

Possibilities and features of the elementary cognitive and educational functions development

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Abstract—The paper discusses research aimed at studying the possibilities of the development of elementary cognitive functions. Various methods of development and their impact on children in the learning process are considered.

Keywords—children, education neuroscience, executive function, attention, working memory, visual search, mental arithmetic

I. INTRODUCTION

Education and the educational environment are extremely important in the development of children. However, each child has an individual experience, interests, skills, and cognitive capabilities. Currently, individualization of learning is becoming relevant. With its help, it is supposed to solve the problem of differentiation of students, i.e. correctly consider their features in the educational process [1, 2].

An important component of learning is cognitive activity. And, unlike other individual differences of students, this component is much more difficult to uniquely identify and evaluate.

In neuropsychology, when assessing cognitive abilities, the formation of Executive Functions (EF) is often investigated, in particular: inhibitory control, processing speed, cognitive flexibility, selective attention, and working memory [3].

Researchers from the Immanuel Kant Baltic Federal University proposed to transform the concept of EF in neuroeducation into Elementary Cognitive-Educational Functions (ECEFs), which are closely related to various types of cognitive activity in learning. Among the ECEF they identified: visual search, working memory, mental arithmetic, and the ability to combine several ECEFs. Based on this concept, scientists have developed an Information Recommendation System (IRS) for personalization and customization of the educational trajectory [4, 5, 6].

Since cognition plays a significant role in a child's life and growing up, we also wondered—if it is possible to develop or compensate for it, and how?

II. RESEARCH PAPERS REVIEW

We have reviewed scientific articles in the following databases: ScienceDirect, PubMed, SpringerLink, Google Scholar.

We found research articles analyzing the effectiveness of different methods for the development of various ECEFs.

The found works can be grouped according to different criteria.

Features in the selection of subjects:

- Age group—studies were conducted on preschoolers, primary school children, teenagers;
- Health status—typically developing children, children with ADHD, dyslexia.

Considered methods of development:

- Sports or outdoor games;
- Art classes;
- Meditation and Mindfulness Training;
- Cognitive training;
- Action games;
- Training with an abacus, and others.

According to Lakes et al., replacing regular physical education lessons with taekwondo classes in typically developing primary school students improved working memory and inhibitory control. Children studying taekwondo, in addition to improved memory, showed better control of emotions and discipline [7].

Ludyga et al. found out that judo training increased the volume of visuospatial working memory in children aged 8–12 years with ADHD. Training was held twice a week, for 1 hour during 12 weeks. Children were taught basic techniques, including game exercises [8].

Jaschke et al. researched the influence of art education on the example of typical primary school students. The subjects were divided into groups—music and visual art. In music classes, children studied music theory, singing and practiced playing musical instruments. Classes were conducted 1–2 times a week. The visual art classes contained knowledge from the history of art, painting, and sculpture lessons. The researchers found that long-term (for 2.5 years) musical education had a positive effect on the functions of inhibition and planning. And visual art classes significantly improved the visuospatial working memory of the subjects [9].

Another study confirmed that art education (in this case, music lessons) has a positive effect on visuospatial working memory. In Frischen et al., 27 children were taught music for 8 months as part of weekly 45-minute classes. As the authors suggest, this result may be related to the structure of the study—it focused on learning to play an instrument, which implies the need to quickly read the notes and convert them into finger movements [10].

Nejati showed that a program for attention rehabilitation and strengthening is an effective cognitive training for children with ADHD. Tasks included: search for auditory and visual information, sorting of three orders, addition, finding differences, making crosswords. Over 12–15 sessions for 4–5 weeks, children improved selective and sustained attention, inhibitory control, and memory [11].

Guo et al. studied the effects of learning to play the harmonica of typical Japanese primary school students for 6 weeks. The children were involved in singing and beating the rhythm, playing the harmonica while walking, learning songs without relying on musical notation. According to the results, the verbal working memory of children improved [12].

Lu et al. investigated the effect of a long (2–3 years) course of training children to count on the abacus. The course of study contained basic theoretical knowledge about the abacus, rules and basics of calculations using it. Practical exercises with physical abacus were also conducted, during which students were gradually taught to carry out mental calculations on imaginary abacus. This course helped to improve the skills of arithmetic calculations and attention [13].

Some studies have shown positive results of mindfulness training on attention [14, 15]. Both studies focused on training children to concentrate on their own thoughts, feelings, and sensations, getting rid of stress.

Franceschini et al. found that nine 80-minute action game sessions a day improved attention and reading abilities in children with dyslexia [16].

In most of the analyzed papers, the experiment was conducted directly in the learning process (in physical education classes, extra classes, lunch breaks), which allowed scientists to study in more detail the possibility and effectiveness of using such methods outside of laboratory settings.

There are also some studies in which the positive effects of the considered methods of ECEFs development have been refuted or not confirmed [17, 18, 19]. Some authors note the inaccuracies of studies with positive results: in methods, form of conducting and analysis, small volume of samples, etc. [20, 21, 22, 23].

III. CONCLUSION

There are a wide variety of approaches to the development of elementary cognitive-educational functions. They differ in purpose (the development of certain functions, different age, and health status of students), speed of impact (the appearance of results in the short or long term), variability (universal methods or strictly regulated), etc. A significant number of studies confirm the effectiveness of various methods of ECEF development.

However, this area of research is relatively young, and some scientists have doubts about the efficiency of a particular method. In this case, it is important to pay attention to the quality of the studies themselves, the volume of samples and consider different points of view.

ACKNOWLEDGMENT

The work is supported by the strategic academic leadership program of the Immanuel Kant Baltic Federal University (“Priority-2030”). AAB was also supported by the

President program for Supporting Leading Scientific Schools in the Russian Federation (grant NSh-589.2022.1.2).

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