Effect of HTKS-R–inspired visual reversal motor play on self-regulation and motor skills in preschoolers

Efecto del juego motor con inversión visual inspirado en el HTKS-R sobre la autorregulación y las habilidades motoras en niños en edad preescolar

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Abstract

Objectives**:** This study aimed at investigating the effect of intervention through cognitively enhanced motor play, based on visual reversal principles, using the modified Head-Shoulders-Knees-Toes Test (HTKS-R), on the behavioral self-regulation and basic motor skills for preschool children.

Design **:**In this study, sixty children with typical growth whose ages are 5 to 6 years. The experimental group and a control group. The experimental group participated in an intervention program that involved eighteen sessions during six weeks. These sessions included motor play stations that require inhibitory responses to the visual signals (like the response to a different color or shape that is different from the stimulus). The control group practiced ordinary physical activities.

Methods**:** In the methodological phase, the self-regulation was evaluated using the HTKS-R scale, while the motor performance was measured by the test of the standing long jump and the balance tasks. Statistical analysis included the t-test for the correlated samples and the covariance analysis (ANCOVA) and the calculation of the impact volumes.

Results**:** Importantly, the results showed a statistically significant improvement in the experimental group through all variables with big impact sizes. Also, the posttest comparisons and the covariance analysis showed a remarkable superiority in the self-regulation, balancing and jump in favor of the experimental group.

Conclusions **:**The results assert the effectiveness of the activities that integrate the executive functions with the motor play to support the behavioral self-regulation and the skills of jumping and balancing in the stage of early childhood.

Keywords

Balance; executive functions; HTKS-R; jumping; motor growth in the preschool stage.

Resumen

Objetivos **:**Este estudio tuvo como objetivo investigar el efecto de la intervención a través del juego motor cognitivamente mejorado, basado en principios de reversión visual, utilizando la versión modificada del Test de Cabeza-Hombros-Rodillas-Pies (HTKS-R), sobre la autorregulación conductual y las habilidades motoras básicas en niños de edad preescolar.

Diseño :En este estudio, sesenta niños con crecimiento típico cuyas edades son (5-6) años. El grupo experimental y un grupo de control. El grupo experimental participó en un programa de intervención que involucró dieciocho sesiones durante seis semanas. Estas sesiones incluían estaciones de juego motor que requieren respuestas inhibitorias a las señales visuales (como la respuesta a un color o forma diferente que es distinto del estímulo). El grupo de control practicó actividades físicas ordinarias.

Métodos **:**En la fase metodológica, la autorregulación se evaluó utilizando la escala HTKS-R, mientras que el rendimiento motor se midió mediante la prueba de salto de longitud desde una posición estática y las tareas de equilibrio. El análisis estadístico incluyó la prueba t para muestras relacionadas y el análisis de covarianza (ANCOVA) y el cálculo de los volúmenes de impacto.

Resultados: Los resultados mostraron una mejora estadísticamente significativa en el grupo experimental a través de todas las variables con grandes tamaños de efecto. Además, las comparaciones postest y el análisis de covarianza mostraron una notable superioridad en la autorregulación, el equilibrio y el salto a favor del grupo experimental.

Conclusiones **:**Los resultados afirman la efectividad de las actividades que integran las funciones ejecutivas con el juego motor para apoyar la autorregulación conductual y las habilidades de saltar y equilibrarse en la etapa de la primera infancia.

Palabras clave

Crecimiento motor en la etapa preescolar; equilibrio; funciones ejecutivas; HTKS-R; saltar.

Introduction

Executive functions (EFs) — They comprise inhibitory control, working memory and cognitive flexibility, which are fundamental cognitive abilities that develop rapidly during the preschool years and are vital predictors of the academic readiness, social-emotional competence and lifelong self-regulated learning (Diamond & Ling, 2016; Willoughby et al., 2021; Zelazo & Carlson, 2012).

These abilities provide a wide range of benefits for children, including physiological benefits (like maintaining a healthy weight), psychological benefits (like enhancing self-perception), and behavioral benefits (like more participation in physical activities) (Li et al., 2025). Executive functions develop during early childhood, especially between the ages (3-5 years) (Garon et al., 2008). During this period, transition and object control skills begin to emerge and develop (Capio et al., 2024) because this stage of high neural flexibility is characterized by the maturation of the anterior frontal cortical networks and this makes the early childhood a sensitive window for interventions that target the executive functions development (Moriguchi & Shinohara, 2019; Zelazo & Carlson, 2012).

Researches showed that there is a two-directional, strong and reciprocal relationship between the motor efficiency and the executive functions in the early childhood. A set of posttest evidences revealed that there are moderate to significant correlations between the motor coordination of children - especially the grand motor skills – and performing the executive functions (González et al., 2024; Schmidt et al., 2017; van der Fels et al., 2015). Moreover, interventions that combine the physical activity and the embedded cognitive requirements (like changing the rules, response inhibition and double coordination of the tasks) that they are permanently superior over the pure physical or cognitive interventions in terms of supporting the executive functions fields (Best, 2010; Diamond & Ling, 2019; Pesce et al., 2016a). Moreover, the use of HTK-R task is widely acknowledged as it is characterized with a multidimensional environmental validity and cognitive requirements. This observational tool requires the children to execute the opposite of the action required to be done, for instance, when the children are asked to touch the knees when commanded – this entails using the inhibitory control, the operational memory and the attentive flexibility in the real time (McClelland et al., 2021; Ponitz et al., 2009). It is worth mentioning that the task of HTKS-R is not only a diagnostic tool, but it also provides a rich conceptional framework to design suitable interventions in terms of growth that involve the executive requirements within the physical activities.

The theoretical basis for this approach is pivoted on the theory of embodied cognition, which confirms that cognitive development is essentially associated with the sensory-motor experience (Barsalou, 2008; Wilson, 2002). Cognitively enriching physical activities, perceptual reversal, and inhibitory alteration can stimulate and develop executive functions through multisensory engagement and adaptive motor planning (Floyer-Lea & Matthews, 2004; Kolovelonis et al., 2022).

Additionally, the theories of Reciprocity and the Automaticity were submitted to explain the positive interaction between the dynamic skills and the executive functions. The reciprocity theory hypothesizes that the motor and cognitive skills reciprocally develop through the interaction with the environment and this contributes to forming high cognitive operations (Campos et al., 2000; McClelland et al., 2019). As for the theory of automaticity, it indicates that the achievement in the motor and cognitive tasks compete for the limited resources of the cognitive attention as mastering a motor task in the beginning requires the allocation of cognitive resources, but with the repeated practices, the behaviors become mechanical and consequently, the consumption of the attention resources for the successful performance decreases (Floyer-Lea & Matthews, 2004). So, if a certain motor skill becomes automated, more of attention resources are available to conduct the cognitive operations (Cameron et al., 2015), and this means that the executive functions will not be involved in the automated motor tasks and this facilitates the execution of another cognitive task that requires executive functions at the same time (Floyer-Lea & Matthews, 2004).

Studies confirm that there is a correlation between the motor efficiency and the executive functions skills, particularly, in the preschool stage, that is considered a sensitive stage for the development of the motor efficiency and the executive functions skills (Cameron et al., 2012; Gandotra et al., 2022, 2023). The studies that applied certain activities that are derived from the HTKS to the normal kindergartens, which were based on motor are few. In particular, it is rare to notice practical researches that explore the way in which integrate the visual reversal logic in organized physical activities that can be executed

in the real educational environments. Moreover, the educators and the designers of curricula lack frameworks that integrate the development of functions and training on the grand motor skills with one form that are suitable in terms of the growth. To bridge this gap, the current study introduces a novel intervention that pivots on play by integrating the visual reversal logic that is derived from the HTKS principles. In this program, pupils participate in motor play stations, in which they are asked to respond to contradicting visual stimuli, such as jumping towards a shape or a color that contradicts with the verbal instruction and such, the executive operations are activated within grand motor challenges.

The continuous developments in the field of Neuroeducation showed the rarity of the programs directed to develop the executive functions, especially, through the body expression, as most of the literature available are confined to studying the correlation of the executive functions with other axes and other variables (Martín et al., 2022).

This gap is more evident in the countries with low and medium income (LMICs) because the education systems (in the early childhood stage) in these countries lack physical interventions with cognitive enrichment, which were tested on a wide scale in the Western contexts. From this point, the current study aims at evaluating the efficiency of a new intervention that is based on the motor play (derived from the visual reversal logic according to HTKS-R principles) on improving the behavioral self-regulation and the motor skill performance for the preschool pupils.

To deal with this gap, the following hypotheses were put forward:

1- The children participating in the intervention derived from HTKS-R showed more improvement in behavioral self-regulation compared to their counterparts in the control group.

2-The experimental group is superior to the control group in the distance of the standing long jump.

3-The intervention group showed a superior performance in the balancing after the end of the program.

Method

The study employed a quasi-experimental pretest–post test control group design to test the effect of the intervention based on the motor play and supported with the cognitive processes – according to the principles of the visual reversal derived from HTKS-R for the executive functions and the motor skills of the preschool children which represented the independent variable. On the other hand, the dependent variables were represented by the behavioral self-regulation, the standing long jump distance and the balance performance.

Participants

The sample consisted of 60 of the healthy-growth preschool children (30 males and 30 females) from two private kindergartens: (ALRaghad and Fullah) in Samaraa city, Iraq. The ages of the children were 5 to 6 years, with an average age of 5.4 years (the standard deviation is 0.3). the test was conducted on the basis of the availability of the convenient conditions and relevant approval were obtained to conduct the research that the two kindergartens are typical for the early childhood education program. The children were distributed randomly into two groups: the experimental group and the control group and each group included (30) children and balancing between the two sexes was taken into consideration.

The samples size was determined using the previous statistical ability analysis by the package (G*Power 3.1) (Faul et al., 2007) hypothesizing an average effect size of ($f = 0.25$), a significance level of ($\alpha = 0.05$), statistical strength of ($1 - \beta = 0.80$). results showed that the minimum number of participants should be 54 participants and to compensate the probable lack, 60 children were recruited.

Children didn't need a verbal intervention to support the language and this enabled classifying them as original Arabic speakers. According to the information submitted from the parents, it was evident that most of the families belong to the middle class as 57% of the parents are university graduates and 43% of them are secondary school graduates.

Procedure

The experimental group participated in an intervention program that consists of 18 sessions for six weeks and with an average of three sessions weekly and the time of each session is 30 minutes. The sessions included motor play stations that were designed to engage the executive functions through the response inhibition and cognitive flexibility. These stations pivoted on the basic logic of HTKS-R tests and the children were asked to perform motor responses that don't match the visual stimulators.

Moreover for instance, a child was asked to jump on the squares consecutively with a a forward movement and after the last square the jumping domain branches into other shapes (triangles, circles and pentagons) with a branch for the square to mislead the child to continue in the same manner. When finishing the jumps on the square, the child has to jump to the shape which is contrary to it based on an inverse rule previously agreed upon (a triangle, for example) and the same is done for the rest of shapes.

In addition, children are asked to jump towards a shape or color that is different from the previous one, in accordance with a previously-determined inverse rule that is similar to the rule of the different shape. Moving to the shapes is performed through jumps with keeping the body balanced within the perimeter of those shapes. The activities were organized according to scrutinized cognitive-motor rules to provoke the inhibition and cognitive alteration skills in a joyful context that is suitable in terms of the growth.

All the sessions were headed by well-trained physical education teachers who received prior instructions to ensure the unification of the procedures. As for the control group, it resumed its usual program of the physical activities and this program didn't involve reflexive cognitive challenges or tasks that direct the executive functions

Instrument

Behavioral self-regulation*:* The behavioral self-regulation was evaluated using HTKS-R (Head-Toes-Knees-Shoulders–Revised) test according to the execution and recording procedures (McClelland et al., 2021) (the test is considered as validity tool and the tool was verified in the Iranian environment (Ahmadi et al., 2025; Khomais & Al-Khalidi, 2019). Also, the test was used and translated into Arabic (before the modified version) in the Arab environment in Saudi Arabia previously, and due to the cultural and educational similarity between Iran, Iraq and Saudi Arabia in addition to the geographical location, proving the validity and invariability of the tool (HTKS-R) in these countries enhances using it in Iraq. Moreover, the tool was comprehended by the sample through the experimental application of the modified version after translating it into Arabic and the application was to the untested sample (30 children). The invariability of the tool was verified by reapplying it and finding the correlation coefficient between the results of the two applications ($r = .917$, $n = 30$, $p < .01$.). this tool measures the inhibition, working memory and the cognitive flexibility by asking the children to touch the knees when they are asked to touch the shoulders). This test involves a total of scores that range between (0) to (118), and the higher scores refer to stronger capabilities of the self-regulation and the executive functions.

Motor Skill Measures

These were evaluated using two performance-based scales, which were selected due to their growth convenience and of their psychometric support (Robinson et al., 2015):

long jump from Standing position: Each child made three trials of jumping from the standing position and the longest distance was recorded in centimeters as an indicator of the lower muscle explosiveness.

Balance Beam Walk: Children made three trials to walk on the beam (3 m long) and (10 cm width) and the average time consumed was recorded with seconds and the children preserved the continuous balancing without any fall to measure the ability to preserve the dynamic balance.

Data analysis

The descriptive statistics were calculated (the arithmetic mean and the standard deviations) of the pretest and the posttest for both groups. The data distribution was tested using the Shapiru-Wilk test and with using the visual check of the replicates to verify the normal distribution hypothesis.

The changes in the groups for the pretest and the posttest were analyzed using the (t) test for the correlated samples for each one of the (HTKS-R) variables: the jumping, time of balance. As for the differences between the groups, they were evaluated using the covariance analysis (ANCOVA) by comparing the

scores of the posttest with a statistical adjustment of the pretest scores. This method helps to increase the statistical capability and dealing with the primary difference between the groups.

In addition to that the impact volumes were calculated using Cohen's d of the paired comparisons and (η^2) of ANCOVA models to evaluate the volume of the effects observed.

All the tests were conducted using IBM SPSS Statistics (version 26) and at a significance level of $p < 0.05$.

Results

Table (1) presents the descriptive statistics of the arithmetic mean and the standard deviations) of the dependent variables in the pretest and the posttest for the experimental and the control groups. These values are manifestations of the performance before commencing the statistical tests.

Table 1. The descriptive statistics of the outcome variables

Experimental Group (n=30), Control Group (n=30)			
Variable	Group	Pre	Post
		Mean (SD)	Mean (SD)
HTKS-R	Experimental	43·33 (9·04)	60·53 (10·52)
Jump	Experimental	74·70 (11·17)	89·30 (11·59)
Balance	Experimental	5·24 (1·32)	6·49 (1·16)
HTKS-R	Control	43·40 (8·32)	46·00 (8·57)
Jump	Control	75·97 (11·74)	79·40 (11·59)
Balance	Control	5·22 (1·38)	5·49 (1·31)

*Significant differences, p< .05.
Note. SD = standard deviation; p < .05

To verify the suitability of using parametric tests, Shapiru-Wilk tests was performed for each variable, as shown in table Table 2.

Table 2. Shapiro-Wilk Normality Test

Experimental Group (n=30), Control Group (n=30)					
Variable	Group	Pre		Post	
		W Statistic	p-value	W Statistic	p-value
HTKS-R	Experimental	0·9644	0·3982	0·932	0·0556
Jump	Experimental	0·9369	0·0753	0·9778	0·7635
Balance	Experimental	0·919	0·0552	0·8851	0·0717
HTKS-R	Control	0·9558	0·2413	0·9708	0·5623
Jump	Control	0·9169	0·0623	0·9283	0·0642
Balance	Control	0·9126	0·0573	0·8819	0·0701

*Significant differences, p< .05.

The t-tests were conducted for the correlated samples to test the differences in the groups for the pretest and the posttest and for all the variables (HTKS-R), jump, balance. In addition to t values, the freedom degrees and the statistical significance levels, the impact volume was calculated (Cohen's d) to estimate the significance of the differences between the two tests and this enables a clearer evaluation of the experimental intervention effectiveness. Table-3 presents the detailed results of these analyses.

Table 3. Paired t-test Within Groups

Degrees of freedom = 29				
Variable	Group	Paired t-test Within Groups		Effect Size (Cohen's d)
		t values	p-value	
HTKS-R	Experimental	-12.403	0.0000	2.264
Jump	Experimental	-12.080	0.0000	2.206
Balance	Experimental	-16.550	0.0000	3.022
HTKS-R	Control	-4.870	0.0000	0.889
Jump	Control	-6.110	0.0000	1.115
Balance	Control	-4.794	0.0000	0.875

*Significant differences, p< .05.

Comparisons were made between the groups after the intervention using t-test for the independent samples – t tests in order to test the differences between the experimental and the control groups in terms of all the dependent variables. Table-4 presents the results in details.

Table 4. Independent Samples t-test Between Post-tests

Degrees of freedom = 58				
Variable	Independent Samples t-test		Effect Size (Cohen's d)	Significance
	t values	p-value		
HTKS-R	9.630	0.0000	1.789	Significant
Jump	6.425	0.0000	1.133	Significant
Balance	16.882	0.0000	2.822	Significant

*Significant differences, p< .05.

For further verification of the differences between the groups and to adjust the variation in the pretests, covariance analysis (ANCOVA) was applied, using the pretest scores as covariates. Table -5 demonstrates the modified statistical comparisons for (HTKS-R) and the performance of jumping and balance.

Table 5. ANCOVA Between Groups

Degrees of freedom = 1.0			
Variable	ANCOVA		Significance
	F value	p-value	
HTKS-R	118·74	0.0000	Significant
Jump	49·58	0.0000	Significant
Balance	273·19	0.0000	Significant

*Significant differences, p< .05.

The results of this study indicated the effectiveness of cognitively enhanced motor play, which pivots on HTKS-R, in terms of consolidating executive functions and motor skills for children.

Shapiru-Wilk test asserted that the data of the variables measured is normally distributed and this justifies the use of parametric analyses. The t tests of the correlated samples showed significant improvements in the experimental group for all the dependent variables, HTKS-R (jumping, balancing after the intervention. It was also clear that the effect sizes (Cohen's d) were large, Thus, the results demonstrate a substantial intervention effect.

Although the control group showed a statistically significant differences improvement for all the variables (HTKS), yet the effect sizes were less than observed in the experimental group. This implies that these improvements might be attributed to the normal growth or the routine body activity more than being attributed to the association with a directed cognitive participation.

As for the t test of the independent samples that compared the pretest scores of the two groups, there were statistically significant differences differences in favor of the experimental group for all the variables. Results show that the intervention caused a significant effect that exceeds the normal growth progress or the general body activity.

The analysis (ANCOVA) results, after adjusting the pre-performance, also confirmed these differences as the factor of the group remained as a significant predictor of the post-performance in each scale and this enhances the strength of the intervention impact.

In general, these results support the theoretical framework that there is a significant correlation between the cognitive and motor fields in the early childhood. Also, it seems that the design of the intervention, which requires that the children should inhibit the dominant responses and behave flexibly in accordance with the variables that rest on rules, has contributed vitally to activating the basic execution functions and, at the same time, enhanced the physical efficiency.

Discussion

The results of the current study contribute, remarkably, to enrich the growing literature of integrating the training of the executive functions in the contexts of the physical activity for children in their early

childhood. The substantial improvements in the behavioral self-regulation and the skill of jump for the children in the experimental group proved the effectiveness of the cognitively-supported motor activities, particularly those that involve the logic of visual reversal that are derived from HTSK-R.

Starting from the Embodied Cognition Theory (Barsalou, 2008), the intervention with the contemporary models that presume that the motor-sensory experiences form a basis for development of the high cognitive functions (Diamond & Ling, 2016). indicated that the most effective intervention on the executive functions are those which integrate the cognitive challenges within stimulating social and physical environments. This study is based on this notion through highlighting that the integration of inhibition requirements, thinking rested on rules, cognitive variation in a motor play can achieve huge growth gains in both cognitive and physical aspects.

The visual reversal model used in this study provided a unique framework to target the executive functions, especially the inhibitory control and the cognitive flexibility, which are major elements for the academic readiness (Zelazo & Carlson, 2012). The children were asked to bypass the spontaneous responses and act instead of that in accordance with abstract rules that are dependent on color or shape, and to bypass the work to the limit of stagnation, which demands from the child to inhibit the usual spontaneous response. According to (Best, 2010) , also the jumps and dynamic balance performance were included within the games that gave the children the opportunity to manifest their motor abilities that are associated with the executive functions and that contributed to positivity on both variables of standing Long jump and dynamic balance performance. So, these tasks activate the frontal nervous systems, which contributes to the maturity of the executive functions throughout the sensitive growth window in the early childhood.

Additionally, the big differences between the groups that resulted from the ANCOVA test, for the independent samples along with the big effect sizes, provide a strong support to the intervention effectiveness. These results are consistent with what was found by (de Greeff et al., 2018; Ibrahim et al., 2019; Pesce et al., 2016b)

These results are consistent with what was found by (Ibrahim et al., 2019; Pesce et al., 2016b) who proved that the cognitive-motor programs are superior than the traditional physical education in terms of enhancing the executive functions and the motor performance. The double advantage of this intervention enhances the call to a pedagogic transformation in the early education that adopting the training integrated programs for the cognitive or the motor skills only.

The effect sizes show the educational importance of these results as the values of η^2 indicated medium to high impacts and this highlights the practical role of the intervention. In the researches of early childhood, the η^2 values that exceed (0.14) are considered significant especially for the skills like the self-regulation and the motor coordination (Cohen, 1988), these results indicate that the HTSK-R based program provides a real practical value along with the statistical significance in terms of supporting the readiness to school.

Also, the design of the intervention shows an ecological validity through integrating activities that simulate the real dynamicity of the study classes such as switching the bases, adjusting the attention and modifying the behavior flexibly. This enhances the applicability of the results practically in the real educational environments and also responds to the recent literature calls to adopt game approaches that are suitable in terms of the growth, which target various growth domains (Ernst et al., 2022; Pérez-Herráez et al., 2025.; Vidal Carulla et al., 2021).

Nevertheless, there are some constrains that should be taken into consideration when interpreting the results. Firstly, although the sample size was sufficient and balanced in terms of the gender, the participants were gathered exclusively from private kindergarten in one geographical environment characterized with being an urban community and this limits the generalization of the results to wider classes of the society that include the rural area, government facilities or people from various cultural, social and economic backgrounds. Moreover, the study was based on a semi-experimental design with randomness, and this leads to a bias in the test or the performance in spite of the equivalence in the pretests. Thirdly, the evaluations were based on behavioral scales only, and although they are valid, but it doesn't show the kinetic neural-cognitive processes that might explain the remarkable improvements. Therefore, the future researches should integrate neural-physiological tool like EEG and fNIRS with the be-

havioral indicators to enhance the construction validity. Additionally, there is a need to conduct longitudinal studies to maintain the improvements after the end of the intervention. Finally, although the intervention was conducted by trained teachers, in adjusted conditions, the ability to generalize it on various class environment still needs a test. Dealing with these constraints in the future studies enhances the external validity and the application value of the intervention and this paves the way to apply it on a wider scale in the preschool education systems.

These results are consistent with similar intervention in the Arab contexts and they provide a support a transcultural support to the HTKS-R based programs. For example, the intervention of (McClelland & Cameron, 2019; Schmitt et al., 2015) Red Light, Purple Light, showed an improvement in the self-regulation for the children from low-income households using cognitively-based motor games although the impact volumes were smaller (Cohen's d ≈ 0.3). alternatively, this study achieved bigger impacts due to the modernity of the activities that were derived from HTKS-R and their density in the educational context in the Middle East. In addition to that, the study of (McClelland et al., 2021) showed that the performance of HTKS-R is considered as a strong indicator and consistent for the prediction in the academic acquisition during the stages of kindergarten and the preschool. This supports the integration of the physical-cognitive tasks into the curricula of the preschool curricula on a global level.

It is important to consider the wider cultural and educational context in which this study was conducted. The western countries integrate the intervention of the executive functions in the preschool curricula, but the Arab countries, which are low-income countries, including Iraq, lack methodological strategies that target self-regulation through the embodies play. The success of this program that is derived from HTKS-R in the kindergartens in the middle east shows the adaptability and applicability of these interventions in various cultures. These results are in agreement with the international literature, but they highlight the urgent need to use and expand the suitable growth programs in the educational environment with limited resources. Also, this study encourages using the cognitive and motor interventions that are derived from HIKS-R in the preschool educational programs. Through the continuity of the synergy between the physical play and executive updates, these interventions provide an effective means to enhance the cognitive and motor development for children simultaneously. The integrative model is considered very important in light of the twenty-first century educational goals that give the priority to adaptation, self-regulation and the learning skills for lifelong for the early stage of growth.

Conclusions

The present study shows that the stations of the motor play based on the visual reversal of (HTKS-R) test has remarkably enhanced the behavioral, self-regulation and basic motor skills (jumping and balance) for the preschool children. Also, the intervention proved its effectiveness in terms of strengthening the inhibitory control, balance and jumping skills within a relatively- short period of time.

Significant differences between the groups and the high effect sizes that were observed through all the variables refer to the strength of the cognitively-enhanced physical activities on consolidating the growth gains whether in the motor or the cognitive aspects. These results contribute to enrich the growing literature that require complete pedagogic models that combine the body movement and the training of the executive functions in the early teaching stage.

Through focusing on replacing the rules, inhibition and the flexible attention within an embodied context, the research submits a suitable, attractive and a high environmentally successful approach to enhance the readiness for school. teachers and curricula designers encourage the introduction of similar double-fielded activities to support the integrated development through this constructional stage.

In the end, the results emphasize the importance of integrating the cognitive – motor activities in the curricula of the official kindergartens as a means to enhance the cognitive, behavioral and physical preparation to learn for lifelong.

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