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USING AN ELECTRONIC APPLICATION TO IMPROVE GRAPHOMOTOR SKILLS AND THEIR IMPACT ON THE LEVEL OF INTELLIGENCE IN CHILDREN

Abstract

The relationship between exercise and cognition is an important research topic that has only recently begun to unfold. The purpose of the article is to study graphomotor skills and their impact on the level of intelligence in children using an electronic application. In the article, the authors experimented with calculating the IQ level of children using data on graphomotor skills obtained after using the «Nimble Fingers» electronic application, which can be done based on the use of standard methods of the Wexler scale, given that the electronic application is focused on the development of fine motor skills and the accuracy of tasks. The authors used two subtests of the Wechsler Intelligence Scale IV (WISC-IV) for children. It was found that two WISC-IV subtests — Block Design and Alphabet Pattern — showed significant correlations with other cognitive functions, which confirms their importance for assessing both graphomotor and cognitive skills in children. Graphomotor skills have been shown to influence academic achievement and cognitive function. The results highlight the importance of investigating the correlation between physical skills and various aspects of cognition.

Key words: Cognition, IQ level, experiment, children, Wechsler intelligence scale, graphomotor skills, cognitive skills.

Introduction

The authors formulated a review based on articles on graphomotor skills and their importance for children's school readiness. Brown [1] investigated ways to enhance fine motor skills in preschool children through structured interventions. The main goal of the study was to explore how various activities for motor skill development influence coordination and movement accuracy in children aged 3–6 years. The study included several groups of children who participated in exercises designed to develop fine motor skills. Among the interventions were drawing and coloring to enhance hand-eye coordination; playing with small objects like construction kits and puzzles; and performing targeted exercises for hands and fingers to improve strength and agility. Conducted over several months, the study gathered data before and after the intervention to track progress in fine motor skills. The article underlines the critical role of early interventions in fostering fine motor skills in preschoolers. Using different techniques and activities can significantly enhance motor and intellectual skills, which in turn supports children's ability to adapt to school life. The findings demonstrate that a holistic approach combining active play and structured exercises is most effective.

Operto et al. [2] analyzed the influence of digital tools like tablets and mobile devices on the development of fine motor skills in children aged 3 to 6 years. Research has shown that tablets and mobile devices can help advance the development of fine motor skills in children, especially through apps aimed at improving movement coordination, such as drawing, following moving objects, or performing tasks requiring precision and focus. The article stresses the importance of balanced and mindful use of digital tools in educational settings, prioritizing both safety and effectiveness.

Martzog and Suggate [3] discuss how screen-based media such as TV programs, video games, and mobile apps affect fine motor skill development in preschoolers. The study highlights that interactive screen devices, particularly those with touch-screen features (e.g., tablets and smartphones), positively impact fine motor skill growth. This is because such tools

demand precise and well-coordinated finger movements, which promote hand-eye coordination and accuracy. The article asserts that screen media, when used judiciously, can support fine motor skill development in young children. Nonetheless, it is vital to strike a balance and supplement screen-based activities with traditional physical games and exercises.

Susfiandari, Jannah, and Fitri [4] present a comparative study examining the effects of educational games on the fine motor abilities of children aged 4 to 5 years in kindergarten. The research focuses on various types of games and their impact on the progress of these skills during this stage of development. The aim of this study is to explore how traditional and digital educational games influence the advancement of fine motor skills in preschoolers. The results demonstrate that educational games contribute positively to improving the motor skills of children aged 4-5. It is important to highlight the necessity of using a well-balanced approach and applying diverse teaching methods to achieve the best outcomes.

In the Republic of Kazakhstan, there has been an increase in the availability of electronic applications for enhancing graphomotor skills among children, especially in urban areas where internet access is widespread. Educational institutions and parents are actively using these applications to educate preschool-aged children [5]. It is essential that such applications are tailored to the age of the children and available in both Kazakh and Russian. As part of government initiatives like the «Digital School» program, digital technologies are being integrated into education, expanding the accessibility of these resources to children throughout the country [6].

There are several authors and researchers in Kazakhstan who study digital technologies, including tools for developing graphomotor skills in children [7]. Some of them specialize in pedagogy, psychology, and information technology in education. Below are some notable researchers and their areas of focus:

Zh.E. Zhakulina and Zh.B. Ashirbekova both examine the integration of digital technologies in education, with a shared focus on early childhood development. While Zhakulina explores the broader challenges of educational digitalization in Kazakhstan and its influence on the creation of educational applications for young schoolchildren and preschoolers, Ashirbekova concentrates on the use of communication tools to enhance children's graphomotor and cognitive abilities. Together, their work highlights complementary aspects of how technology can support and advance early learning [8].

These researchers, along with other specialists in education and psychology, contribute to the creation of both theoretical and practical methods for implementing digital tools in children’s education in Kazakhstan [9].

An analysis of scientific literature and online sources shows that electronic applications designed for improving graphomotor skills in preschool children are becoming an essential educational resource [10]. Recent studies validate the effectiveness of digital technologies in strengthening children’s coordination, precision, and motor skills, especially when integrated with traditional teaching methods [11]. Additionally, Kazakhstan has seen increased adoption of such technologies through the government’s initiative to digitalize education and expand access to mobile technologies [12]. However, despite these advancements, it is vital to ensure a balance and regulate the time children spend on digital devices to avoid potential negative impacts on their overall development.

Materials and research methods

Currently, there is a limited body of research exploring connections between motor skills, cognitive functions, academic performance, and IQ. To address this issue, we conducted a study to investigate these relationships in children.

Our sample included 30 children aged 4–6 years from kindergartens in Astana, Kazakhstan. Using neuropsychological tools (WISC-IV), we gathered data on their motor abilities, executive functioning, academic achievements, and IQ. Assessments were carried out randomly

every alternate day in the kindergarten environment. All participants and their parents provided informed consent before taking part in the study.

Cognitive evaluation process

This phase of assessment was conducted within a single session lasting about 3 hours, with the option of extending it to three more sessions of 1 hour each, if needed. Participants were evaluated using the WISC-IV subtests. These subtests are designed to measure core executive functions and other cognitive abilities. The total score for each subtest was calculated by summing up the weighted points assigned for correct responses.

Block Design - This subtest is strongly associated with the enhancement of graphomotor skills, as it emphasizes hand-eye coordination and spatial awareness. Block Design is a time-sensitive subtest that measures perceptual reasoning skills. For children between the ages of 4 and 6, a task can be performed using the «Nimble Fingers» electronic tool. The task is as follows: children are instructed to trace a path connecting animals from well-known fairy tales to their favorite food using the application. For each animal, the screen will display an image of the animal and its corresponding favorite food. Children must utilize their fingers to link the animals to their food by tracing the appropriate path. An example of the application's interface is illustrated in Figure 1, which shows the home screen for completing the Block Design subtest.

Here's an example:

1. The bear's favorite food is raspberries. A picture of a bear and raspberries will be shown on the screen. The child's task is to guide the bear across the screen to the raspberries by drawing a connection. This activity is illustrated in Figure 2.
2. The rabbit's favorite food is carrots. A rabbit and a carrot image will be displayed, and the child will connect them using their fingers. This task is shown in Figure 3.
3. The monkey's favorite food is bananas. Images of a banana and a monkey will appear, and the child needs to connect them with a drawn line. This activity is illustrated in Figure 4.

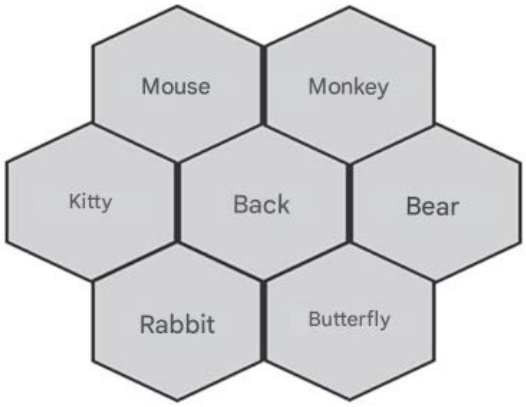

Figure 1 - Home page completing the Block Design subtext assignment

Note: Compiled by authors

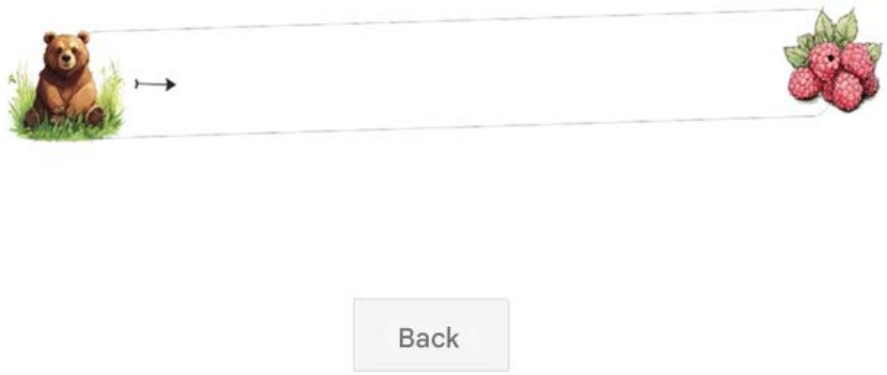

Figure 2 - The Bear Task

Note: Compiled by authors

Figure 3 - The Rabbit Task

Note: Compiled by authors

Figure 4 - The Monkey Task

Note: Compiled by authors

The tasks not only develop attention and memory but also enhance logical thinking. Children are required to determine which animal corresponds to which food. They also need to draw lines using their fingers, which contributes to the development of their motor skills.

Alphabet Pattern - the primary purpose of this task is to assess a child's capacity to accurately and consistently produce letters, enabling the evaluation of their cognitive and motor abilities, such as: graphomotor coordination - the skill of precisely and effectively replicating symbols within a defined space; task accuracy - the extent to which the reproduced letters

match the original, reflecting the enhancement of fine motor skills; focus and attention - the ability to concentrate on a task while avoiding external distractions; motor memory - the capacity to recall and replicate the correct form of a symbol. Task procedure: the child is presented with a sample alphabet in uppercase letters; these letters are displayed clearly, and the child's objective is to replicate them on the device's screen in the correct sequence and form. Throughout the task, the child must ensure precise graphic reproduction of the letters and their correct placement on the screen. The starting interface of this task is shown in Figure 5, while an example of letter reproduction is presented in Figure 6.

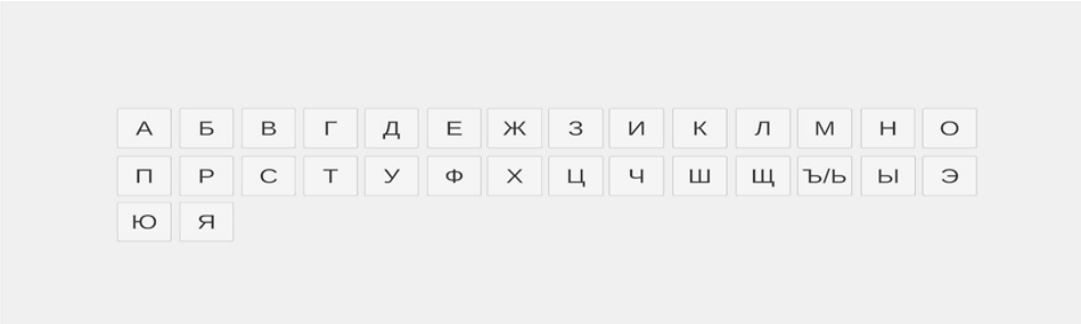

Figure 5 - Home page completing the Alphabet pattern subtext assignment

Note: Compiled by authors

Figure 6 - The task of reproducing letters

Note: Compiled by authors

Subtests comparable to the ones provided through the «Nimble Fingers» application are connected to the domain of graphomotor skills, which could be linked to the Information Processing Speed Index (PSI) on the Wechsler scale. Although this subtest on its own does not provide a comprehensive IQ assessment, its outcomes can influence specific scale indices such as:

- The Information Processing Speed Index (PSI), which involves tasks that require quick motor responses and accuracy in performing graphical tasks.
- The Perceptual Reasoning Index (PRI), which depends on a child's ability to solve visual and motor problems that require an analytical approach.

Results and Discussion

To assess the relationship between graphomotor skills measured using an electronic

application and intellectual indicators, using two main indices from the Wechsler Intelligence Scale (PSI and PRI). Tables 1 through 3 present a comprehensive overview of the classification of intellectual development levels, the distribution of children according to these levels at the beginning of the study, and the changes observed after using the «Nimble Fingers» electronic application.

Table 1 shows the classification of intellectual development based on IQ scores, ranging from profound mental retardation (IQ less than 20) to very high intelligence (IQ 130 and above). This classification serves as a reference framework for assessing the children's intellectual abilities.

Table 2 illustrates the initial distribution of the 30 children participating in the study according to their levels of intellectual development. Notably, 70% of the children demonstrated intellectual development below the average norm at the beginning of the study, with the majority classified within the mild and moderate mental retardation categories.

Table 3 compares the children's verbal, non-verbal, and general intelligence scores before and after the use of the «Nimble Fingers» application. The results indicate improvements across all measured indicators, suggesting that the intervention had a positive effect on the cognitive development of the participants.

Figure 7 shows the average intelligence indicators before and after using the app. It demonstrates a positive change in verbal, non-verbal, and general intelligence, with the most notable increase in non-verbal intelligence.

Table 1 - Levels of intellectual development

№	IQ	The level of intellectual development
1	130 and more	Very high
2	120-129	High
3	110-119	A good norm
4	90-109	Average
5	80-89	Low rate
6	70-79	Border zone
7	50-69	Mild mental retardation
8	35-49	Moderate mental retardation
9	20-34	Severe mental retardation
10	Less than 20	Profound mental retardation
Note: Compiled by authors		

Table 2 - Distribution of children by level of intellectual development at the beginning of using the «Nimble Fingers» electronic application

The level of intellectual development	The number of abs children.	%
Moderate mental retardation	2	6.7
Mild mental retardation	12	40.0
Border zone	7	23.3
Low rate	4	13.3
Average	5	16.7
Total	30	100
Note: Compiled by authors		

Thus, when starting to utilize the electronic application, the majority of children (70%) did not demonstrate normal intelligence levels during the testing phase. However, the observed delays in intellectual development among most children exhibited a specific pattern, marked by significant irregularities in the results of individual subtests. By the conclusion of applying the tool, an improvement in verbal, non-verbal, and overall intelligence coefficients was noted across all groups.

Table 3 - Intelligence indicators before and after using the «Nimble Fingers» electronic application

Intelligence indicators	Getting started using the app	End of using the app
Verbal intelligence (average value)	84.8	86.8
Minimum value	72	72
Maximum value	110	114
Non-verbal intelligence (average value)	94.2	98.7
Minimum value	72	62
Maximum value	111	118
General intelligence (average value)	90	93.8
Minimum value	70	70
Maximum value	109	117
Note: Compiled by authors		

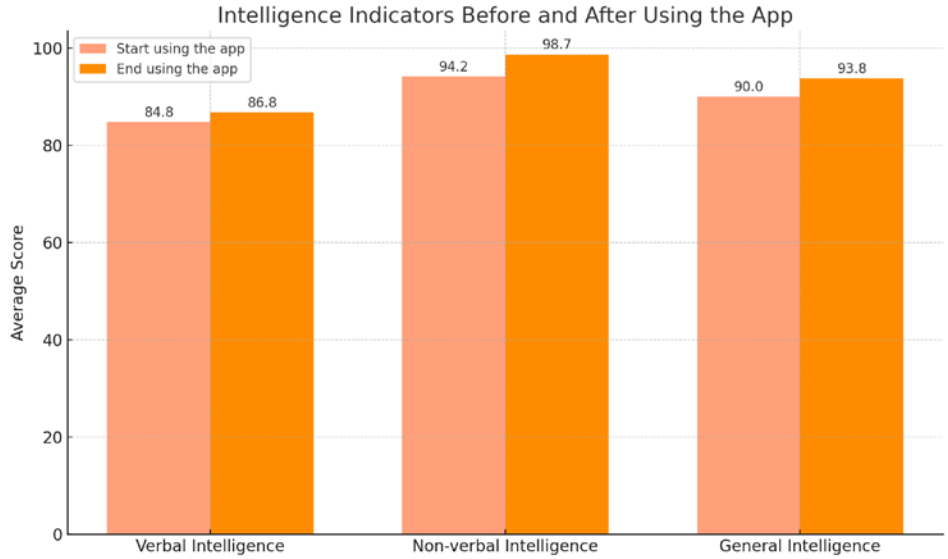

Figure 7 - Change in the level of intelligence in children at the end of using the electronic application

Note: Compiled by authors

After completing the trial, a significant improvement was observed in the coefficients of verbal, non-verbal, and general intelligence among the children who took part in the study, based on the results gathered through the electronic application.

Conclusions. Data collected on the Processing Speed Index (PSI) and the Perceptual Reasoning Index (PRI) showed that most children exhibited improvements in these areas. This resulted in an overall increase in IQ scores. Specifically, children with developmental delays and inconsistent subtest results during the initial evaluation phase showed progress in both verbal and non-verbal skills after using the application. This indicates that training graphomotor skills through carefully structured activities, such as those provided by the «Nimble Fingers» application, not only enhances processing speed (PSI) but also improves perceptual reasoning (PRI). Based on these findings, it can be inferred that using an electronic tool to develop graphomotor skills helps achieve balanced cognitive development in children, correcting irregularities in IQ indicators and leading to an overall enhancement in intelligence among children aged 4–6 years.

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ИСПОЛЬЗОВАНИЕ ЭЛЕКТРОННОГО ПРИЛОЖЕНИЯ ДЛЯ УЛУЧШЕНИЯ ГРАФОМОТОРНЫХ НАВЫКОВ И ИХ ВЛИЯНИЕ НА УРОВЕНЬ ИНТЕЛЛЕКТА У ДЕТЕЙ

Аннотация

Взаимосвязь между физическими упражнениями и когнитивными способностями - важная тема исследований, которая только недавно начала раскрываться. Цель статьи – исследование графомоторных навыков и их влияние на уровень интеллекта у детей с использованием электронного приложения. В статье авторы поэкспериментировали с расчетом уровня IQ детей, используя данные о графомоторных навыках, полученные после использования электронного приложения «Ловкие пальчики», что можно сделать на основе использования стандартных методик шкалы Векслера, учитывая, что электронное приложение ориентировано на развитие мелкой моторики и точность выполнения заданий. Авторы использовали два субтеста IV шкалы интеллекта Векслера (WISC-IV) для детей. Было обнаружено, что два субтеста WISC-IV — «Дизайн блоков» и «Алфавитный узор» — показали значимую корреляцию с другими когнитивными функциями, что подтверждает их важность для оценки как графомоторных, так и когнитивных навыков у детей. Было показано, что графомоторные навыки влияют на академическую успеваемость и когнитивные функции. Полученные результаты подчеркивают важность изучения взаимосвязи между физическими навыками и различными аспектами когнитивных способностей.

Ключевые слова. Познание, уровень IQ, эксперимент, дети, шкала интеллекта Векслера, графомоторные навыки, когнитивные навыки.

ГРАФОМОТОРЛЫҚ ДАҒДЫЛАРДЫ ЖАҚСАРТУ ҮШІН ЭЛЕКТРОНДЫҚ ҚОСЫМШАНЫ ПАЙДАЛАНУ ЖӘНЕ ОЛАРДЫҢ БАЛАЛАРДЫҢ ИНТЕЛЛЕКТ ДЕҢГЕЙІНЕ ӘСЕРІ

Аңдатпа

Жаттығулар мен когнитивті қабілеттер арасындағы байланыс - бұл жақында ғана ашыла бастаған маңызды зерттеу тақырыбы. Мақаланың мақсаты-графомоторлық дағдыларды және олардың электронды қосымшаны қолдана отырып, балалардың интеллект деңгейіне әсерін зерттеу. Мақалада авторлар электрондық саусақ қосымшасын қолданғаннан кейін алынған графомоторлық дағдылар туралы мәліметтерді қолдана отырып, балалардың IQ деңгейін есептеумен тәжірибе жасады, бұл электрондық қосымшаның ұсақ моториканы дамытуға және тапсырмаларды орындау дәлдігіне бағытталғанын ескере отырып, стандартты Векслер шкаласы әдістерін қолдану негізінде жасалуы мүмкін. Авторлар балаларға арналған Векслер интеллект шкаласының (WISC-IV) екі IV субтестін қолданды. Екі WISC-IV субтесттері - «Блок дизайны «және» Алфавиттік үлгі « — басқа когнитивтік функциялармен мағыналы корреляцияны көрсетті, бұл олардың балалардағы графомоторлық және когнитивтік дағдыларды бағалаудағы маңыздылығын растайды. Графомоторлық дағдылар оқу үлгерімі мен когнитивті функцияға әсер ететіні көрсетілген. Нәтижелер физикалық дағдылар мен танымдық қабілеттердің әртүрлі аспектілері арасындағы байланысты зерттеудің маңыздылығын көрсетеді.

Негізгі сөздер. Таным, IQ деңгей, тәжірибе, балалар, Векслер интеллект шкаласы, графомоторлық дағдылар, танымдық дағдылар.

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