Correction of developmental coordination disorder (DCD) in preschool-aged children: results of a pedagogical experiment

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Abstract

This article presents the results of an experimental study on the effectiveness of an electronic differential intervention model for preschool-aged children with Developmental Coordination Disorder (DCD). In a pedagogical experiment conducted in Urgench, Khorezm region, involving 90 children aged 5-6 (30 in each group), diagnostics were carried out using the MABC-2 test, and a three-group (control, experimental 1, experimental 2) comparative design was employed. ANCOVA and Wilcoxon statistical analyses demonstrated that the electronic differential individual approach (EG-2) had a statistically significant higher level of effectiveness across all MABC-2 components compared to the generalized approach (EG-1) ($p<0.001$; eta-squared=0.352-0.778). In the EG-2 group, 76.7% of the children transitioned into the normative development zone. The results of the study scientifically substantiate the necessity of an individual differential approach for DCD correction in preschool educational institutions in Uzbekistan.

Keywords: DCD (Developmental Coordination Disorder), MABC-2, electronic differential intervention, preschool children, coordination abilities, ANCOVA, balance, fine motor skills.

Introduction

Developmental Coordination Disorder (DCD) is a neurodevelopmental disorder found in 5-6% of preschool and school-aged children, recognized as an independent clinical condition in the DSM-5 and ICD-10 international classifications. DCD has a complex negative impact on a child's motor, cognitive, emotional, and social development. Difficulties with balance, fine motor skills, and hand-eye coordination complicate the child's daily activities, such as dressing, writing, playing, and sports.

The issue of DCD is understudied in Uzbekistan: standardized diagnostic tools are not employed, and there are no scientifically-based programs in preschool educational institutions aimed at DCD intervention. It has been found that the majority of educators (78%) are unfamiliar with the concept of DCD, and 92% do not use the MABC-2 or other standardized assessment tools.

International research has shown that task-oriented approaches (e.g., CO-OP, NTT) are the most effective for DCD intervention (Smits-Engelsman et al., 2018). However, these approaches do not fully consider a child's individual MABC-2 profile—specifically, which component is impaired. To address this gap, this study developed an electronic differential intervention model based on the MABC-2, and its effectiveness was experimentally tested.

Research Objective: To determine the effectiveness of a differentiated intervention model, developed through the digitization of the MABC-2 assessment system, in improving the coordination abilities of preschool children with DCD.

Research Hypothesis: If an electronic differentiated intervention program based on the MABC-2 is developed for preschool children with DCD, and the content of the sessions is tailored to each child's individual coordination profile, then their coordination abilities will show a statistically significant improvement compared to those participating in traditional, generalized sessions.

The study was conducted in March-April 2025 at State Preschool Education Organization No. 3 in Urgench, Khorezm region. A total of 90 children aged 5-6 years participated, all of whom scored at or below the 15th percentile on the MABC-2 (indicating DCD or being in the at-risk zone). The participants were divided into three groups of 30, with each group comprising an equal distribution of 15 boys and 15 girls:

- Control Group (CG): participated in traditional physical education classes.
- Experimental Group 1 (EG-1): followed a generalized program of 120 motor games, administered in the same sequence to all children.
- Experimental Group 2 (EG-2): utilized the electronic differentiated individual intervention program, with exercises structured according to each child's MABC-2 profile.

The intervention lasted for 4 weeks, with four 50-minute sessions per week.

Methods

Table 1. Comparative statistical analysis of pre-test results (One-Way ANOVA)

MABC-2 Component	CG (n=30) M±SD	EG-1 (n=30) M±SD	EG-2 (n=30) M±SD	F	p
Manual Dexterity	5.1±1.5	4.9±1.6	4.8±1.6	0.412	0.663
Aiming & Catching	5.0±1.7	5.1±1.8	5.2±1.8	0.158	0.854
Balance	4.5±1.3	4.4±1.4	4.3±1.4	0.261	0.771
Total Test Score	14.6±3.0	14.4±3.2	14.3±3.2	0.113	0.893

Diagnostic Tool: MABC-2. The study utilized the Age Band 1 (3-6 years) version of the Movement Assessment Battery for Children-2 (MABC-2, Henderson and Sugden, 2007). The test assesses three components:

- Manual Dexterity: placing coins, threading beads, drawing along a trail;
- Aiming and Catching: catching a beanbag and throwing it at a target;
- Balance: standing on one leg, walking on tiptoes, hopping.

The assessment is three-tiered: ≤5th percentile (red, definite DCD), 6th-15th percentile (yellow, at-risk zone), and ≥16th percentile (green, normal). Only children at or below the 15th percentile were included in the study.

Electronic Differential Platform. An electronic platform was developed for Experimental Group 2 (EG-2). The platform analyzes the MABC-2 pre-test results to identify the weakest component and allocates intervention time accordingly: 50-60% of the time to the weakest component, with the remaining time distributed proportionally among the other components. In contrast, for Experimental Group 1 (EG-1), all 120 games were administered in a uniform sequence. Both experimental groups used the same database of 120 games; the only difference was the allocation algorithm.

Statistical Analysis

A One-Way ANOVA was used to check for baseline equality between the pre-test groups. Post-test results were evaluated using a one-way analysis of covariance (ANCOVA, with the pre-test as a covariate) and a post-hoc Tukey HSD test. The Wilcoxon signed-rank test was used for within-group changes. The effect size was determined using the eta-squared (η2) indicator.

Table 2. ANCOVA and Tukey HSD Analysis of Post-Test Results

MABC-2 Component	F (ANCOVA)	p	eta2	Effect Size	Tukey HSD Result
Manual Dexterity	24.318	<0.001	0.456	Large	EG-2 > EG-1 > CG
Aiming & Catching	15.627	<0.001	0.352	Large	EG-2 > EG-1 > CG
Balance	41.853	<0.001	0.641	Very Large	EG-2 > EG-1 > CG
Total Test Score	72.416	<0.001	0.778	Very Large	EG-2 > EG-1 > CG

Pre-test: Baseline Equality Between Groups. The One-Way ANOVA results showed that no statistically significant differences were found among the three groups across all four MABC-2 components ($p > 0.05$). This confirms that children with a similar level of coordination abilities were selected for the three groups, establishing equal conditions for comparing the results.

The results of the post-test conducted at the end of the 4-week intervention showed that statistically significant differences had emerged between the groups across all MABC-2 components ($p<0.001$). The post-hoc Tukey HSD test confirmed the order EG-2 > EG-1 > CG for all components—that is, the electronic differentiated individual approach (EG-2) was found to be statistically significantly more effective than the generalized motor games program (EG-1).

Table 3. Wilcoxon Test Results (Within-Group Changes)

MABC-2	CG: z	CG: p	EG-1: z	EG-1: p	EG-2: z	EG-2: p
Manual Dexterity	−1.890	0.059	2.847	0.004	3.651	<0.001
Aiming & Catching	0.420	0.674	2.534	0.011	3.318	0.001
Balance	−0.843	0.399	2.716	0.007	3.527	<0.001
Total Test Score	−0.740	0.459	3,102	0,002	3,894	<0,001

Within-Group Changes (Wilcoxon Test)

The Wilcoxon signed-rank test was used to evaluate the differences between pre-test and post-test scores within the groups. In the control group (CG), no statistically significant change was observed for any component (all $p>0.05$). In EG-1, a reliable improvement was recorded across all components ($p<0.05$). Meanwhile, EG-2 showed the highest and most reliable improvement (all $p<0.001$).

Changes in Growth Indicators and DCD Status

An analysis of growth indicators by component clearly shows the difference between the three groups. The highest growth across all MABC-2 components was recorded in group EG-2. Regarding the total test score, a 69.9% increase was observed in EG-2 and a 33.3% increase in EG-1, while only an insignificant change of 2.7% was identified in the control group.

Analysis of the change in DCD status demonstrates clinical significance: in group EG -2, 76.7% of children (n=23) moved into the normative development range. In EG-1, this figure was 63.3% (n=19), whereas in the control group, it was only 3.3% (n=1). In EG-2, the rate of definite DCD decreased from 33.3% to 6.7%.

Table 4. Growth indicators for MABC-2 components (%)

MABC-2 Component	CG Growth (%)	EG-1 Growth (%)	EG-2 Growth (%)	eta2 (effect size)
Manual Dexterity	3.9%	32.7%	68.8%	0.456 (large)
Aiming & Catching	2.0%	29.4%	59.6%	0.352 (large)
Balance	2.2%	38.6%	81.4%	0.641 (very large)
Total Test Score	2.7%	33.3%	69.9%	0.778 (very large)

Results and discussion

The study results confirm three important conclusions. First, the coordination indicators of children with DCD in the control group did not spontaneously improve over the 4-week period (all $p>0.05$). This is consistent with the 'activity deficit hypothesis' proposed by Cairney and colleagues, which suggests that children with DCD avoid physical activity due to motor difficulties, leading to a further decline in coordination skills. The borderline result for Manual Dexterity ($z=-1.890$; $p=0.059$) suggests that a lack of intervention may negatively impact fine motor skills.

Second, the generalized set of exercises (EG-1), consisting of 120 motor games, was also effective, with a significant improvement observed across all components ($p<0.05$). This demonstrates that the system of dynamic games developed in the Uzbek and Russian schools of thought can also be applied to children with DCD.

Third, the electronic differential approach (EG-2) demonstrated statistically significantly higher results than EG-1 across all indicators ($p<0.001$; eta2=0.352–0.778). A crucial methodological point is that both experimental groups used the same database of 120 games and the intervention lasted for the same duration (1 month). The sole difference was that in the EG-2 group, the electronic system allocated 50-60% of the training time to each child's specific area of weakness. This reveals the 'net effect' of the differential approach and proves the fundamental importance of an individualized approach in DCD intervention.

Table 5. Change in DCD Status at the End of the Intervention

Change in DCD Status	CG (n=30)	EG-1 (n=30)	EG-2 (n=30)
Moved to normative range (≥16th percentile)	1 (3.3%)	19 (63.3%)	23 (76.7%)
Remained in at-risk range (6th-15th percentile)	20 (66.7%)	8 (26.7%)	5 (16.7%)
Definite DCD (≤5th percentile)	9 (30.0%)	3 (10.0%)	2 (6.7%)

The Balance component had the largest effect size (eta2=0.641). In the pre-test, balance was the lowest-scoring indicator across all three groups, confirming that the specialized exercise program had the strongest impact on the weakest component. This aligns with Lyakh's theory of sensitive periods (ages 5-6 being a sensitive period for balance development) and Bernstein's hierarchical model of motor control.

In comparison with international research, a meta-analysis by Smits-Engelsman et al. (2018) showed that the average effect size of DCD interventions was d=0.56. In the present study, the effect size for the EG-2 group (eta2=0.778 — Total Score) is considerably higher. The reasons for such a high result include: the moderate-to-severe level of DCD in the children (providing significant room for improvement); the frequency of intensive sessions (4 times a week); and the effective organization of the circuit training method.

Conclusion

This study is based on the following key conclusions:

Among preschool children with DCD, coordination indicators do not improve spontaneously without targeted intervention. Early and targeted correction is essential.

A specialized exercise program consisting of 120 games (40 for Balance, 40 for Aiming & Catching, and 40 for Manual Dexterity), structured in accordance with the MABC-2 components, reliably improves coordination skills in children with DCD.

The electronic differential individual approach is approximately twice as effective as the generalized approach, showing a 69.9% improvement in EG-2 and a 33.3% improvement in EG-1 based on the Total Score. This demonstrates the fundamental importance of an individual differential approach in DCD correction.

4. In the EG-2 group, 76.7% of children moved into the normative development zone—a clinically significant result.

Practical Recommendations: It is recommended to: (a) implement the MABC-2 screening system for all children aged 5-6 in preschool educational institutions of Uzbekistan; (b) apply a special set of exercises consisting of 120 games, 4 times a week for 50 minutes, for a minimum of 4 weeks; (c) create an individual training program for each child through the electronic differential system; (d) conduct special 36-hour training sessions to raise awareness about DCD among physical education instructors.

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