

«Eduball» as an innovative interdisciplinary pedagogical method in physical education. Review of the evidence-based research

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Анотація. Останнім часом спостерігається підвищення інтересу до фізичної активності, що пов'язано з її позитивним впливом на академічні та когнітивні здібності. Існує велика кількість доказів того, що фізична активність впливає як на фізіологічний, так і на когнітивний розвиток. Одним із прогресивних методів, який поєднує фізичну активність з академічним навчанням і передбачає розвиток і вдосконалення когнітивних здібностей дітей через рух та гру, є метод EduBall. Це інноваційний підхід до навчання, заснований на міждисциплінарній моделі викладання фізичного виховання. *Мета.* Представити результати двадцятирічних досліджень впровадження інноваційного міждисциплінарного підходу у фізичному вихованні – методу EduBall. *Методи.* Аналіз, синтез, узагальнення та порівняння науково-методичної літератури. *Результати.* За ключовими словами «educational balls» та «EduBall» знайдено та опрацьовано статті, що представляють результати дослідження впровадження методики EduBall на уроках фізичної культури. Розглянуто вплив методики як на фізичну підготовленість і рухові навички, так і на когнітивні функції дітей. Отримані результати свідчать, що використання методу EduBall на уроках фізичної культури впливає на фізичну підготовленість дітей такою ж мірою, як і традиційна програма фізичного виховання. Але при цьому метод має більший позитивний вплив на загальну координацію тіла, координацію очей і рук, часово-просторове орієнтування, рівень розвитку координації обох рук та локомоторні навички учнів початкових класів. Також підтверджено суттєвий вплив фізичної активності з використанням EduBalls на мовні здібності дітей, навички читання та письма, графомоторні навички, математичні компетентності. Доведено, що метод EduBall є ефективним інструментом підтримання навчання для учнів з діагнозом дислексія. Дослідження були проведені у польських школах, але слід зазначити, що цей інноваційний міждисциплінарний педагогічний метод може стати ефективним засобом підтримання навчання і для українських дітей.

Ключові слова: educational balls, EduBall, фізичне виховання, когнітивні функції, навчальні досягнення.

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EDUBALL AS AN INNOVATIVE INTERDISCIPLINARY PEDAGOGICAL METHOD IN PHYSICAL EDUCATION. REVIEW OF THE EVIDENCE-BASED RESEARCH

Abstract. Recently, there has been an increase in interest in physical activity, which is associated with its positive effect on academic and cognitive abilities. There is a large body of evidence that physical activity affects both physiological and cognitive development. One of the progressive methods that combines physical activity with academic learning and involves the development and improvement of children's cognitive abilities through movement and play is the EduBall method. This is an innovative approach to teaching, based on an interdisciplinary model of teaching physical education. *Objective.* To present the results of twenty-year research into the implementation of an innovative interdisciplinary approach in physical education, the EduBall method. *Methods.* Analysis, synthesis, generalization and comparison of scientific and methodical literature. *Results.* Using the keywords «educational balls» and «EduBall», the articles presenting the results of research on the implementation of the EduBall method in physical education classes were retrieved and processed. The impact of the method on physical fitness and motor skills, as well as on children's cognitive functions was examined. The obtained results showed that the use of the EduBall method in physical education classes affects the physical fitness of children to the same extent as the traditional physical education program. However, the method has a greater positive effect on general body coordination, hand-eye coordination, time-spatial orientation, the level of development of coordination of both hands, and locomotor skills in primary school

Introduction. What role does physical education play in the modern system of school education? Is it fair to say that physical education at school affects only the development of physical side of a child's growth, not adding too much to the sound development? It is known, that fitness level is a potent biomarker of health status from an early age, with physical exercise being one of the main determinants of physical fitness [35]. But, in addition to its health and wellness benefits, many studies have shown [8] that regular physical activity is beneficial for children's brain function development. The study of the relationship between physical activity and motor and cognitive function in youth children has shown that physical activity leads to brain structure and function changes.

In recent years, there has been increased interest in physical activity due to its positive impact on academic and cognitive skills [35]. To date, numerous studies have proven that physical activity has a close connection with the development of children's cognitive functions. There is a huge body of evidence indicating that physical activity has both physiological and psychological benefits, being associated with better mental health and enhancement of brain function and cognition [7]. Recent research shows that combining movement with learning didactic content brings many benefits to students – both in terms of health and school achievements [7, 16, 41].

Recent examples of the studies confirming the relationship between physical activity and the development of cognitive skills are the works of academics from the Department of Team Sport Games at the University School of Physical Education in Wrocław, which has been going for 20 years. In 2001 academic Andrzej Rokita, Tadeusz Rzepa and Zbigniew Naglak have created an innovative educational concept that combines physical activity with academic learning and involves the development

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students. The significant influence of physical activity using EduBalls on children's language abilities, reading and writing skills, graphomotor skills, and mathematical competencies was also confirmed. The EduBall method was demonstrated to be an effective learning support tool for students with dyslexia. The research was conducted in Polish schools, but it should be noted that this innovative interdisciplinary pedagogical method can become an effective means of maintaining learning for Ukrainian children as well.

Keywords: educational balls, EduBall, physical education, cognitive functions, academic achievements.

and improvement of children's cognitive abilities through movement and play. The idea was based on an interdisciplinary model of teaching physical education and was to create an innovative teaching method with using of special didactic aids – educational balls (EDUballs/BRAINballs) used in physical education setting with specially modified tasks that require cognitive skills and cognitive functions activated during physical activity.

The main goal that guided the creators of the innovative concept was to create a solution that would allow to combine the child's physical activity with his education. Teaching methodology should propose new ideas in education covering the following spheres: cognitive, emotional and psychomotor, taking into account somatic differences, motor predispositions and personality traits of children [1].

Children at younger school age are characterized by a need for physical activity, which, according to the recommendation of the World Health Organization, should be satisfied by at least 60 minutes of daily physical activity [46]. Children in preschool and primary school age feel a natural need to move, they are happy to play and perform various physical exercises. Movement plays and games, especially with balls, are their favorite forms of physical activity [32].

Since autumn 2001, Andrzej Rokita and Tadeusz Rzepa, and later Ireneusz Cichy taught teachers of integrated education and physical education in the use of educational balls «edubal» during physical activities in Wrocław, Jelenia Góra, Oława, Bydgoszcz and Legnica. Educational balls «edubal» have been patented (industrial design of September 25, 2002 No. Wp – 1797) [17]. They were positively received and approved by the Polish Ministry of Education

and Sport. A set of educational balls «edubal» has been included in the list of teaching aids recommended for school use and intended for general education and integrated education at the primary school level [20]. Educational balls were also recommended by the Parliamentary Committee on Physical Culture and Sport in Poland [23].

Objective. Presentation of the results of twenty years of research on the use of an innovative interdisciplinary approach in physical education – the EduBall method.

Methods. Analysis, synthesis, generalization and comparison of scientific and methodical literature.

Results. This section presents an analysis of the results of research on the implementation of the EduBall method in physical education classes, which allows to understand the possibilities of this method, its influence on both physical fitness and motor skills, as well as on the cognitive functions and academic achievements of children and also its prospects for future implementation and research in the system of physical education at school.

What are EduBall educational balls?

Almost 20 years ago, the creators of educational balls assumed that physical activity with the use of these innovative balls would affect not only the physical fitness and motor skills of students, but also their academic performance. Guided by this assumption, they modified traditional balls in four colors (red, blue, green and yellow), marking them with letters of the Polish alphabet, numbers and signs of mathematical operations [28, 27]. The first set of 94 balls, then called «edubal», was created in 2002. After 12 years of experience in working with and researching «edubal», another version was prepared and they were named «EduBall». The number of balls in the set was increased (to 100

balls now), balls with the most common vowels in Polish were added, as well as four universal (unmarked) balls in orange [23].

Placing letters, numbers and signs on the balls allowed for their versatile use in various areas of student education during physical education classes. Children participating in physical activities with EduBalls learn about colors, letters, numbers, basic mathematical operations (addition, subtraction, multiplication and division), and numerous language and mathematical rules. At the same time, they develop fine and gross motor skills as well as basic motor skills (e.g., passing and catching, dribbling, throwing, rebounding and receiving the ball). Plays and games with EduBall are based on natural forms of movement (running, jumping, throwing, grabbing, etc.) and holistically stimulate children's development. Numbers, letters and signs, as well as the colors of educational balls enable their wide application in teaching or improving the content of almost all school subjects, e.g., native and foreign languages, mathematics, biology, and in older classes geography, history or even chemistry, during physical education classes [21, 30]. Properly designed plays, games and exercises with educational balls become a very helpful means in comprehensive preparation of a child for life, and most of all for learning process in education system in other school subjects.

Academic, motor skills and physical fitness effects with educational balls

Classes with educational balls usually take place during physical education lessons or preschool physical activities, so it was important to determine their effects in the field of physical fitness of students. At first, Rzepa [39] stated that physical activities with educational balls can significantly increase the level of fitness. However, Cichy and Rzepa [4], Rzepa and Wojcik [36] did not confirm the physical impact of classes with EduBall on students of grades 1-3 of primary school. It was noted that changes in the level of physical fitness occurred both in the experimental and the control groups, regardless of the experimental factor. Similar conclusions were formulated by Krajewski [14]. On the basis of

research conducted in a group of six-year-olds, he believed that the introduction of an unconventional program into preschool education (including EduBall method with numerous exercises with educational balls, relaxation and playing with a sheet) affects the physical fitness of children to the same extent as in the traditional physical education program. Rokita [33] indicated that the use of educational balls is expedient and justified, as it allows for the integration of the content of the physical education program with the content of other school subjects, without causing deterioration of the physical fitness of pupils.

In subsequent studies, Cichy [5] observed that physical activities with educational balls did not cause undesirable changes in the area of physical fitness, but had a positive effect on the results of overall body coordination. Cichy et al. [6] noted that it is the specificity of plays and games with EduBall is greater importance for the development of the child's coordination than for some efficiency components physical, which are conditioned, among others, by biological development (e.g., strength). Previously, Wójcik-Grzyb [45] stated that the development of coordination abilities is directly related to learning speed reading and writing. It was one of the reasons of the article to search for connections between the implementation of physical activities with the use of educational balls and literacy skills [23].

Surynt and Rokita [40] found that the development of eye-hand coordination determines progress in mastering the writing technique, and Wójcik-Grzyb [45] proved that children with a higher degree of orientation in space write more efficiently, making fewer mistakes, and write more fluently and they read better. In subsequent studies, it was decided to diagnose eye-hand coordination and time-spatial orientation in pupils participating in classes with educational balls [3, 43]. What's more, meeting the needs and requirements of modern children, in the conducted scientific projects used research tools with the use of the latest technological solutions (e.g., Vienna Test System, Smart Speed System), thanks to which participation in research

was attractive for children, and above all, it provided reliable and objective results.

Cichy et al. [3] presented the results of an experiment aimed at determining the level of development of coordination of both hands among primary school students. Better results were found with respect to time (trial 2 HAND – Viennese Test System). The authors also observed that girls showed greater accuracy than boys when performing the test. Wawrzyniak et al. [43] conducted research on the time-spatial orientation of first-graders and noted that the pedagogical experiment with EduBalls resulted in more favorable changes in time-spatial orientation among students from the experimental class than among their peers from the control class.

Another milestone in the research on educational balls was the decision to diagnose the fundamental motor skills of students using the world-renowned research tool Test of Gross Motor Development (TGMD-2) [12]. Due to the nature of the classes (with balls), it was decided to check how their implementation will affect the students' manipulative (e.g., throws, passing) and locomotion (e.g., running, jumping, stepping and delivery) movement skills. After a one-year pedagogical experiment, it turned out that the use of EduBalls had a positive impact on the development of locomotor skills of students from all experimental classes. They also obtained significantly better results in terms of manipulative motor skills than students from the control class [12].

The effects of educational balls and the educational achievements of students

From the very beginning, the creators of educational balls assumed that physical activities with their use would have a positive impact on the cognitive development of students. In the first study, it was decided to verify whether participation in lessons with the use of EduBall balls will significantly affect the acquisition of language competences in students. Rzepa [39] noted that the application educational balls during physical activities significantly improves children's skills in the field of mother tongue (Polish). Similar conclusions were reached by Cichy and Rzepa [4],

who described the results of the study of first grade pupils of primary school. The significant impact of physical activities with the use of educational balls on children's reading and writing skills was confirmed by the results of three-year research conducted among primary school pupils. It was observed that the use of educational balls in integrated education context contributed significantly more to the change in the reading skills of pupils from the experimental group than in children from the control one [34, 37, 38]. Rokita [33] also pointed to the relationship between the introduction of physical activities with educational balls in grades I-III of integrated education and the intellectual development of students in reading and writing.

In subsequent studies, Rokita et al. [26] noted some positive trends in the ability to writing in lines in primary school students participating in classes with educational balls. Similar conclusions were drawn by Rokita et al. [31]. Based on the previously obtained results of research on the ability to write, Wawrzyniak [44] decided to assess the development of graphomotor skills in children of the first grade of primary school. After a six-month experiment, it turned out that the students from the study class obtained significantly better results of graphomotor efficiency than children carrying out classes without educational balls.

Previous research on other subjects' competences has focused on students' language skills (reading and writing). Kaczmarczyk and Rokita [9] decided to verify the usefulness of educational balls in acquiring mathematical competences. Their study in a public school [24, 10] showed that after participating in a year-long pedagogical experiment, using educational balls, students in the experimental group scored higher in math knowledge and skills at the end of the year than students in the control group. The authors proved that experimental class students gained more information during the school year and math skills (in all activity categories) compared to their peers in the control class [9, 10, 2].

Interesting results have been obtained from studies that show that educational balls can perform a revali-

dition and therapeutic function, while at the same time being a supplement to traditional therapeutic methods that are used in traditional and integration kindergartens or in therapeutic schools [13]. Cichy et al. [6] verified the effects of physical activities with EduBalls in terms of skills and knowledge of students from integration classes in relation to educational competences. After a year-long experiment, they have become an educational ball in a therapeutic primary school for students with disabilities. Another research project concerned the introduction of a lexeme. Carrying out a pedagogical experiment, Rokita and Krysmann [25], Krysmann [15] and Rokita et al. [29] used exercises, games and games with EduBall educational balls as activities supporting the education of students with diagnosed dyslexia. The results of the study confirmed the authors' assumptions about the legitimacy of using this teaching aid. At the end of the school year, children with dyslexia had a significant improvement in reading and writing skills [15, 25]. Kasperska and Białoszewski [11] also point to some areas of rehabilitation where educational balls can be used. In their opinion, this «[...] new, Polish method of «edubal» fits into the circle of such recognized methods of psychophysical rehabilitation, such as Paul's Educational Kinesiology Dennison (so-called brain gymnastics), The Good Start Method, The Developmental Movement Method of Weronika Sherborne» [11, p. 29]. Encouraging children to mental and physical effort as well as sparking creativity, with building of a nice atmosphere during classes, the use of praise, adapting the way classes are conducted to the individual needs and abilities of students will undoubtedly increase the efficiency of physiotherapists' work. The authors also point out to the need of familiarization of physiotherapy students with this method as part of the subject of movement teaching methodology [In 2022, Wawrzyniak et al. [42] decided to look for an answer to the question of who should conduct classes with educational balls to make them most effective (regular classroom teachers, physical education teachers, or maybe both in cooperation?). The experiment involved

three experimental groups and one control group. In the first experimental group EduBall-classes were conducted by the classroom teacher, in the second, by the physical education teacher, and in the third, collaboratively. After one year intervention, all experimental groups significantly improved both their cognitive (mathematical, reading, and writing) and gross motor (locomotor and object control) skills, and these effects were larger than in the control group participating in traditional PE. Importantly, there were no differences in progression between the EduBall groups. This study showed that methods that link physical education to cognitive tasks can be effectively used by both physical education specialists and general classroom teachers.

Due to the internationalization of EduBall, the results of research of the impact of EduBall method in integrated education on the acquisition of reading and writing skills in English may be interesting. In 2019, an international research project was launched in one of the Vietnamese primary schools. Its aim was to check how physical education classes with educational balls affect physical fitness, selected motor skills and reading and writing skills in English in class II students. The results confirmed what has so far been studied only in Poland – in the case of students from Vietnam, EduBall classes also had a positive impact on school achievements and physical fitness [18, 19].

Taking into account the results of long-term research by the Polish academics, which confirm the efficiency of the implementation of the EduBall method and its positive impact on the development of cognitive functions and academic achievements of primary school students, this method can be effective when it is implemented in schools of Ukraine. The use of the experience of Polish scientists and the implementation of the EduBall method by physical education teachers and classroom teachers of Ukrainian schools can also provide wide opportunities in the development of cognitive functions and educational achievements of Ukrainian students. This innovative interdisciplinary pedagogical method in physical edu-

cation can become as effective a means of supporting the learning of Ukrainian children as it is of Polish children.

Conclusions. Method EduBall is an innovative educational concept that combines physical activity with academic learning and involves the development and improvement of children's cognitive abilities through movement and play. Since the creation of educational balls there have been many pedagogical experiments conducted to determine the effects of movement classes with EduBall. Findings show that the unconventional program including EduBall method affects the physical fitness of children to the same extent as in the traditional physical education program. It has been proven that educational balls allow for the integration of the content of the physical education program with the content of other school subjects, without causing deterioration of the physical fitness of pupils. At the same time, it's been observed that physical activities with educational balls had a positive effect on the results of overall body coordination, eye-hand coordination, time-spatial orientation, level of development of coordination of both hands and locomotor skills of primary school students.

But the main feature of the EduBall method is its impact on the development of cognitive functions and academic achievements. It was confirmed the significant impact of physical activities with the use of educational balls on children's language skills (native and foreign languages), reading and writing skills. It's been noted positive trends in the graphomotor efficiency of primary school students. Also, the study showed the usefulness of educational balls in the acquisition of mathematical competencies. Important results were obtained in an experiment on the introduction of educational balls in a therapeutic primary school for students with disabilities. The study confirmed that EduBalls are an effective learning support tool for students diagnosed with dyslexia.

Another important conclusion is that the effectiveness of the methodology does not depend on the specialization of the teacher. The researchers showed that EduBall method can be effectively

used by both physical education specialists and general classroom teachers.

Prospects for further research. The EduBall method has significant potential. Researches into the possibilities of using this method and its influence on the development of other cognitive functions continue. It should also be noted that this innovative interdisciplinary pedagogical method in physical education can become as effective a means of supporting the learning of Ukrainian children as it is of Polish children.

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