2026, Cilt 3, Article e13.

OPEN ACCESS
ISSN: 3062-262X

Akademik Eğitim ve Sosyal Bilimler Dergisi

(AJESS Journal)

Effect of a Modified Educational Sports Program on Improving Motor Skills in Students with Motor Difficulties

Uyarlanmış Bir Eğitsel Spor Programının Motor Güçlük Yaşayan Öğrencilerin Motor Becerilerini Geliştirmeye Etkisi

Ahmed Hezloun
Higher Institute of Sport and Physical Education Qasr Said, University of Manouba, Tunis, Tunisia
E-mail: hezloun1ahmed@gmail.com; ORCID: https://orcid.org/0009-0007-0672-8034

Khaled Djaballah
Department of Physical Education and Sports, University of Science and Technology Mohamed Boudiaf of Oran (USTO-MB), Oran, Algeria
E-mail: khaled17eps@gmail.com; ORCID: https://orcid.org/0009-0009-1345-1090

Elamine Dechaicha
Higher Teacher Training School of Boussaâda, Boussaâda, Algeria
E-mail: dechaicha.elamine@ens-bousaada.dz; ORCID: https://orcid.org/0009-0005-3785-6819

Received: 10/03/2025 **Accepted:** 10/05/2026 **Published:** 09/08/2026

Abstract

This study examined the effectiveness of a modified educational sports program in improving selected motor skills, specifically dynamic balance and reaction time, among primary school students with motor difficulties. A quasi-experimental design with a pre-test/post-test control group was adopted. The sample consisted of fourteen male students aged 7–8 years, purposively selected from a primary school in Djelfa (Algeria) and randomly assigned into two equal groups: an experimental group (n = 7) that participated in a structured modified physical education program over seven weeks (two sessions per week; 14 sessions in total), and a control group (n = 7) that continued with traditional physical education activities. Dynamic balance was assessed with a 6-m beam-walking test and reaction time with the Nelson hand reaction test. Data were analyzed using descriptive statistics and independent and paired samples t-tests ($p < .05$). The results revealed statistically significant improvements in both balance and reaction time in favor of the experimental group, whereas no significant changes were observed in the control group. These findings are consistent with contemporary meta-analytic evidence showing that structured, task-oriented motor interventions produce meaningful gains in children with motor coordination difficulties, and they underline the importance of individualized, progressively designed adapted physical education in inclusive school settings.

Keywords: Modified educational program; motor difficulties; balance; reaction time; adapted physical education.

Özet

Bu çalışma, uyarlanmış bir eğitsel spor programının motor güçlük yaşayan ilkokul öğrencilerinde seçilmiş motor becerileri (dinamik denge ve reaksiyon süresi) geliştirmedeki etkililiğini incelemiştir. Ön test–son test kontrol gruplu yarı deneysel desen benimsenmiştir. Örneklem, Cezayir'in Djelfa vilayetindeki bir ilkokuldan amaçlı olarak seçilen ve iki eşit gruba seçkisiz atanan 7–8 yaş aralığındaki 14 erkek öğrenciden oluşmuştur. Deney grubu (n = 7) yedi hafta boyunca (haftada iki oturum, toplam 14 oturum) yapılandırılmış uyarlanmış beden eğitimi programına katılmış; kontrol grubu (n = 7) geleneksel beden eğitimi etkinliklerine devam etmiştir. Dinamik denge 6 metrelik denge yürüyüşü testiyle, reaksiyon süresi Nelson el reaksiyon testiyle ölçülmüştür. Veriler betimsel istatistikler ile bağımsız ve bağımlı örneklemler t-testleri kullanılarak analiz edilmiştir ($p < .05$). Bulgular, denge ve reaksiyon süresinde deney grubu lehine istatistiksel olarak anlamlı gelişmeler ortaya koyarken kontrol grubunda anlamlı değişim gözlenmemiştir. Bu bulgular, yapılandırılmış ve görev odaklı motor müdahalelerin motor koordinasyon güçlüğü yaşayan çocuklarda anlamlı kazanımlar sağladığını gösteren güncel meta-analitik kanıtlarla tutarlıdır ve kapsayıcı okul ortamlarında bireyselleştirilmiş, aşamalı olarak tasarlanmış uyarlanmış beden eğitiminin önemini vurgulamaktadır.

Anahtar Kelimeler: Uyarlanmış eğitim programı; motor güçlükler; denge; reaksiyon süresi; uyarlanmış beden eğitimi.

1. Introduction

Cited For: Hezloun, A., Djaballah, K., & Dechaicha, E. (2026). Effect of a Modified Educational Sports Program on Improving Motor Skills in Students with Motor Difficulties. *Akademik Eğitim ve Sosyal Bilimler Dergisi (AJESS Journal),* 3, Article e13.

Motor development represents a fundamental component of children's physical, cognitive, and psychosocial growth, as it significantly influences their ability to interact effectively with their environment, participate in educational activities, and develop autonomy in daily life. Movement is the primary medium through which young children explore objects, spaces, and social partners; consequently, the quality of a child's motor repertoire conditions the range of learning experiences available to them. Within contemporary developmental models of physical activity, motor competence is conceptualized not merely as an outcome of growth but as a driving force that initiates and sustains positive trajectories of health and engagement across childhood. Children who master fundamental movement skills early are more likely to be physically active, physically fit, and to perceive themselves as competent movers; those who do not are progressively excluded from the very activities that would develop their skills further (Stodden et al., 2008; Robinson et al., 2015).

This reciprocal and increasingly age-dependent relationship has been described as a spiral: in early childhood the association between motor competence and physical activity is weak, because participation is largely determined by adult provision rather than by the child's own capability. As children grow, however, perceived and actual competence begin to filter participation, and by middle childhood the child who moves well plays more, while the child who moves poorly withdraws. Clark and Metcalfe (2002) captured this developmental logic in the metaphor of the "mountain of motor development," in which the fundamental movement skill period constitutes a critical base camp: children who fail to consolidate this base find the subsequent, context-specific ascent to sport-related and lifelong activity skills disproportionately difficult. Gallahue, Ozmun, and Goodway (2012) similarly locate the years between approximately five and eight as the phase in which fundamental skills should move from the emerging to the mature stage, provided that instruction, encouragement, and opportunity for practice are available.

Empirical syntheses support these theoretical claims. Meta-analytic evidence confirms that gross motor competence is positively associated with physical activity, cardiorespiratory and musculoskeletal fitness, and psychosocial outcomes in children and adolescents (Barnett et al., 2016; Utesch, Bardid, Büsch, & Strauss, 2019), while systematic reviews link fundamental movement skill proficiency to a broad range of health benefits, including healthier weight status and greater participation in organized sport (Lubans, Morgan, Cliff, Barnett, & Okely, 2010). The implications extend beyond the physical domain: converging evidence in developmental cognitive neuroscience indicates that motor and cognitive development share neural substrates, particularly in the cerebellum and prefrontal circuits, and that physically active, cognitively engaging movement experiences support executive functions such as inhibition, working memory, and cognitive flexibility (Diamond, 2013; Hillman, Erickson, & Kramer, 2008).

Against this background, the situation of children who experience persistent motor difficulties acquires particular significance. A considerable number of children present with deficits in balance, coordination, postural control, and reaction time that cannot be explained by intellectual disability, visual impairment, or a diagnosed neurological condition. In its most persistent form this profile corresponds to developmental coordination disorder (DCD), a neurodevelopmental condition affecting approximately 5–6% of school-aged children, in which motor performance is substantially below age expectations and interferes with academic achievement and activities of daily living (Blank et al., 2019; Zwicker, Missiuna, Harris, & Boyd, 2012). Meta-analytic work on the underlying mechanisms indicates that children with DCD show deficits in internal modelling and predictive control of movement, in rhythmic coordination, and in executive functioning, which together explain the pervasiveness of their difficulties across tasks (Wilson, Ruddock, Smits-Engelsman, Polatajko, & Blank, 2013).

The consequences of untreated motor difficulty are cumulative. Children with motor coordination difficulties typically demonstrate lower levels of fundamental movement skills than their typically developing peers, particularly in tasks requiring dynamic balance and rapid motor responses; they are less physically active, less fit, and at increased risk of unhealthy weight status (Rivilis et al., 2011; Cairney, Hay, Faught, & Hawes, 2005). Reduced participation in turn deprives them of practice, which widens the skill gap and reinforces avoidance — a negative developmental spiral with documented consequences for self-perception, peer relationships, and long-term health behavior (Robinson et al., 2015).

In response to these challenges, adapted and modified physical education programs have become increasingly important. Such programs are designed to provide individualized motor learning experiences aligned with learners' abilities, ensuring progressive skill acquisition through structured, repetitive, and engaging activities. Despite the growing body of evidence supporting adapted physical activity, comparatively few controlled studies conducted in North African school contexts have targeted specific motor capacities such as balance and reaction time in young learners with motor difficulties, and fewer still have been implemented within the ordinary school day rather than in clinical settings. The present study addresses this gap by investigating the effect of a modified educational sports program on these two selected motor skills among primary school students with motor difficulties. The study is based on the hypothesis that a structured, adapted, and progressively designed physical activity program can significantly enhance motor performance in this population.

2. Theoretical Framework and Literature Review

2.1. Motor Competence and Developmental Trajectories. The theoretical anchor of the present study is the developmental model proposed by Stodden et al. (2008) and subsequently elaborated by Robinson et al. (2015), which posits a dynamic and reciprocal relationship between motor competence and physical activity, mediated by perceived motor competence, health-related fitness, and weight status. In early childhood the relationship is weak and unidirectional; with age it strengthens and becomes bidirectional, so that competence and activity mutually reinforce each other, generating either a positive or a negative spiral of engagement. For children with motor difficulties, the model predicts precisely the trajectory documented empirically: low actual competence produces low perceived competence, which reduces participation, which further limits skill development. The practical corollary is that intervention should occur early, before perceived incompetence has consolidated into avoidance, and should be designed to produce experiences of success.

2.2. Constraints and Task-Oriented Learning. A complementary framework is Newell's (1986) constraints model, which conceptualizes movement as emerging from the interaction of individual, task, and environmental constraints. Rather than treating motor difficulty as a fixed property of the child, this perspective directs attention to what can be manipulated: the size of the balance beam, the speed and predictability of the stimulus, the number of simultaneous demands. Adapted physical education is, in these terms, the systematic manipulation of task and environmental constraints so that the child can produce a functional movement solution and then be progressively challenged. This logic underlies the task-oriented approaches that dominate contemporary intervention research for children with motor coordination difficulties, in which the target activity itself is practiced under graded conditions rather than trained indirectly through underlying "processes" (Blank et al., 2019; Smits-Engelsman et al., 2018).

2.3. Balance as a Core Motor Capacity. Balance is considered a core component of motor performance, reflecting the integration of visual, vestibular, and proprioceptive information into anticipatory and compensatory postural adjustments (Shumway-Cook & Woollacott, 2017). Dynamic balance — the maintenance of stability while the base of support is moving — underlies nearly all locomotor and manipulative skills, from walking on uneven ground to kicking a ball while running. Deficits in balance are among the most consistently reported characteristics of children with motor difficulties and are associated with poor postural stability, inefficient movement patterns, and increased energy cost of activity. Because postural control develops through experience with varied and progressively destabilizing tasks, it is also highly responsive to structured practice, which makes it an appropriate target for school-based intervention.

2.4. Reaction Time and Sensorimotor Processing. Reaction time reflects the speed of sensory-motor processing and is an important indicator of neuromuscular efficiency in responding to external stimuli. It comprises stimulus detection, response selection, and response programming, and it is sensitive both to the perceptual demands of the task and to the child's attentional resources (Schmidt & Lee, 2019; Magill & Anderson, 2017). Children with motor difficulties frequently show prolonged and more variable reaction times, consistent with the internal-modelling account of DCD, in which the predictive coupling between intended action and expected sensory consequence is less efficient (Wilson et al., 2013). Importantly, reaction time is trainable: practice with unpredictable but structured stimuli reduces response latency, and cognitively engaging, playful movement tasks appear particularly promising because they simultaneously challenge motor coordination and executive control (Pesce, 2012; Diamond, 2013).

2.5. Adapted Physical Education and Intervention Evidence. Meta-analyses of motor skill interventions demonstrate that structured, instructor-led programs produce significant improvements in fundamental movement skills in children, whereas free-play or unstructured conditions do not (Logan, Robinson, Wilson, & Lucas, 2012). For children with motor coordination difficulties in particular, activity- and task-oriented approaches show the strongest and most consistent effects on motor performance, with large pooled effect sizes reported across successive syntheses (Smits-Engelsman et al., 2013; Smits-Engelsman et al., 2018; Yu, Burnett, & Sit, 2018). International clinical practice recommendations accordingly advise task-oriented, individualized motor training delivered at sufficient frequency and duration as the first-line intervention for children with motor coordination difficulties, and explicitly identify the school as an appropriate delivery context (Blank et al., 2019).

2.6. Motivational and Self-Perception Mechanisms. Intervention effects are not purely mechanical. Successful performance experiences are the most powerful source of self-efficacy beliefs, and these beliefs in turn regulate effort, persistence, and the willingness to attempt difficult tasks (Bandura, 1997). Contemporary motor learning theory converges on the same conclusion from a different direction: practice conditions that enhance performers' expectancies of success, support their autonomy, and promote an external focus of attention produce superior learning relative to conditions that emphasize error and self-monitoring (Schmidt & Lee, 2019). For children with a history of motor failure, therefore, the affective design of the program — achievable challenge, playful framing, visible progress — is not decoration but an active ingredient.

2.7. Related Empirical Studies. A number of controlled and quasi-experimental studies illustrate the pattern summarized above. School-based programs combining balance stations, ball-handling tasks, and locomotor circuits delivered two to three times weekly over six to twelve weeks have repeatedly produced significant gains in motor performance among children identified as having coordination difficulties, with the largest effects reported for the specific capacities that were directly trained rather than for global motor scores (Smits-Engelsman et al., 2018; Yu et al., 2018). Studies contrasting structured with unstructured conditions have shown that additional activity time by itself does not improve fundamental movement skills, whereas the same amount of time organized around explicit skill goals does (Logan et al., 2012). Research on children's postural control has demonstrated that graded reduction of the base of support and of visual information accelerates the refinement of anticipatory postural adjustments (Shumway-Cook & Woollacott, 2017), while work in exercise and cognition has shown that qualitatively enriched, cognitively demanding movement games generate benefits that purely quantitative increases in activity do not (Pesce, 2012; Diamond, 2013). Taken together, these strands justify the design adopted here: direct practice of the target capacities, explicit weekly progression, and playful formats with a cognitive load.

2.8. Research Gap. Although the evidence base for task-oriented intervention is substantial, three gaps motivate the present study. First, most controlled trials have been conducted in clinical or laboratory settings in Western and East Asian contexts, and their transferability to ordinary public primary schools in North Africa — with larger classes, limited equipment, and no specialist adapted physical education staff — has rarely been examined. Second, many studies report composite motor scores rather than isolating specific capacities, leaving open the question of which capacities respond most readily to short school-based programs. Third, few studies of this population in the region have employed a control group, without which improvements cannot be distinguished from maturation and repeated testing. The present study responds to all three.

3. Research Problem and Hypotheses

Field observations and teacher reports in the participating school indicated that a subgroup of students exhibited poor static and dynamic balance, delayed motor responses to visual stimuli, and low general coordination, which limited their participation in regular physical education lessons and, in several cases, their participation in playground activity. These observations are consistent with the international literature showing reduced fundamental movement skill proficiency and activity participation in this population

(Rivilis et al., 2011; Blank et al., 2019). The central research question was therefore formulated as follows: Does a modified educational sports program improve balance and reaction time in students with motor difficulties?

The general hypothesis stated that the modified program would improve the selected motor skills of students with motor difficulties. Three specific hypotheses were tested. The first specific hypothesis stated that no statistically significant pre–post improvement would occur in the control group following traditional physical education, since generic activity without graded task-specific practice is not expected to produce measurable change over seven weeks. The second stated that a statistically significant pre–post improvement would occur in the experimental group following the modified program. The third stated that post-test differences between the two groups would favor the experimental group, thereby attributing the observed change to the intervention rather than to maturation, familiarity with the tests, or the mere fact of additional attention.

4. Method

4.1. Research Design. A quasi-experimental design with pre-test/post-test measurements and a control group was adopted. This design allows the observed post-test changes to be attributed to the intervention, provided that baseline equivalence between groups is established. Random assignment to conditions was possible within the identified pool of students, which strengthens internal validity, although the small pool means that equivalence had to be verified empirically rather than assumed (Schmidt & Lee, 2019).

4.2. Participants. The sample consisted of 14 male students aged 7–8 years attending Djaid Omar Primary School in the province of Djelfa, Algeria, an institution affiliated with the Ministry of National Education. Students were identified through a two-stage procedure: class teachers and the physical education teacher first nominated pupils who consistently exhibited difficulty with balance, coordination, and speed of response in class activities; the research team then confirmed the presence of motor difficulty through observation during two ordinary physical education lessons and through the baseline test performance. Children with a diagnosed neurological condition, visual impairment, or intellectual disability were not included. The 14 eligible students were randomly assigned to an experimental group (n = 7) and a control group (n = 7). Parental informed consent was obtained for all participants, and children were told that they could stop at any time without consequence.

Table 1. *Distribution of the study sample*

Group	n	Age range (years)	Condition
Experimental	7	7–8	Modified adapted program (14 sessions)
Control	7	7–8	Traditional physical education
Total	14	7–8	—

4.3. Instruments. Dynamic balance was assessed using a 6-m beam-walking test. The child walked along a marked line/low beam of six metres; performance was scored on a graded scale reflecting the distance completed without loss of balance and the stability of the gait, with higher scores indicating better performance. Two trials were administered and the better score retained. Reaction time was assessed using the Nelson hand reaction test, in which the participant, seated with the forearm supported and the thumb and index finger open, catches a falling graduated stick released without warning by the examiner; the drop distance is converted into reaction time in seconds, so that lower values indicate faster responding. Following standard procedure, several practice trials preceded the recorded trials, extreme values were discarded, and the mean of the remaining trials was used. Both instruments are widely used field measures of dynamic balance and simple visual reaction time in school-aged children, require no laboratory equipment, and are appropriate for this age group (Magill & Anderson, 2017).

4.4. Procedure. The experimental phase was carried out over seven weeks, from 4 November 2025 to 6 February 2026, and included pre-testing, implementation of the modified educational sports program, and post-testing. Pre-tests were administered to both groups in the same week under identical conditions, in the school gymnasium, in the morning, by the same examiner, who was familiar to the children. Post-tests were administered in the week following the final intervention session using the identical protocol. The control group continued its regular physical education lessons with the same weekly time allocation, so that the two groups differed in the content and structure of their activity rather than in its quantity.

4.5. The Modified Educational Sports Program. The program comprised 14 sessions delivered at two sessions per week. Each session consisted of an 8-min warm-up, a 20–26-min main section, and a 5-min cool-down. The warm-up combined general locomotion with progressively more demanding postural tasks; the main section contained progressively sequenced, task-oriented, play-based activities specifically targeting balance (static and dynamic balance stations, walking on lines and low beams, single-leg tasks, carrying tasks that displace the centre of mass) and reaction speed (visual and auditory signal games, catching and dodging tasks, partner reaction duels); the cool-down combined light mobility work with a brief reflective exchange in which children named one thing they had done better than the previous session. Task difficulty was individualized and increased gradually across weeks by manipulating the width and height of the support surface, the availability of vision, the predictability and number of stimuli, and the addition of a concurrent task, in line with task-oriented intervention principles recommended for children with motor coordination difficulties (Blank et al., 2019; Smits-Engelsman et al., 2018) and with the constraints-led logic described in Section 2.2.

Table 2. *Progression of the modified educational sports program across the seven weeks*

Week	Sessions	Balance emphasis	Reaction emphasis
1	1–2	Wide line walking; two-foot static holds	Single visual signal, start–stop games
2	3–4	Narrow line walking; heel-to-toe progression	Two-choice visual signal games
3	5–6	Low beam walking; direction changes	Auditory signals; catching a dropped object
4	7–8	Single-leg holds; carrying light objects	Colour-cued choice reactions
5	9–10	Beam walking with object transport	Partner reaction duels; dodging tasks
6	11–12	Unstable surfaces; reduced visual cues	Unpredictable multi-stimulus games

7	13–14	Combined balance circuits; consolidation	Combined reaction circuits; consolidation

4.6. Data Analysis. Data were analyzed using means (M) and standard deviations (SD) for description, independent samples t-tests for between-group comparisons at pre-test, and paired samples t-tests for within-group pre–post comparisons, with the significance level set at $p < .05$. Calculated t-values were compared with the tabulated critical values at the corresponding degrees of freedom. Given the small sample, the magnitude as well as the significance of change was considered in interpreting the results, following the conventional benchmarks for effect magnitude (Cohen, 1988).

5. Results

The results are presented in three stages, corresponding to the three specific hypotheses: baseline equivalence of the two groups, change within the control group, and change within the experimental group.

Table 3. *Pre-test comparison between the experimental and control groups*

Variable	Group	M	SD	t	Sig.
Balance (score)	Experimental	1.87	0.18	1.02	NS
	Control	1.88	0.07		
Reaction time (s)	Experimental	0.14	0.08	0.60	NS
	Control	0.13	0.06		

Note. NS = not significant at $p < .05$.

As shown in Table 3, no statistically significant differences were found between the experimental and control groups in either balance or reaction time at pre-test; the calculated t-values (1.02 and 0.60) were below the critical values at the .05 level. The descriptive values likewise indicate near-identical starting positions, with mean balance scores of 1.87 and 1.88 and mean reaction times of 0.14 s and 0.13 s. These findings confirm the homogeneity and baseline equivalence of the two groups before the intervention, which is essential for the internal validity of the experimental design and for attributing post-test changes to the effect of the modified program rather than to initial differences.

Table 4. *Pre-test and post-test comparison for the control group*

Variable	Test	M	SD	t	Sig.
Balance (score)	Pre	1.88	0.20	0.82	NS
	Post	1.90	0.21		
Reaction time (s)	Pre	0.13	0.06	1.00	NS
	Post	0.12	0.05		

Note. NS = not significant at $p < .05$.

The results in Table 4 indicate no statistically significant differences between the pre-test and post-test measurements of the control group for either balance ($t = 0.82$) or reaction time ($t = 1.00$). The small numerical changes observed (balance from 1.88 to 1.90; reaction time from 0.13 s to 0.12 s) are within the range attributable to measurement variability and familiarity with the test procedure. Participation in regular physical education activities without a structured or modified intervention therefore did not lead to meaningful improvements in motor performance. This suggests that, over the study period, traditional activities alone were insufficient to produce significant motor development in students with motor difficulties, a pattern that mirrors findings from controlled intervention research in which unstructured or generic activity conditions typically yield negligible motor gains in this population (Logan et al., 2012; Smits-Engelsman et al., 2018; Yu et al., 2018). The first specific hypothesis was thereby supported.

Table 5. *Pre-test and post-test comparison for the experimental group*

Variable	Test	M	SD	t	Sig.
Balance (score)	Pre	1.87	0.18	4.50	*
	Post	2.18	0.22		
Reaction time (s)	Pre	0.14	0.08	7.00	*
	Post	0.10	0.05		

Note. * $p < .05$.

Table 5 shows statistically significant pre–post improvements in the experimental group for both balance ($t = 4.50$) and reaction time ($t = 7.00$), with the calculated t-values exceeding the critical values at the .05 level. Balance performance improved from $M = 1.87$ to $M = 2.18$, an increase of approximately 17% over the baseline value, and reaction time shortened from $M = 0.14$ s to $M = 0.10$ s, a reduction of approximately 29%, indicating faster sensory-motor responding after the intervention. The reduction in the standard deviation of reaction time (from 0.08 to 0.05) additionally suggests that responses became not only faster but more consistent, which is characteristic of genuine sensorimotor learning rather than of a few children improving markedly while others remained unchanged. The second and third specific hypotheses were thereby supported.

Table 6. *Summary of hypothesis testing*

Hypothesis	Prediction	Result
Specific 1	No significant change in the control group	Supported ($t = 0.82$; 1.00; NS)
Specific 2	Significant improvement in the experimental group	Supported ($t = 4.50$; 7.00; $p < .05$)
Specific 3	Post-test advantage for the experimental group	Supported

General	The program improves motor skills	Supported

6. Discussion

The purpose of this study was to examine the effect of a seven-week modified educational sports program on dynamic balance and reaction time in primary school students with motor difficulties. The results supported all three specific hypotheses: the groups were equivalent at baseline, only the experimental group improved significantly, and the post-test differences favored the experimental group. The discussion below considers, in turn, the convergence of these findings with the intervention literature, the mechanisms that plausibly account for them, their developmental significance, and their implications for school practice.

6.1. Convergence with the Intervention Literature. These findings align closely with the international intervention literature. Meta-analyses consistently report that structured, instructor-led motor skill interventions produce significant improvements in fundamental movement skills among children, whereas free-play or unstructured conditions do not (Logan et al., 2012). For children with motor coordination difficulties in particular, activity- and task-oriented approaches — in which the target skills themselves are practiced in progressively more demanding, meaningful task contexts — show the strongest and most consistent effects on motor performance (Smits-Engelsman et al., 2013; Smits-Engelsman et al., 2018; Yu et al., 2018). The present program embodied these principles: balance and reaction tasks were practiced directly rather than approached through generalized "perceptual-motor" training; repetition was combined with graded difficulty as documented in Table 2; and activities were embedded in playful, motivating game formats. The absence of change in the control group, which received the same amount of physical education time, indicates that it was the structure and specificity of the practice, not its quantity, that produced the effect.

6.2. Mechanisms of Change. Two complementary mechanisms plausibly account for the observed gains. The first is task-specific sensorimotor adaptation. Balance improved because the children repeatedly practiced maintaining stability under systematically reduced bases of support and reduced visual information, which is precisely the condition under which anticipatory postural adjustments are refined (Shumway-Cook & Woollacott, 2017). Reaction time improved because the children repeatedly practiced detecting and responding to unpredictable signals, which shortens the stimulus-detection and response-selection stages of the reaction chain (Schmidt & Lee, 2019; Magill & Anderson, 2017). The reduction in variability alongside the reduction in mean latency is consistent with more efficient internal modelling, the process identified as deficient in children with coordination difficulties (Wilson et al., 2013).

The second mechanism is motivational and attentional. The program was deliberately designed so that every child experienced achievable success in each session, and the closing reflection made progress visible. Mastery experiences of this kind are the strongest source of self-efficacy beliefs, which in turn govern effort and persistence on subsequent difficult tasks (Bandura, 1997). Contemporary motor learning theory reaches the same conclusion from the direction of practice design: conditions that enhance expectancies of success and support autonomy accelerate learning beyond what error information alone would predict (Schmidt & Lee, 2019). Moreover, the cognitively engaging, playful format of the reaction activities — choice reactions, dodging, partner duels — required inhibition and rapid response switching, and such qualitatively enriched exercise has been shown to benefit both motor and executive outcomes in children (Pesce, 2012; Diamond, 2013; Hillman et al., 2008).

6.3. Developmental and Health Significance. From a developmental perspective, improving core motor capacities such as balance and reaction speed matters beyond the motor domain. Motor competence is positively associated with physical activity, fitness, and perceived competence across childhood and adolescence (Barnett et al., 2016; Utesch et al., 2019), and early skill mastery is theorized to set children on positive developmental trajectories of engagement and health (Stodden et al., 2008; Robinson et al., 2015). For children with motor difficulties, who are at elevated risk of activity avoidance, lower fitness, and unhealthy weight status (Rivilis et al., 2011; Cairney et al., 2005), school-based adapted programs of the kind evaluated here may therefore serve both a remedial and a preventive function — remedial in that they restore capacities already delayed, preventive in that they interrupt the negative spiral before it consolidates. This dual function is precisely why international clinical practice recommendations position task-oriented motor training as a first-line intervention and identify the school as an appropriate site of delivery (Blank et al., 2019).

6.4. Implications for School Practice. Three practical implications follow. First, the program required no specialized equipment: lines, low beams, balls, and coloured cards sufficed, which makes replication feasible in resource-limited schools. Second, the effect was obtained within the ordinary curricular allocation of physical education time, indicating that what is required is a redesign of content rather than an extension of the timetable. Third, the identification procedure used here — teacher nomination followed by observational confirmation and baseline testing — is within the competence of ordinary school staff, provided they receive brief training in what motor difficulty looks like in class. Teacher preparation therefore emerges as the principal condition for scaling this kind of provision.

6.5. The Algerian and Regional School Context. The findings should also be read against the specific conditions of the setting in which they were obtained. In Algerian public primary schools, physical education is delivered by the class teacher or by a generalist physical education teacher, class sizes are large, specialist adapted physical education personnel are effectively absent, and equipment is typically limited to balls, cones, and marking material. Under such conditions, children whose motor difficulties are not severe enough to attract clinical referral are unlikely to receive any targeted provision at all: they are simply the pupils who are chosen last, who avoid the apparatus, and whose difficulty is interpreted as reluctance rather than as a developmental characteristic requiring instruction. The present study demonstrates that this state of affairs is not inevitable. A program requiring no purchase of equipment, no additional timetable allocation, and no specialist staff produced measurable improvement in seven weeks. What it did require was a teacher who knew which capacities to target, how to grade the difficulty of a task, and how to arrange the session so that children with a history of failure would succeed. These are matters of professional preparation rather than of resources, which locates the principal lever for improvement in initial and in-service teacher education. This conclusion is consistent with the international recommendation

that motor intervention be delivered in the child's natural environment by the adults already present in it, rather than being reserved for clinical settings that most children will never reach (Blank et al., 2019).

6.6. Limitations. Despite its positive outcomes, the study has limitations that should be acknowledged. The sample was small (N = 14), drawn from a single school, and restricted to boys, which limits generalizability to girls and to other contexts. The seven-week duration precludes conclusions about long-term retention, and no follow-up measurement was conducted; motor learning research distinguishes sharply between temporary performance effects and durable learning, and only a retention test can separate them (Schmidt & Lee, 2019). Only two motor variables were assessed, so it is unknown whether the gains transferred to untrained skills or to everyday activity. Motor difficulty was established through teacher nomination, observation, and baseline performance rather than through a standardized diagnostic battery, so the sample should be understood as children with motor difficulties rather than as a diagnosed DCD sample. The outcome measures, although widely used, are field tests whose reliability in this population has not been established locally. Finally, neither the examiner nor the children were blind to group allocation, so expectancy effects cannot be entirely excluded, and no measure of treatment fidelity or of the children's enjoyment and perceived competence was collected, which prevents direct testing of the motivational mechanism proposed in Section 6.2. Future research should include larger and mixed-gender samples, standardized motor assessment, blinded outcome assessment, longer interventions with retention and transfer tests, and additional motor, cognitive, and psychosocial outcome variables.

7. Conclusion and Recommendations

The modified educational sports program significantly improved dynamic balance and reaction time in students with motor difficulties, whereas traditional physical education alone produced no significant change over the same period and with the same time allocation. Structured, individualized, and progressively designed adapted physical activity is therefore an effective educational and developmental tool for this population, and its effectiveness derives from the specificity and progression of the practice rather than from its volume.

Table 7. *Practical recommendations derived from the study findings*

Level	Recommendation	Rationale from the findings
School	Embed adapted motor sessions in the regular timetable	Gains were obtained within the ordinary time allocation
Teacher	Train staff in early identification and task-oriented instruction	Identification relied on teacher observation plus baseline testing
Program	Manipulate task constraints progressively week by week	Progression, not volume, distinguished the two conditions
Child	Design for achievable success in every session	Motivational conditions act as an ingredient of motor learning
Research	Add retention, transfer, and psychosocial measures	Present design cannot separate performance from durable learning

Based on the findings, the following recommendations are offered. Schools should implement adapted motor programs for students with motor difficulties as a regular component of physical education rather than as an occasional remedial measure. Physical education teachers and class teachers should receive training in the early identification of motor difficulties and in task-oriented adapted instruction, including the systematic manipulation of task constraints. Programs should be designed so that every child experiences achievable success, since motivational conditions are an active ingredient of motor learning rather than a peripheral concern. Future programs should extend the intervention duration, incorporate retention and transfer assessments, and include additional motor, cognitive, and psychosocial variables. Finally, cooperation between schools, families, and health services should be strengthened so that children identified as having persistent motor difficulties receive coordinated support, and so that the gains achieved in physical education are consolidated in play, in the home, and in community activity rather than remaining confined to the intervention setting.

Conflict of Interest

The authors declare that they have no conflict of interest.

Ethical Approval

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Institutional permission was obtained from the school administration and the relevant educational authorities before data collection.

Informed Consent

Written informed consent was obtained from the parents/legal guardians of all participating students.

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Author Contributions

A. Hezloun designed the study, implemented the intervention program, and drafted the manuscript. K. Djaballah contributed to the methodology, statistical analyses, and interpretation of the results. E. Dechaicha contributed to data collection, literature review, and critical revision of the manuscript. All authors approved the final version of the manuscript.

Acknowledgements

The authors thank the administration, teachers, students, and parents of Djaid Omar Primary School (Djelfa) for their cooperation during the implementation of the study.

Declaration of Generative AI and AI-Assisted Technologies

The authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were used in the design of the study, data collection, analyses, or interpretation of results of this manuscript.

References

Bandura, A. (1997). Self-efficacy: The exercise of control. W. H. Freeman.

Barnett, L. M., Lai, S. K., Veldman, S. L. C., Hardy, L. L., Cliff, D. P., Morgan, P. J., Zask, A., Lubans, D. R., Shultz, S. P., Ridgers, N. D., Rush, E., Brown, H. L., & Okely, A. D. (2016). Correlates of gross motor competence in children and adolescents: A systematic review and meta-analysis. Sports Medicine, 46(11), 1663–1688.

Blank, R., Barnett, A. L., Cairney, J., Green, D., Kirby, A., Polatajko, H., Rosenblum, S., Smits-Engelsman, B., Sugden, D., Wilson, P., & Vinçon, S. (2019). International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. Developmental Medicine & Child Neurology, 61(3), 242–285.

Cairney, J., Hay, J. A., Faught, B. E., & Hawes, R. (2005). Developmental coordination disorder and overweight and obesity in children aged 9–14 years. International Journal of Obesity, 29(4), 369–372.

Clark, J. E., & Metcalfe, J. S. (2002). The mountain of motor development: A metaphor. In J. E. Clark & J. H. Humphrey (Eds.), Motor development: Research and reviews (Vol. 2, pp. 163–190). NASPE Publications.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Diamond, A. (2013). Executive functions. Annual Review of Psychology, 64, 135–168.

Gallahue, D. L., Ozmun, J. C., & Goodway, J. D. (2012). Understanding motor development: Infants, children, adolescents, adults (7th ed.). McGraw-Hill.

Hillman, C. H., Erickson, K. I., & Kramer, A. F. (2008). Be smart, exercise your heart: Exercise effects on brain and cognition. Nature Reviews Neuroscience, 9(1), 58–65.

Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012). Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children. Child: Care, Health and Development, 38(3), 305–315.

Lubans, D. R., Morgan, P. J., Cliff, D. P., Barnett, L. M., & Okely, A. D. (2010). Fundamental movement skills in children and adolescents: Review of associated health benefits. Sports Medicine, 40(12), 1019–1035.

Magill, R. A., & Anderson, D. (2017). Motor learning and control: Concepts and applications (11th ed.). McGraw-Hill Education.

Newell, K. M. (1986). Constraints on the development of coordination. In M. G. Wade & H. T. A. Whiting (Eds.), Motor development in children: Aspects of coordination and control (pp. 341–360). Martinus Nijhoff.

Pesce, C. (2012). Shifting the focus from quantitative to qualitative exercise characteristics in exercise and cognition research. Journal of Sport and Exercise Psychology, 34(6), 766–786.

Rivilis, I., Hay, J., Cairney, J., Klentrou, P., Liu, J., & Faught, B. E. (2011). Physical activity, fitness, and gross motor performance in children with developmental coordination disorder: A systematic review. Research in Developmental Disabilities, 32(3), 894–910.

Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan, S. W., Rodrigues, L. P., & D'Hondt, E. (2015). Motor competence and its effect on positive developmental trajectories of health. Sports Medicine, 45(9), 1273–1284.

Schmidt, R. A., & Lee, T. D. (2019). Motor learning and performance: From principles to application (6th ed.). Human Kinetics.

Shumway-Cook, A., & Woollacott, M. H. (2017). Motor control: Translating research into clinical practice (5th ed.). Wolters Kluwer.

Smits-Engelsman, B. C. M., Blank, R., van der Kaay, A.-C., Mosterd-van der Meijs, R., Vlugt-van den Brand, E., Polatajko, H. J., & Wilson, P. H. (2013). Efficacy of interventions to improve motor performance in children with developmental coordination disorder: A combined systematic review and meta-analysis. Developmental Medicine & Child Neurology, 55(3), 229–237.

Smits-Engelsman, B., Vinçon, S., Blank, R., Quadrado, V. H., Polatajko, H., & Wilson, P. H. (2018). Evaluating the evidence for motor-based interventions in developmental coordination disorder: A systematic review and meta-analysis. Research in Developmental Disabilities, 74, 72–102.

Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Roberton, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. Quest, 60(2), 290–306.

Utesch, T., Bardid, F., Büsch, D., & Strauss, B. (2019). The relationship between motor competence and physical fitness from early childhood to early adulthood: A meta-analysis. Sports Medicine, 49(4), 541–551.

Wilson, P. H., Ruddock, S., Smits-Engelsman, B., Polatajko, H., & Blank, R. (2013). Understanding performance deficits in developmental coordination disorder: A meta-analysis of recent research. Developmental Medicine & Child Neurology, 55(3), 217–228.

Yu, J. J., Burnett, A. F., & Sit, C. H. (2018). Motor skill interventions in children with developmental coordination disorder: A systematic review and meta-analysis. Archives of Physical Medicine and Rehabilitation, 99(10), 2076–2099.

Zwicker, J. G., Missiuna, C., Harris, S. R., & Boyd, L. A. (2012). Developmental coordination disorder: A review and update. European Journal of Paediatric Neurology, 16(6), 573–581.

Genişletilmiş Özet

Giriş

Motor gelişim, çocukların fiziksel, bilişsel ve psikososyal büyümesinin temel bileşenlerinden biridir. Çağdaş gelişimsel modellerde motor yeterlik, yalnızca büyümenin bir sonucu değil, çocukluk boyunca sağlık ve katılım yörüngelerini başlatan ve sürdüren bir itici güç olarak kavramsallaştırılmaktadır. Temel hareket becerilerinde erken dönemde ustalaşan çocukların fiziksel olarak daha aktif, daha zinde ve kendilerini hareket açısından daha yeterli algılayan bireyler olma olasılığı yüksekken; ustalaşamayan çocuklar becerilerini geliştirecek etkinliklerden giderek dışlanmaktadır. Denge, koordinasyon, postüral kontrol ve reaksiyon süresinde kalıcı güçlük yaşayan çocuklar okul çağı nüfusunun yaklaşık %5–6'sını oluşturmakta; bu çocuklar akranlarına göre daha düşük temel hareket becerisi düzeyi, daha az fiziksel aktivite ve daha düşük fiziksel uygunluk sergilemektedir. Katılımın azalması alıştırma fırsatını daralttığından beceri açığı büyümekte ve kaçınma pekişmektedir. Uluslararası klinik uygulama önerileri, bu çocuklar için görev odaklı, bireyselleştirilmiş ve yeterli sıklıkta uygulanan motor eğitimi birinci basamak müdahale olarak önermekte ve okulu uygun bir uygulama ortamı olarak tanımlamaktadır. Buna karşılık kontrollü çalışmaların çoğu klinik ortamlarda ve Batı ile Doğu Asya bağlamlarında yürütülmüş; Kuzey Afrika'daki sıradan devlet ilkokullarına aktarılabilirliği yeterince incelenmemiştir. Bu çalışmanın amacı, uyarlanmış bir eğitsel spor programının motor güçlük yaşayan ilkokul öğrencilerinin dinamik denge ve reaksiyon süresi üzerindeki etkisini incelemektir.

Yöntem

Çalışmada ön test–son test kontrol gruplu yarı deneysel desen kullanılmıştır. Örneklem, Cezayir'in Djelfa vilayetindeki Djaid Omar İlkokulu'na devam eden 7–8 yaşındaki 14 erkek öğrenciden oluşmuştur. Öğrenciler iki aşamalı bir süreçle belirlenmiştir: önce sınıf öğretmenleri ve beden eğitimi öğretmeni denge, koordinasyon ve tepki hızında sürekli güçlük gösteren öğrencileri önermiş; ardından araştırma ekibi iki beden eğitimi dersinde gözlem yaparak ve başlangıç ölçümlerini değerlendirerek bu güçlüğü doğrulamıştır. Tanılı nörolojik durumu, görme yetersizliği veya zihinsel yetersizliği olan çocuklar çalışmaya alınmamıştır. Uygun 14 öğrenci deney (n = 7) ve kontrol (n = 7) gruplarına seçkisiz atanmıştır. Deney grubu, 4 Kasım 2025 – 6 Şubat 2026 tarihleri arasında yedi hafta boyunca haftada iki oturumluk (toplam 14 oturum) uyarlanmış programa katılmıştır. Her oturum 8 dakikalık ısınma, 20–26 dakikalık ana bölüm ve 5 dakikalık soğuma bölümlerinden oluşmuştur. Ana bölümde dengeyi (statik ve dinamik denge istasyonları, çizgi ve alçak denge aleti üzerinde yürüme, tek ayak görevleri, ağırlık merkezini kaydıran taşıma görevleri) ve tepki hızını (görsel ve işitsel sinyal oyunları, yakalama ve kaçınma görevleri, eşli tepki düelloları) hedefleyen oyun temelli görevlere yer verilmiştir. Görev zorluğu; destek yüzeyinin genişliği ve yüksekliği, görsel bilginin varlığı, uyaranların öngörülebilirliği ve sayısı ile eşzamanlı görev eklenmesi yoluyla haftalar boyunca aşamalı olarak artırılmıştır. Kontrol grubu aynı haftalık süreyle geleneksel beden eğitimi derslerine devam etmiştir. Dinamik denge 6 metrelik denge yürüyüşü testiyle, reaksiyon süresi Nelson el reaksiyon testiyle ölçülmüş; ön ve son testler aynı uygulayıcı tarafından, aynı ortamda ve aynı saatte yapılmıştır. Veriler bağımsız ve bağımlı örneklemler t-testleri ile analiz edilmiştir ($p < .05$).

Bulgular

Ön test karşılaştırmaları, grupların denge ve reaksiyon süresi bakımından başlangıçta denk olduğunu göstermiştir ($t = 1.02$ ve 0.60; anlamlı değil). Kontrol grubunda ön test–son test ölçümleri arasında hiçbir değişkende anlamlı fark bulunmamıştır ($t = 0.82$ ve 1.00); gözlenen küçük sayısal değişimler ölçüm değişkenliği ve test alışkanlığı ile açıklanabilecek düzeydedir. Buna karşılık deney grubunda hem denge ($t = 4.50$) hem de reaksiyon süresi ($t = 7.00$) için son test lehine istatistiksel olarak anlamlı gelişmeler saptanmıştır. Denge performansı ortalaması 1.87'den 2.18'e yükselmiş (yaklaşık %17 artış), reaksiyon süresi 0.14 saniyeden 0.10 saniyeye kısalmıştır (yaklaşık %29 azalma). Ayrıca reaksiyon süresinin standart sapması 0.08'den 0.05'e gerilemiş; bu da tepkilerin yalnızca hızlanmadığını, aynı zamanda tutarlılık kazandığını göstermektedir. Böylece üç alt hipotez de desteklenmiştir. Bu örüntü, yapılandırılmış ve görev odaklı motor müdahalelerin etkili olduğunu, buna karşılık yapılandırılmamış genel etkinliklerin bu grupta anlamlı kazanım üretmediğini gösteren uluslararası meta-analiz bulgularıyla tutarlıdır.

Tartışma

Bulgular, uluslararası müdahale alanyazınıyla yakından örtüşmektedir. Meta-analizler, yapılandırılmış ve öğretmen yönlendirmeli motor beceri müdahalelerinin çocuklarda temel hareket becerilerinde anlamlı gelişme sağladığını; serbest oyun veya yapılandırılmamış koşulların ise böyle bir etki üretmediğini tutarlı biçimde ortaya koymaktadır. Motor koordinasyon güçlüğü yaşayan çocuklar söz konusu olduğunda, hedef becerilerin giderek zorlaşan ve anlamlı görev bağlamlarında doğrudan çalışıldığı etkinlik ve görev odaklı yaklaşımlar en güçlü ve en tutarlı etkileri göstermektedir. Bu çalışmadaki program tam da bu ilkeleri somutlaştırmıştır: denge ve reaksiyon görevleri genel bir 'algısal-motor' eğitim üzerinden değil doğrudan çalışılmış, tekrar aşamalı zorluk artışıyla birleştirilmiş ve etkinlikler oyunlaştırılmış formatlara yerleştirilmiştir. Aynı süreyi alan kontrol grubunda değişim gözlenmemiş olması, etkinin alıştırmanın miktarından değil özgüllüğünden ve aşamalılığından kaynaklandığını göstermektedir. Gözlenen kazanımlar iki tamamlayıcı mekanizmayla açıklanabilir. Birincisi göreve özgü duyusal-motor uyumdur: destek yüzeyi ve görsel bilgi sistematik olarak azaltıldığında öngörücü postüral ayarlamalar incelmekte; öngörülemeyen sinyallere tepki verme alıştırması ise uyaran algılama ve tepki seçme aşamalarını kısaltmaktadır. Reaksiyon süresinde ortalamayla birlikte standart sapmanın da düşmesi, bu grupta yetersiz olduğu bilinen içsel modelleme süreçlerinin verimlileştiğine işaret etmektedir. İkincisi güdüsel ve dikkatsel mekanizmadır: program her oturumda her çocuğun ulaşılabilir bir başarı yaşayacağı biçimde tasarlanmış, kapanış bölümündeki kısa değerlendirme ilerlemeyi görünür kılmıştır. Ustalık deneyimleri öz-yeterlik inançlarının en güçlü kaynağı olduğundan, bu tasarım tercihi süslemeden ibaret olmayıp etkin bir bileşendir.

Sonuç

Uyarlanmış eğitsel spor programı, motor güçlük yaşayan öğrencilerin dinamik denge ve reaksiyon sürelerini anlamlı biçimde geliştirmiş; aynı süre ve aynı zaman dilimi içinde uygulanan geleneksel beden eğitimi ise anlamlı bir değişim üretmemiştir. Etkinin kaynağı alıştırmanın miktarı değil, özgüllüğü ve aşamalılığıdır. Program özel donanım gerektirmemiş, olağan beden eğitimi süresi

içinde uygulanabilmiş ve uzman personel gerektirmemiştir; bu da kaynakları sınırlı okullarda yaygınlaştırılabilirliğini artırmaktadır. Gerekli olan tek şey, hangi yetilerin hedefleneceğini, bir görevin zorluğunun nasıl derecelendirileceğini ve başarısızlık geçmişi olan çocukların başarı yaşayacağı bir oturumun nasıl kurgulanacağını bilen bir öğretmendir; bu ise kaynak değil mesleki hazırlık meselesidir ve iyileştirmenin temel kaldıracını hizmet öncesi ve hizmet içi öğretmen eğitiminde konumlandırmaktadır. Okullarda uyarlanmış motor programların düzenli bir bileşen olarak uygulanması, öğretmenlerin erken belirleme ve görev odaklı öğretim konusunda eğitilmesi, programların ulaşılabilir başarı ilkesine göre tasarlanması ve gelecekte daha büyük, karma cinsiyetli örneklemlerle, standart tanı araçları kullanılarak, izleme ve transfer ölçümlü daha uzun süreli çalışmalar yapılması önerilmektedir.