, a method of conducting classes is proposed, in which exercises for the development of fine motor skills are conditionally divided into 6 game groups, characterized by the complexity and activity of the child during the game.

It is necessary to take into account a number of restrictions and rules, failure to comply with which can harm the health and psycho-emotional development of the child. It should be noted that for the full implementation of the proposed concept it is necessary to conduct additional experimental studies.

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