ELEMENTARY EDUCATION IN THEORY & PRACTICE Vol. 20, 2025, No. 3(78)
e-ISSN 2353-7787
DOI: 10.35765/eetp.2025.2078.09

Submitted: 04.08.2025 | Accepted: 10.09.2025

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The Importance of Physical Activity in the Holistic Development of Children in Early School and Preschool Education

Znaczenie aktywności ruchowej w holistycznym rozwoju dziecka w wieku edukacji wczesnoszkolnej i przedszkolnej

KEYWORDS

physical activity, pedagogical innovations, cross-curricular integration, educational balls EDUballs

ABSTRACT

Movement, as an integral part of education, is an important element supporting children's holistic development. An interdisciplinary approach to education is the foundation of contemporary teaching and learning, integrating various areas of student development. Numerous studies on the characteristics of preschool and early school-age children confirm this, indicating that integral teaching is the optimal solution for organizing the teaching process, as it focuses on children's well-being, their holistic functioning, and their comprehensive development. Physical activity supports neurogenesis and the development of cognitive functions such as memory and concentration, which has a direct impact on the effectiveness of teaching and learning processes. The interdisciplinary combination of education and movement is distinguished by a more comprehensive achievement of teaching objectives. The aim of the research, conducted over 20 years, was to determine the effects of using EDUballs and during movement classes integrated with subject content (Polish, English, and mathematics) on physical and cognitive development. To this end, 13 pedagogical experiments were conducted in natural settings using EDUballs. It was found that there are positive relationships between physical activity integrated with subject content using EDUballs and students'

reading, writing, and numeracy skills. EDUballs also positively impact students' motor skills, eye-hand coordination, time-space orientation, and graphomotor skills.

SŁOWA KLUCZE

aktywność ruchowa, innowacje pedagogiczne, integracja międzyprzedmiotowa, piłki edukacyjne EDUballs

ABSTRAKT

Ruch jako integralna część edukacji stanowi ważny element wsparcia holistycznego rozwoju dzieci. Interdyscyplinarne podejście do edukacji stanowi fundament współczesnego nauczania-uczenia się, integrując różne obszary rozwoju uczniów. Potwierdzają to liczne badania nad właściwościami dzieci w wieku przedszkolnym i młodszym szkolnym, wskazując, że nauczanie integralne jest optymalnym rozwiązaniem organizowania procesu dydaktycznego, gdyż skupia się na dobru dzieci, ich całościowym funkcjonowaniu i wszechstronnym rozwoju. Aktywność fizyczna wspiera neurogenezę oraz rozwój funkcji poznawczych, takich jak pamięć i koncentracja, co ma bezpośrednie znaczenie dla efektywności procesów nauczania i uczenia się. Interdyscyplinarne połączenie edukacji z ruchem wyróżnia się pełniejszym osiągnięciem celów dydaktycznych. Celem zrealizowanych w ciągu 20 lat badań było określenie efektów wykorzystania piłek edukacyjnych EDUball podczas zajęć ruchowych zintegrowanych z treściami przedmiotowymi (językiem polskim, angielskim, matematyką) w zakresie rozwoju fizycznego i poznawczego. W tym celu przeprowadzono 13 eksperymentów pedagogicznych w warunkach naturalnych z wykorzystaniem EDUballi. Okazało się, że istnieją pozytywne związki pomiędzy zajęciami ruchowymi zintegrowanymi z treściami przedmiotowymi realizowanymi z EDUballami a umiejętnościami czytania i pisania uczniów oraz rachowania. EDUballe pozytywnie wpływają także na umiejętności ruchowe uczniów, na zdolności koordynacyjne: oko-ręka, orientacja czasowo-przestrzenna czy umiejętności grafomotoryczne.

Intoduction

Movement is an important element in the educational process, playing a key role in the development (not only physical and motor) of preschool and early school-age children. Research clearly indicates that movement can also support the development of cognitive, emotional, and social functions (Webster et al., 2015; Donnelly et al., 2016; Klichowski & Przybyła, 2017; Tremblay et al., 2017; Daly-Smith et al., 2020; Mavilidi et al., 2023; Rokita et al., 2024; Rościszewska & Klichowski, 2024; Mavilidi et al., 2025).

The physical fitness status of children and adolescents in Poland in 2024 is highly concerning. The systematic, significant deterioration in strength, coordination, and

endurance test results is causing considerable concern. Negative trends have been observed for several decades, including weight gain (increasing numbers of overweight and obese young people) and decreased physical fitness, which in many cases has fallen below the levels observed in Poland at the turn of the 1970s and 1980s. Przewęda defined this phenomenon, for both boys and girls, at the beginning of the 21st century as the "spreading scissors syndrome" (Dobosz, 2024). Not only is physical fitness declining, but there is also a noticeable lack of motor skills. Basic motor skills are essential in children's motor development, providing the foundation for more complex physical and sporting activities (Barnett et al., 2016). Early school age (6–9 years) is a key period for the development of skills such as running, jumping, throwing, and kicking. These skills not only support the development of coordination and physical fitness but also strengthen children's self-confidence, both in new movement challenges and in building social relationships (Makaruk, 2025). Firek (2025), in a report, compared literacy skills, and I would also add numeracy skills (i.e., basic competencies of early childhood education students), which enable understanding the world, meanings, and words, to movement skills, which allow people to understand, experience, and act in the physical world, in which the body is not a tool or an adjunct to the mind but an integral element of human identity and cognitive, emotional, and social abilities.

The younger school age, around 7–10 years old, is the period when children achieve the best results in motor learning (Raczek, 2010). One of the key achievements of this period is the development of motor coordination and precision, which allows children not only to write but also to play instruments, draw, and cut.

Especially in the early stages, people develop their entire selves simultaneously (Pesce et al., 2016). Development in one area has consequences in others. It is therefore not surprising that physical activity positively affects all areas of human functioning: emotional, physical, cognitive, and social (Kruszwicka, 2023). Physically, physical activity affects physical fitness, stimulates body growth, influences skeletal mineralization, prevents and corrects postural defects, strengthens and stabilizes joints, strengthens attachments, tendons, and ligaments, increases the cross-section and volume of muscle fibers, has a positive effect on the respiratory and immune systems, enhances cardiac function, increases brain volume, and has a beneficial effect on BDNF protein levels in the blood. Mentally, physical activity improves well-being, reduces stress, develops responsibility, improves self-esteem, stimulates a sense of security, facilitates adaptation processes, provides relaxation, reduces anxiety, and prevents mental illness and reduces symptoms of depression, bipolar disorder, schizophrenia, and anxiety disorders. Cognitively, physical activity positively affects academic progress, develops attention, memory, and executive functions, shortens decision-making time, increases selective attention, improves concentration and perception, increases cognitive control, accelerates information processing, develops problem-solving skills, improves

planning ability, increases decision-making speed, and stimulates creativity. In the social sphere, physical activity teaches interpersonal and social communication, teaches cooperation and collaboration, promotes the formation of relationships with others, supports the acquisition of social skills, promotes the creation of bonds, love, and cooperation, and teaches how to cope with victories and defeats (Kruszwicka, 2023).

Recently, in May of this year, Psychological Bulletin published the article "How physical activity context relates to cognition across the lifespan: A systematic review and meta-analysis," in which the authors conducted a review and meta-analysis of the impact of physical activity on cognitive functions. Mavilidi et al. (2025) found that the impact of physical activity on cognitive functions depends on many factors, including individual factors (age, gender, special educational needs, motivation, and emotions) and those directly related to physical activity (where it is performed, when and why, how and with whom, how often, with what intensity, for how long, and what type). The greatest impact of physical activity on cognitive abilities was observed in situations of prolonged outdoor physical activity of moderate to high intensity and high cognitive load, as well as in the case of sudden episodes of moderate-intensity outdoor physical activity (Mavilidi et al., 2025).

Considering the above considerations regarding the importance of physical activity in the holistic development of early childhood education, it is clear that it significantly supports physical, social, emotional, and cognitive development. The question that arises is: are early childhood and preschool teachers sufficiently prepared to implement curricular activities integrated with physical activity (whether in the classroom, in the gym, or outdoors)?

Research by Daly-Smith et al. (2020) and Webster et al. (2015) indicates that teachers equipped with the ability to integrate curricular content with physical activity achieve higher levels of teaching effectiveness and student engagement.

The aim of this study was to determine the relationship between the implementation of proprietary curricula integrated with subject-specific content, implemented using EDUballs, and reading, writing, mathematical skills, fine motor skills, and graphomotor skills. Research questions: What relationships exist between the implementation of proprietary curricula integrated with subject-specific content, implemented using EDUballs, and reading, writing, mathematical skills, fine motor skills, and graphomotor skills?

Method

The author conducted a systematic review of the literature on the use of EDUballs in pedagogical experiments (Cichy et al., 2020, 2022a, 2022b, 2022c; Kaczmarczyk

& Rokita, 2011; Krysmann & Rokita, 2011; Pham et al., 2021, 2023; Rokita, 2008; Rokita & Cichy, 2014; Rokita & Kaczmarczyk, 2011; Rokita & Krysmann, 2011; Rokita et al., 2017, 2024; Wawrzyniak et al., 2015, 2017, 2019a, 2019b, 2021, 2022).

Results

It turned out that 13 pedagogical experiments were conducted in natural settings using EDUballs. In all EDUball interventions, the independent variable was a proprietary curriculum integrated with subject content implemented using EDUballs. The interventions were implemented at the early childhood education stage, with the exception of one, which was implemented in a preschool group of 6-year-olds. The vast majority of interventions were implemented throughout the school year, but there were also three-year and semester-long interventions (Rokita et al., 2024). The dependent variables were reading and writing skills (Cichy, 2022a, 2022b; Krysmann & Rokita, 2011; Rokita & Krysmann, 2011; Rokita, 2008; Rokita & Cichy, 2014; Rokita et al., 2017; Wawrzyniak et al., 2017, 2019b, 2022), mathematical skills (Cichy et al., 2020; Kaczmarczyk & Rokita, 2011; Rokita & Kaczmarczyk, 2011; Rokita et al., 2017; Wawrzyniak et al., 2019a, 2022), physical fitness (Cichy et al., 2022c; Pham et al., 2021, 2023; Rokita & Kaczmarczyk, 2011; Rokita & Krysmann, 2011; Wawrzyniak et al., 2015, 2022), and graphomotorics (Wawrzyniak et al., 2017, 2021).

The interventions were implemented in public schools (Cichy et al., 2020, 2022a, 2022b, 2022c; Kaczmarczyk & Rokita, 2011; Krysmann & Rokita, 2011; Rokita, 2008; Rokita & Cichy, 2014; Rokita & Kaczmarczyk, 2011; Rokita & Krysmann, 2011; Rokita et al., 2017, 2024; Wawrzyniak et al., 2015, 2017, 2019a, 2019b, 2021, 2022) and private schools (Pham et al., 2021, 2023), in integrated schools attended by children with disabilities (Rokita et al., 2024), and in schools for students with dyslexia (Rokita & Krysmann, 2011; Krysmann & Rokita, 2011).

The research was carried out in Poland (Cichy et al., 2020, 2022a, 2022b, 2022c; Kaczmarczyk & Rokita, 2011; Krysmann & Rokita, 2011; Rokita, 2008; Rokita & Cichy, 2014; Rokita & Kaczmarczyk, 2011; Rokita & Krysmann, 2011; Rokita et al., 2017, 2024; Wawrzyniak et al., 2015, 2017, 2019a, 2019b, 2021, 2022) and in Vietnam (Pham et al., 2021, 2023). Regardless of where and when the intervention using EDUballs was implemented, the experimental groups always achieved better results in reading, writing, arithmetic, graphomotor skills, and physical fitness, which was always at least at a level comparable to the control groups that implemented the traditional physical activity program (without EDUballs).

The article by Wawrzyniak et al. (2022) provides some particularly interesting research results. The authors conducted a year-long intervention with three experimental

groups and one control group. The aim of the study was to investigate the relationships between fundamental motor skills, graphomotor skills, and academic achievement of first-grade primary school students and the implementation of movement activities integrated with subject content conducted with EDUballs.

The question was also answered whether students who followed the same program of physical activity classes using EDUballs but with different teachers (one group with an early childhood education teacher, another with a physical education teacher, and another with an early childhood education teacher and a physical education teacher simultaneously) achieved similar and better results in terms of fundamental motor skills and graphomotor skills and had better academic achievements in other subjects, such as Polish or mathematics, compared to students from a class in which EDUballs were not used during classes conducted by early childhood education teachers. At the beginning and end of the 2015/2016 school year, fundamental motor skills were assessed using the Test of Gross Motor Development 2nd Edition (Ulrich, 2000), graphomotor skills were assessed using the MovAlyzeR software (Neuroscript LLC, USA), and school achievements were assessed using the School Start-Up Skills Test (Kaczan & Rycielski, 2012).

The teaching process in all first-grade classes was implemented in accordance with the school's educational program (Rozporządzenie…, 2009). The experimental classes (E1-E3) and the control class (K) followed the same integrated curriculum: "Our Primer: Autumn, Winter, Spring, Summer" (Lorek & Wolman, 2014a, 2014b; Lorek et al., 2014a, 2014b). An experimental element was introduced in the experimental classes (E1-E3), which consisted of a program of physical activity using Eduballs integrated with the subject content of Polish language and mathematics. During the year-long pedagogical experiment, lesson plans and scenarios using Eduballs were prepared in consultation with teachers. These plans were compatible with the subject content taught in the classroom and in line with the thematic cycle and the daily theme.

In all classes, both experimental and control, physical education classes were held for three hours per week. In the experimental classes, physical activity classes were held twice a week with EDUballs and once without them, while in the control class, all three hours of physical activity classes were conducted without EDUballs.

After a year of intervention, it was found that students from all experimental classes (E1, E2, and E3 – regardless of who led the physical activity classes integrated with subject content using EDUballs) achieved better academic achievement than students from the control class (K). Results of the Test of Gross Motor Development were similar across all groups (no statistically significant differences were found) (Wawrzyniak et al., 2022).

Summary and Conclusions

Over 20 years of experimental research carried out in natural conditions using EDUballs during movement activities integrated with subject content (Polish, English, and mathematics) allows us to state with certainty that there are positive relationships between movement activities integrated with subject content implemented with EDUballs and students' reading, writing, and arithmetic skills (Cichy et al., 2020, 2022a, 2022b; Kaczmarczyk & Rokita, 2011; Rokita & Kaczmarczyk, 2021; Krysmann & Rokita, 2011; Rokita & Krysmann, 2011; Rokita, 2008; Rokita & Cichy, 2014; Rokita et al., 2017; Wawrzyniak et al., 2017, 2019a, 2019b, 2022). EDUballs also positively impact students' motor skills, eye-hand coordination, time-space orientation, and graphomotor skills (Cichy et al., 2022c; Pham et al., 2021, 2023; Rokita & Kaczmarczyk, 2011; Rokita & Krysmann, 2011; Wawrzyniak et al., 2015, 2017, 2021, 2022). Physical activities with EDUballs are attractive to children, in part because children "learn through play." And yet, a child does not cease to be a child once they enter school (Rokita et al., 2024). A child aged 6–10 explores the world with all their senses, preferably directly experiencing it through their own activities (Michalak, 2011).

Many researchers have confirmed that movement supports the teaching-learning process (Michael, 2006; Webster et al., 2015; Daly-Smith et al., 2020; Mavilidi et al., 2023; Rościszewska & Klichowski, 2024). Children's acquisition of key competencies such as writing, reading, and counting (including in English) occurs in interaction with mastery of both gross and fine motor skills. Education through movement is not only an opportunity to teach/improve reading, writing, and counting skills (including in English) – it also impacts children's emotional and social development (Tremblay et al., 2017; Bailey, 2006).

Examples of Good Practices in Education Through Movement

One of the few examples of integrating movement into the teaching process in early childhood education, verified over 21 years in 13 pedagogical experiments, are classes with EDUballs (https://eduball.awf.wroc.pl/) and (https://eduball.awf.wroc.pl/?lang=en).

EDUballs are teaching aids recommended for school use, developed over 20 years ago at the University of Physical Education in Wrocław (Rokita & Rzepa, 2005).

Photo 1. EDUballs in the Basket

Photo 2. Numbers and Mathematical Symbols Placed on EDUballs

Photo 3. The Word „Tort"/„Cake" Made of EDUballs

Photo 4. Letters, Mathematical Symbols, and Others Placed on EDUballs

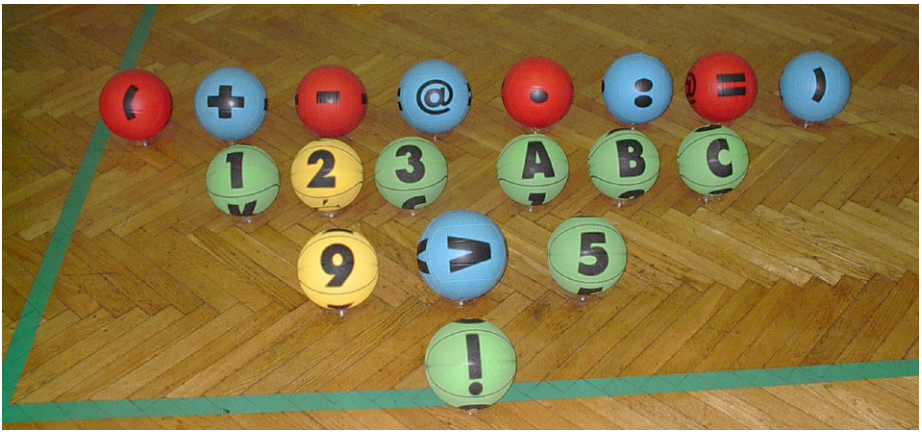


Photo 5. The Phrase "How are you" composed of EDUballs

EDUball activities (photos 6–10) are based on games and activities using a set of 100 colorful balls for mini team games (basketball, volleyball, soccer, and handball). The letters, numbers, and symbols printed on the balls allow for the combination of motor and cognitive activities in one activity. This allows children to learn math, Polish, foreign languages, and other subjects through movement, while simultaneously developing their motor skills and improving their motor skills. The activities implemented with EDUballs are tailored to the daily theme or weekly activity cycle.

Children participating in physical activities with EDUballs improve their ability to distinguish colors and consolidate the letters and numbers learned at school and practice arithmetic operations (addition, subtraction, multiplication, and division)

while developing their fine and gross motor skills as well as basic movement skills (e.g., passing and catching, dribbling, throwing, hitting, and receiving the ball).

Fun exercises and games with EDUballs are based on natural forms of movement (running, jumping, throwing, catching, etc.) and holistically stimulate children's development. The introduction of numbers, letters, and mathematical symbols, as well as the selection of appropriate ball colors, allows for their wide use in teaching or improving content from almost all curriculum areas in grades I–III (including Polish, English, mathematics, and science) (Rokita et al., 2017; Rokita et al., 2018). Properly designed and integrated with the subject content (Polish, mathematics, foreign language, and science), fun, games, and exercises with EDUballs become a very helpful, utilitarian tool in implementing the core curriculum in grades I–III of primary school.

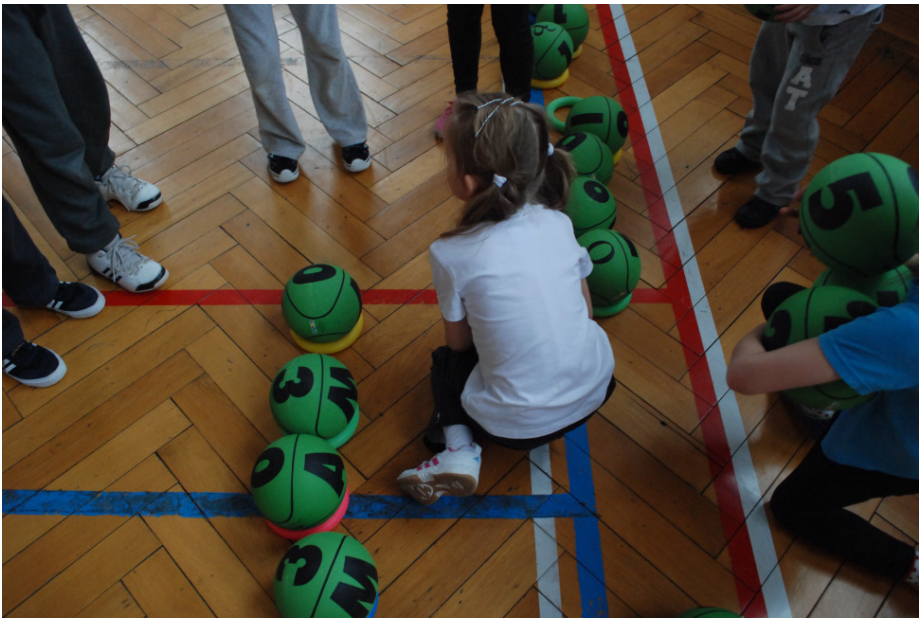
Photo 6. Children During Physical Activity With EDUballs

Photo 7. Children During Physical Activity With EDUballs

Photo 8. Children During Physical Activity With EDUballs

Photo 9. Children During Physical Activity With EDUballs

Photo 10. Children During Physical Activity With EDUballs



Examples of Exercises, Activities, and Games with EDUballs (Rokita et al., 2024)

Example 1: Language Education (Polish)

Objective: Improving the ability to create words beginning with the letter "a" and teamwork, developing selected motor skills and movement abilities.

- Number of participants: any
- Supplies: Eduballs
- Location: sports hall or outdoor area

Description: Students are divided into two teams (yellow and green teams). Each team receives a ball with the letter "a," which they place in a ring at the starting line. The students' task is to create as many words starting with the letter "a" as possible. The yellow team uses green balls, while the green team uses yellow balls. Time to complete the task is 4 minutes. After completing the task, the teacher checks the correctness of the words.

Organizational notes: The teacher may assign points to teams: 1 point for each word or 1 point for each letter in the word. The team with the most points wins.

Example 2: Math Education

EVEN AND ODD NUMBERS

Objective: Consolidate recognition of even and odd numbers, improve selected motor skills.

- Number of participants: any
- Supplies: Eduballs
- Location: sports hall or outdoor area

Description: Educational balls scattered throughout the room. Students line up in a circle in the center of the room. The teacher indicates the locations of the even and odd balls in each corner of the room. Students move around the room in any way they like. On the teacher's signal, students are tasked with sorting all the balls according to the guidelines.

Organizational notes: Team competition can be implemented.

Modification: All students have a green or yellow ball. The teacher indicates the bases of the even and odd balls in each corner of the room. Students move around the room in the manner directed by the teacher. On the teacher's signal, students are tasked with moving as quickly as possible to the base according to the number and color of their ball. After completing the task, students exchange balls.

Example 3: Foreign Language Education (English)

WORDS

Objective: Expanding English vocabulary and improving selected movement skills.

- Number of participants: any
- Supplies: an eduball for everyone
- Location: sports hall or outdoor area

Description: All students have yellow or green eduballs and move around the room in any way they like. At the instructor's signal, students exchange balls by saying an English word that begins with the letter on the ball they received. The person giving the ball back must translate it into Polish. After saying the words, the students exchange balls.

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