WROCLAW UNIVERSITY OF HEALTH AND SPORTS SCIENCES
FACULTY OF PHYSICAL EDUCATION AND SPORTS

Van Han Pham

PHYSICAL EDUCATION WITH "BRAINBALLS" TO IMPROVE ENGLISH, MATH SKILLS, MOTOR SKILLS AND PHYSICAL FITNESS IN 7-YEARS-OLD PUPILS IN VIETNAM

DEPARTMENT OF TEAM SPORTS GAMES

Supervisor: prof. dr hab. Michał Bronikowski, AWF Poznań

Co-supervisor: dr. Sara Wawrzyniak, AWF Wroclaw

WROCŁAW 2022

Contents

I INTRODUCTION

A child grows not just in biological terms but also develops in many different ways. From the early stages of our life, we become stimulated by various sources of influence and via a range of activities that we undertake. A child learns the world through the senses – by touching things, seeing them from different angles and perspectives, and listening to the surrounding voices and sounds that the world generates. The child also learns first acts of movement literacy trying to control the neuromuscular machinery of his body. It takes many repetitions of specific movements for the child to perform a particular activity with the level of accuracy that they will need when grown-up; therefore, early childhood is the suitable period for mastering those movement skills. Sensomotoric stimulation happens almost at every single second of a child's life – the body's proprioception is awakening all the time, recording incoming data of the movements, range of angles, level of power applied, speed, and accuracy that activity generally requires.

Later, but still, in early childhood, a little help can be found in the play and physical movements the child performs and in the equipment that the child uses for those activities. The toy business is a lucrative one, but it provides children (and their parents or educational authorities) with a range of very useful and specially designed educational devices, which when used in the educational context and for educational purposes, can foster the learning process, not just in terms of physical literacy (from hand manipulation to hand-to-eye coordination, to special orientation), but also by stimulating cognitive functions (like memory, attention, concentration), as well as some educational needs (like recognizing letters, numbers, spelling, or simple mathematical operations). Most of these situations happen in simple play, where children, first on their own, then together with peers, create their magical world of a parallel reality. The magical world of sport is governed by unique rules and fantasy-like fables, where anything can happen, and it all depends on the child's creativity. This creative thinking plays the most critical role in that phase of a child's development.

So, for the study described in this thesis, it is the physical, physiological, psychological, and cognitive factors that are the most influential ones and play the most significant role in the overall sound development of the child. These factors will be analyzed in detail in the introductory part of the thesis. This is needed so that the reader

understands the context of the study and the theoretical framework of the research, which aims at looking for new potential ways of enhancing the learning process. This is done by using specially designed educational equipment called Brainballs, a set of 100 colorful balls with alphabet letters and mathematical numbers printed on them, used in specially designed tasks via the Brainball method.

1.1 The role of physical activity and exercise in children's development

Physical activity is a fundamental aspect of a growing child as it supports optimal growth, physical development, and psychological health (Haskell et al., 1985). Many researchers agree that physical activity and exercises play an essential role in a child's development. Physical activity not only benefits children's physical health but also improves their brain and emotional function (Maghan, 2016; Chaddock et al., 2010).

The role of physical activity and exercise on physical development and bodily functions.

Physical activity involves the movement of the body. It could be daily activities, physical exercise, sports, games, exercises, or even housework. In children, fun and enjoyable games and practices are some of their favorite physical activities. Children participate in games naturally and enthusiastically. Fundamental motor skills (FMS) and bodily functions can easily be formed and developed through these activities (Cliff et al., 2009; Korbecki, 2019). It has been shown that there are positive relationships between fundamental motor skills, physical activities, and exercises that children participate in. Children regularly participate in physical activities, exercises, and games to help develop fundamental motor skills. These fundamental motor skills are considered an essential element of motor ability and represent the prerequisites for practicing advanced physical and athletic activities (Gallahue & Ozmun, 2006). Fundamental motor skills include two types: locomotor skills (running, galloping, skipping, hopping, sliding, and leaping), and object control skills (throwing, catching, bouncing, kicking, striking, and rolling) (Sgrò et al., 2017; Haywood & Getchell, 2005). Children who are competent in basic motor skills have the foundation for forming more specific and general skills. It not only helps children engage and confidently participate in physical and sports activities but also leads to the prevention of weight-related diseases, which is a critical step to ensure that children can engage in long-term physical activity (Haywood & Getchell, 2005; Walkley et al., 1996).

Many researchers have also demonstrated a variety of health benefits related to physical activity in children. There are clear examples of scientifically proved evidence that regular physical activity enhances the strength of bones and muscles, improves blood circulation and cardiovascular health while reducing the risk of chronic diseases such as (cardiovascular disease, diabetes, cancer, obesity, and metabolic syndrome) (Boreham & Riddoch, 2001; Strong et al., 2005; Janssen & LeBlanc, 2010). Exercise also increases serotonin levels, endorphins, and melatonin, which increase positive emotions (Conyers & Wilson, 2015). In Italy, the researchers implemented an intervention by incorporating two-hour-weekly physical education (PE) classes into the school curriculum, designed and supervised by professionals with expertise in physical education and sports science. After eight months of implementation, research showed that promoting physical activity in a school environment can help children of primary school age be healthier, physically, mentally, and psychologically (Pippi et al., 2020).

In Poland, researchers from the Wroclaw University of Health and Sport Sciences have been seeking for the effects of children's participation in PE classes with educational balls Eduballs/Brainballs on their development. They have proven that fun physical activity, games, and exercises along with educational balls have a positive effect on the development of students both physically and mentally (Rokita, 2008; Cichy & Rokita, 2012; Rokita et al., 2017). Studies have also shown that participation in physical education integrated with educational balls had some positive influence on physical fitness, motor coordination, and eye-hand coordination, although there were no statistically significant differences between experimental and control groups (Krajewski, 2007; Rokita, 2008; Cichy & Rokita, 2012; Rokita & Krysmann, 2011). However, it is worth noticing that integrating physical education with Eduballs/Brainballs did not have a negative impact on physical fitness and motor coordination either. Additionally, the implementation of educational balls had a positive impact on temporal-spatial orientation (Rokita & Kaczmarczyk, 2011), although significant improvements in the experimental group were limited to the "Run to 5 gates" test (Wawrzyniak, 2016; Rokita et al., 2018a).

The role of physical activity and exercise on brain functions and academic achievements

In addition to its health and wellness benefits, many studies have shown that regular physical activity is beneficial for children's brain function development. A survey of the relationship between physical activity and motor and cognitive function in young children (Fisher, 2009) has shown that physical activity leads to brain structure and function changes. These changes include increased blood flow in the brain, increased euphoria levels, and stimulation of brain development. One of the most critical brain functions that can predict academic success is memory. According to Chaddock et al. (2010), exercise increases blood flow and connection in the hippocampus, a critical memory formation, and consolidation region. This finding suggests that there is a positive relationship between physical activity and academic performance. Children who regularly participate in physical activity will help enhance memory function, thereby creating more success in learning than sedentary children. Chaddock-Heyman et al. (2015) also stated that students at higher fitness levels have superior performance on tasks that challenge working memory and standardized tests of mathematics and reading relative to less fit students.

Neurogenesis is the process by which new nerve cells are formed in the brain. Conyers and Wilson (2015) believe that physical activities enhance this process while creating connections between neurons in response to learning and sensory input, known as experience-dependent synaptogenesis. Neurogenesis is crucial because it activates the higher-order cognitive functions in the brain, which is essential for monitoring, maintaining, and strategizing higher-level cognitive abilities that enhance academic performance. Many processes in the brain occur when the body is engaged in physical activity, and the more students are exposed to these activities, the more these functions will continue to increase. There is also evidence that the prefrontal cortex may function more efficiently after engaging in physical activity programs (Maghan, 2016).

Many researchers have also demonstrated that physical activity and exercises positively affect cognitive function in children (Etnier et al., 1997; Sibley & Etnier, 2003). Budde et al. (2008) has shown that attention and concentration are enhanced following acute bouts of either coordinative exercise or formal sport lessons provided in physical

education classes in adolescent children. One hundred and fifteen healthy teenagers aged 13–16 years from an elite performing school were randomly assigned to an experimental group and a control group and tested for attention and concentration. Both groups performed the attention and concentration test after a regular school lesson (pre-test), after 10 minutes of joint exercise (experimental group), and a standard sports lesson (control group). Both groups have significantly improved attention and concentration performance from pre to post-test. However, the experimental group was more effective at completing the focus and attention task than the control group. The experimental group can activate the parts of the brain responsible for attention and focus.

A comprehensive review study by Tomporowski et al. (2008) conducted concerning exercise and children's intelligence, cognition, and learning achievement, found that the overall effect size of 0.32 that physical activity was significantly related to improved cognition in children. The type of exercise training did not appear to matter; Positive effects were found following resistance training, motor skills training, physical education interventions, and aerobic training programs. The effect of physical activity was greatest for middle school and young elementary-age children (ES = 0.40). Further, physical's activity effect on cognition was task-dependent. Effect size was largest for tests of perceptual skills (ES = 0.49), followed by IQ (ES = 0.34), achievement (ES = 0.30), and then math tests (ES = 0.20) and verbal tests (ES = 0.17). The authors also concluded that systematic exercise programs could indeed enhance the development of specific types of mental processing known to be important in meeting the challenges encountered both in learning and throughout life.

The benefits of physical activity and exercise on brain function and cognitive function have led to a high correlation of academic achievement in children. There were many studies conducted to examine the effects of physical activity and exercise on student performance. Most researchers show that physical activity positively impacts academic performance, while others believe that there is no relationship between physical activity and performance. In particular, there are no published studies that have found that time spent in physical activity reduces educational goals (Bailey et al., 2013). Numerous studies have shown that increased levels of physical activity help students maintain or improve academic performance, even though classroom time has been reduced. A survey of the

relationship between physical activity and overall academic achievements was conducted in France in the 1950s (Hervet, 1952). Researchers reduced the curriculum time by 26%, replacing it with physical activity. The results showed that student performance did not decrease; students were more active and diligent in their studies, had fewer disciplinary problems, and were absent. Another study of the health effects of a daily physical activity program was conducted on 10-year-olds in Adelaide, South Australia (Dwyer et al., 1983). The researchers applied for a physical activity program during classroom instruction for 14 weeks (or 45-60 minutes a day). The results showed no evidence of any loss of academic performance as measured by arithmetic and reading tests despite 45-60 minutes' loss of formal teaching time each day.

Studies of the enhancement of physical activity and exercise-intensive exercises during student learning have positively affected academic areas such as mathematics, subjects that require concentration and memory. Students who were more physically active in aerobic exercise showed higher success rates in math than in other areas of study. Aerobic activities are related to cognitive function, response rate, working memory, and attention (Desai et al., 2015; Chaddock-Heyman et al., 2015). Another study also found that student achievements improved when vigorous physical activity was applied and increased physical activity time during their school day (So, 2012). In Swedish intervention program, Ericsson (2008) showed that increasing the number of exercise lessons from 2 lessons per week to daily is associated with improved scores in math, reading, and writing, even though none of these areas are covered in the extra lessons.

It is also interesting how children gain both language and numerical literacy. Findings from the research indicate that children learn to count using their bodies (mainly hands and fingers). Thus mathematical cognition is related to neural substrates of motor action (Andres et al., 2008). This idea is supported by neuropsychological studies on children and behavioral studies on the SNARC (the spatial-numerical association of response codes) effect, a phenomenon of mental processing numbers on a numerical axis, which reveals a strong relation between math and spatial cognition (Dehaene et al., 1993). Moreover, neuroimaging studies also show that brain areas involved in arithmetic are closely related to praxis representation brain network (Przybylski & Króliczak, 2017). Therefore, it is claimed that counting skills are rooted in bodily experiences, representing

the so-called idea of embodied mathematical cognition (Domahs et al., 2010; Klichowski & Króliczak, 2017).

An analogical situation has been observed with language skills. The language has evolved from praxis, as well as it is embodied (Arbib, 2005). Neuroimaging studies confirm that praxis and language depend on common cortical specialization, i.e., in a similarly organized manner (Króliczak et al., 2016; Kubiak & Króliczak, 2016), or discuss one of the most significant features of the human brain: the lateralization of functions such as language, the use of gestures and the ability to produce and use of tools (Frey, 2008). As a teaching-learning method, Eduball/Brainball proved its effectiveness in some aspects of language writing skills (Naskręt et al., 2018; Wawrzyniak et al., 2021).

1.2 Psychological and physiological characteristics of early primary school children

In the early years of life, children learn about their surroundings through their instincts and senses. However, by the stage of elementary school (6-11 years old), children approach the world through both reasoning and thinking. This is considered an important stage in forming and developing in terms of physiology, psychology, and society of the children. The process of formation and development has a profound impact on the psychology and organs of the child's body, causing significant changes and changes in important qualities. Therefore, educators and teachers need to fully understand the child's body and correctly identify and master the child's developmental characteristics through stages to best their support and provide the most accurate stimuli.

Psychological characteristics of children

At the primary preschool level, learning and playing activities significantly affect the psychological life of children, creating a qualitative change in the psychological structure.

Pupils can quickly adapt and absorb "the new" during this stage, as their "internal hard drive" is relatively little loaded. However, the high concentration, intentional memory, and attention ability have not been strongly developed; hyperactivity and emotion are also clearly expressed but not always under control. Pupils remember things very quickly and forget very soon; visual memory - symbolic development prevails over the word - logic. Therefore, students at this time only pay attention to subjects that have

objects, vivid visuals, interesting, games exciting exercises (Tô & Nguyễn, 1991; Lê et al., 2008).

In the early grades of elementary school, pupils' perception is general, less detailed and not so focused on details. The perception of things and phenomena usually occurs when pupils are directly affected by various phenomena with their senses. Primary school pupils' intentional attention is weak, and willpower is not strong enough to adjust attention to the pace of the changes in the souring environment. Therefore, the use of teaching aids is an important means to organize pupil's attention and perception. At the same time, teachers should also have teaching methods that make class time engaging to attract pupils' attention (Nguyễn, 1995).

The thinking of elementary school pupils gradually shifts from visual concretely to abstraction and generalization. In the early grades of elementary school, pupils often based on specific and visual features to analyze, synthesize, and generalize their version of the things and phenomena. Therefore, to stimulate positive cognitive activities, students must interact, listen, and observe objects and phenomena in diverse and abundant ways. Increases external impression acquisition with the various senses, making pupils' symbolic world even more accurate; on that basis, schematic thinking appears and plays an intermediate role to help develop thinking to a new step, giving rise to elements of logical thinking. In these final grades of primary schooling, pupils usually have gotten rid of the direct nature of perception, gradually becoming aware of the nature of things and phenomena, reflecting the attributes and signs of essence into thinking (Tô & Nguyễn, 1991; Lê et al., 2008).

Several psychological qualities such as independence, empathy, cooperation, and discipline are also formed and developed. In order to educate these mental qualities, in the teaching process, teachers need to create conditions for pupils to act in familiar circumstances, to know for themselves to use familiar ways in new, but not unfamiliar situations; the rules that children grasp are generalized, becoming the norm that regulates their behavior in any situation (Nguyễn, 1998).

The student's need to communicate with others, peers, and surroundings becomes a strong need for children during this period. The emotions and emotional lives of the pupils are pretty rich, diverse, and fundamentally positive. The pupils are usually surprised to

discovering new things in social relationships, unfamiliar to each other, but quickly caught up with new friends and classmates. Children are proud of joining the team, proud of being highly appreciated by their parents, teachers, or assigned to specific jobs. They start to know how to control their mood and even hide their emotions when necessary. Primary school pupils often have a carefree, cheerful attitude, making favorable conditions to educate them on ethical standards and form essential intellectual qualities (Tô & Nguyễn, 1991; Nguyễn, 1998).

Children's linguistic abilities develop strongly in phonetics, vocabulary, and grammar. During this period, pupils pronounce more and more correctly, and their language is abundant. In addition to receiving the number of words, students have understood the meaning of words and know how to use them in specific contexts and individual cases. Understanding basic grammatical principles helps students develop more vital oral and written skills (Tô & Nguyễn, 1991).

Physiological characteristics of a child

At the beginning of primary school, children's bodies have had many new developments. The height and weight significantly develop; the muscle and nervous systems are strongly developed, but the skeletal and digestive systems are still incomplete.

Skeletal system

During this period, bones contain fewer minerals, more cartilage, and are in the process of consolidation, so bones are soft, prone to warping and deformation. Most of the joints have not yet formed. Large joints such as hip joints, knee joints, shoulder joints, and elbow joints are formed first but are still very weak. Joints of wrists, ankles, fingers, toes are formed after. In children, joints, tendons, and ligaments are still loose, so children are susceptible to sprains and wrong joints (Phan, 2009; Bùi, 2006).

Students' bones are soft and unstable, easily deformed, and warped when they hold the wrong posture, repetitive wrong movements many times affecting posture, circulation, respiration, and motor development - these distortions are difficult to repair in later years. Therefore, teachers need to pay attention to correct the correct posture for children in the teaching process, form a habit of movement, maintains a proper posture while walking, standing, and sitting. At the same time, the teacher also needs to pay attention to the amount of exercise, make the requirements suitable to the child's health, and gradually

increase the child's requirements to master the movement and gross motor skills (Lê, 2015).

Muscular system

The muscular system is a complex and vital network for the human body. Muscles are involved in many bodily activities. They control heart rate, breathing rate, help digestion, and allow us to move (Lưu, 1994). During this stage, the elementary school students' muscles are not fully developed, soft, and water-filled, so they quickly get tired in practice and study. The development of separate muscle groups was not uniform. Therefore, too much exercise can damage the joints and affect the outcome of mobility in children. During the teaching process, teachers should alternate between movement activities and rest appropriately. Teachers also need to let children practice strength-strengthening exercises for muscle groups and ligaments around the spine, including neck muscles, back muscles, chest muscles, breast muscles, etc (Phan, 2009; Trịnh & Trần, 1998; Lưu & Phạm, 2003).

The students' muscle development process at this time is not uniform. Major muscles such as back muscles, thigh muscles, shoulder muscles, arm muscles develop first. Small muscles such as finger muscles, hand muscles grow later. Therefore, students are not able to perform moves that require dexterity and meticulousness. The development of muscle groups depends on their activity level; the more active the muscle group, the faster it grows. Muscle growth is also dependent on diet. The students' muscle structure and function are weak, and they cannot exercise with high intensity for long periods. In order to help their musculature and skeletal system develop well, attention should be paid to nutrition, movement games, rest (including appropriate amounts of sleep), and practical motor activities suitable for them (Bùi, 2006; Trịnh & Trần, 1998; Lưu, 1994; Lưu & Phạm, 2003). According to Trịnh and Trần (1998), children should practice systematic exercises and physical activities suitable for their age with the proper loads and intensity. These exercises have a good impact on the development of the motor system and the whole organ system, improve the growth and control of the muscles, the muscle contraction rhythm, increase the endurance of the muscles, and the whole-body control.

Circulatory system

The circulatory system plays a leading role in the body to ensure human life. The circulatory system transports nutrients, oxygen, carbon dioxide, hormones, blood cells out and into the cells in the body to nourish them and help fight disease, stabilize body temperature and pH, and maintain homeostasis (Trịnh & Trần, 1998; Lưu, 1994). An inefficient circulatory system becomes the cause of many diseases later in life, resulting in lower general health and poorer quality of life.

For elementary school pupils, the heart has a great deal of development but is still in the process of growth. Children's hearts are easily excited and quickly tired, heart rate is usually about 85 - 90 beats per minute, but it can grow rapidly in a simple game of tugs to the maximal rates. Therefore teachers, especially physical education teachers, need to be aware of that characteristic and plan the physiological loads during the physical education classes with great care. A growing body with relatively enlarged blood vessels, low arterial blood pressure, and the circulatory system still in the process of formation (Lưu, 1994; Lưu & Phạm, 2003) requires a lot of professional attention. Therefore, to avoid making the heart fail, teachers need to pay attention not to let the pupils move too long (or too intense) and let them rest properly between playing hours, allowing their bodies for some regeneration.

Respiratory system

At the age of primary school students, the respiratory system is in the perfect stage; they are gradually creating a habit of changing from abdominal breathing to chest breathing. The chest is developed but not yet complete, the respiratory force is weak, the breathing is shallow, the breathing capacity is small, so the respiratory frequency of the children is higher than that of adults. The older the student is, the lower the respiratory rate is, but living capacity will increase (Lưu & Phạm, 2003).

Nerve system

At the elementary school age, a child's nervous system is improving in terms of functioning; the thinking ability has gradually changed from action visualization to symbolic thinking, abstract thinking. These changes facilitate the formation of the conditional reflex, and arousal quickly occurs. Therefore, in teaching new movements, teachers need to use rich visual forms to conceptualize movement skills and use various

methods and activities to develop whole-body coordination and make the nervous system highly adaptable. At this age, pupils have begun to master themselves in controlling their body movements, spatial orientation is increasing, and their analytical and synthesizing abilities are also enhanced (Lưu, 1994).

1.3 Factors affecting the physical and cognitive development of early primary school children

Human development is subject to a specific law. The development order and speed depend on many factors such as genetics, environment, education, nutrition, physical activity. It comes in phases, and the intensity and range of the mediating factors differ individually and depend strongly on the environmental aspects. In elementary school, as this is the period that we are the most interested in this thesis, their bodies are not yet complete in structure and function, so even small changes also affect their physical development and cognitive ability. The most important for their sound development seems to be appropriate application of the education (mental, physical, and physiological) loads, adjusted to the individually different rate of growing and maturing (Adler, 2015).

Genetic factors

Heredity is the re-creation of biological properties in the previous life, the transmission from parents to children specific characteristics and qualities (strength within the body, which exists in the form of qualities and abilities) that have been recorded in the genetic system. Suppose grandparents and parents have good physical and mental characteristics (body structure, physical attributes, intelligence, personality, etc.). In that case, the next generation will inherit that good quality, which helps their future development (Nguyễn, 1996). According to Nguyễn (1990), genetics affects body morphology such as height, width, circumference, length of body parts and dramatically affects the development of the endocrine glands, internal organs, and physical qualities.

Genetics is the primary factor, the foundation that plays a vital role in the development of an individual. On the other hand, it is also a factor demonstrating the potential of that individual. Knowing an individual's abilities enables us to steer that individual's development in the right direction, relevant to the individual and society through education, living conditions, different activities, and learning (Đồng, 2016).

Natural environmental factors

The natural environment (altitude, climate, weather, season, the rhythm of day and night, pollution levels) is considered the factor that directly affects human physical development. Many researchers have proven that children will have optimal physical and mental development if developed in a green, healthy environment. On the contrary, if children have a bad living environment, it will significantly affect their health, character formation, and thinking style. The study of Schell et al. (2009) investigated the roles of pollutants and other aspects of the human-made environment in affecting human growth and development patterns, specifically the timing of sexual maturation and the development of obesity. The study results showed that the people of Akwesasne were affected by exposure to toxic substances entering the food chain, which were previously released into the environment by local producers. There is evidence of effects on prenatal and postnatal development. Levels of toxicants seen among the Akwesasne are sufficiently similar to groups in the general population of many countries to suggest that toxicant effects may be widespread. The Akwesasne is one example of being impacted by new environmental forces that impinge on development in prenatal and postnatal life with consequences for growth, development, and later health. Similar research led by Żurek (2012) on the population of Polish children from a highly polluted area of Silesia (Poland) indicated the strong influence of heavy environmental polluting elements (such for example as lead) on the intellectual potential of primary school children affecting their achievements negatively.

Social environmental factors

The social environment includes the groups to which we belong, the neighborhoods in which we live, the organization of our workplaces, and the policies we create to order our lives (Yen & Syme, 1999). A child's social environment is largely dictated by where their parents live and send them to school. In turn, the social environment largely determines who children form social relationships with and the quality of those social relationships, as many of the connections children form are within their family or neighborhood. Parents' choices (or conversely, no choice) about where to live, work, and send their children to school can markedly affect their children's health and well-being (Žumarova, 2014).

An individual's physical surroundings are important for their healthy development. The environment is characterized by adequate surrounding amenities, the stability of the residential area, the quality of educational facilities and good medical resources which are positively related to the development of children. Children living in these social settings are less likely to drop out of school and have better academic outcomes than children living in polluted surroundings, lacking good educational facilities and various health-related resources (e.g., healthy or unhealthy foods, recreational resources, medical care) (Council & Population, 2013; Pem, 2015).

Children learn new things and explore the world mainly by imitating adults and those around them, so their relationships help shape the worldview and influence the child's development in all aspects. In relationships, parents and relatives play an essential role in a child's development. When children receive love from their parents and relatives, they learn how to properly communicate, behave and express emotions, and feel secure and safe. Fostering love will help the relationship between parents and children become close and sustainable. As a result, children feel more confident and ready to explore the world around them (Žumarova, 2014). Besides, the relationship between parents and those around them also plays a vital role in their development. Children often observe the way parents treat and communicate with others to understand and learn basic social skills. So, through treating people with kindness and respect, parents can teach their children how to build a quality and lasting relationship (To et al., 2001; Klebanov et al., 1998). Discussing things with respect for all parties involved, with attention paid to the arguments brought by each side, also teaches a child how to build their educational and social relationships.

Living in an excellent and positively oriented social environment increases the likelihood that a child will develop positive social relationships. Social behavior and the ability to create positive relationships with others were traditionally conceived as skills that would develop naturally. However, there is an increasing recognition that social behaviors are learned. Children must be taught pro-social behaviors via education (first parental at home, then by teachers during schooling years). Children learn from their social environment, for example, by mimicking (or challenging) the social behavior of their peers, and thus what they see in their day-to-day environment is likely to influence their social behavior. Social environment enables the development of sociability, i.e., the

genetically determined ability of social learning. It is the microenvironment (family, schools, peers, groups) which plays the essential role, as it affects the individual directly and with greater intensity than other environments (Žumarova, 2014).

Nutritional factors

Nutrition plays a vital role in children's physical and brain development. Nurturing the proper method, enough in quantity and guaranteed quality, will help children develop quickly and comprehensively. According to Lưu (1994) and Nguyễn (1996), a complete and balanced diet has a positive effect on the development of the body of adolescents. In contrast, lack of food or overeating will negatively affect their development, such as malnutrition or obesity. Nutrition also dramatically affects the brain and mental development of children. Children undernourished for a long time can impair the number and quality of brain cells, degrading their function and intelligence.

Educational factor

Hereditary factors - genetics, environment, and personal activity all affect the child's development to different degrees. Still, educational factors can affect these factors to create more favorable conditions for children's development.

For genetics, education creates favorable conditions to train and promote the perfection of the senses and body movements. Through education, it is possible to discover the qualities of individuals and create conditions to develop talents (predispositions) into specific competencies. At the same time, education also seeks to overcome physical deficiencies to limit the difficulties faced by people with disabilities in development.

Education affects the natural environment by equipping with human knowledge and awareness of environmental protection, overcoming the ecological imbalance, and making the natural environment fresh, more beautiful. In addition to positive influences, the social environment also causes negative effects. Education can help students prevent and eliminate negative impacts and motivate students to practice self-discipline in learning.

For individual activities, education organizes beneficial and healthy communication activities to promote personal qualities and capacities. Education also always builds positive communication relationships between teachers and friends and organizes and orientates children to participate in key activities at each age stage to promote push development (Osher et al., 2014).

1.4 Physical education, maths and English in primary school system in Vietnam

Education objectives are to comprehensively develop Vietnamese people with ethics, knowledge, culture, health, aesthetics, and profession; have quality, capacity, and sense of citizenship; have patriotism, national spirit, loyalty to the ideal of national independence and socialism; promoting the potential and creativity of each individual; improving people's knowledge, developing human resources, fostering talents, meeting the requirements of the cause of national construction, national defense and international integration (Quốc Hội, 2019).

Education in Vietnam is centralized and is under the management of the Ministry of Education and Training. According to the Decision, "Structure of the national education system" was approved by the Prime Minister on October 18, 2016 (Chính phủ, 2016); the educational levels and qualifications of the national education system: Preschool education (from 3 years old to 6 years old), primary education (from 6 years old to 11 years old), general education (4 years of secondary school, three years of high school), vocational education and higher education (research and applications).

Children start school officially when they are six years old. They spend five years of primary education (from grade 1 to grade 5). After finishing primary school, students will be recognized for the completion of the primary school program.

The curriculum at primary school level is agreed upon nationwide, including the following subjects:

a) Educational content

Compulsory educational subjects and activities include Vietnamese; Maths; Civic education; English 1 (grade 3, grade 4, grade 5); Nature and Social (in grade 1, grade 2, grade 3); History and Geography (grade 4, grade 5); Science (grade 4, grade 5); Informatics and Technology (in grade 3, grade 4, grade 5); Physical education; Art (Music, Fine Arts); Experience activities.

Elective subjects: Ethnic minority language, English 1 (grade 1, grade 2).

b) Duration of education

The actual study time in a school year is equivalent to 35 weeks. Schools can organize teaching one session/day or two sessions/day. There are no more than seven lessons per day: 35 minutes per lesson.

Table 1. Summary table of primary education subject plans

Educational content	***Number of periods/school year***				
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Compulsory subject					
Vietnamese	420	350	245	245	245
Math	105	175	175	175	175
English 1			140	140	140
Civic education	35	35	35	35	35
Natural and social	70	70	70		
History and Geography				70	70
Science				70	70
Informatics and Technology			70	70	70
Physical education	70	70	70	70	70
Art (Music, Fine Arts)	70	70	70	70	70
Compulsory educational activities					
Experience activities	105	105	105	105	105
Elective subject					
Ethnic minority languages	70	70	70	70	70
English 1	70	70			
Total number of periods/school year (excluding optional subjects)	875	875	980	1050	1050
Average periods per week (excluding optional subjects)	25	25	28	30	30

Physical Education:

Physical education is a compulsory subject conducted in primary schools, secondary schools, and high schools in Vietnam. The goal of physical education is to help students form and develop health care habits, motor skills, sports, and physical training habits and train the qualities and abilities to become sound develop a human being in physical and mental harmony, meeting the requirements of the cause of national

construction and defense and international integration, contributing to the development of stature and physical strength of Vietnamese people; at the same time discovering and fostering sports talent (Bộ Giáo dục và Đào tạo, 2018b).

All primary and high schools in the country follow a standard physical education curriculum developed by the Ministry of Education and Training. The content of the Physical Education program has been designed with three main parts, including General knowledge of Physical Education, Basic movement, Elective sport. Based on the psychological - physiological characteristics of the age and the laws of students' physical development, the program's educational content has been designed according to different requirements at each grade level.

In elementary school, educational content was designed to help students achieve the following goals:

- General knowledge of Physical Education: The purpose of education content is to help students know and practice personal hygiene to ensure safety during practice hours of Physical Education; learn how to choose a natural environment that is conducive to exercise; know how to follow the instructions on nutrition during exercise to increase mobility.

- Basic movement: educational content aims to help students implement the team formation content, exercise movements, basic postures, motor skills, basic movements of sports content, and apply in collective activities.

- Elective sports: educational content includes age-appropriate sports and motor games. The purpose is to help students practice posture, reflexes and apply the knowledge and skills learned in collective activities.

The duration of the PE program in each class is 70 periods/school year, two periods/week (1 period 35 minutes) interwoven in the daily schedule of students. The time allocated for educational content is estimated (in%) in each class as follows: Evaluation at the end of the semester, the end of the school year accounts for about 10% of the program duration; Basic movement accounts for about 65% (formation 20%; posture, basic motor skills 35%; fitness 10%); Elective sports account for about 25%. All primary school physical education teachers have a college or bachelor's degree in physical education.

Evaluation of course results: Primary school students' physical education performance is determined by qualitative assessment. Teachers directly evaluate learning results by describing comments or showing them the following ratings: Excellent; Great; Medium; Weak. The assessment content focuses on practical skills and students' physical fitness, and it is coordinated with a regular assessment to provide information to classify students and adjust the content and educational methods.

Organizing educational content for the Physical Education curriculum is up to the decision of each school. At the beginning of the school year, teachers and schools shall base themselves on actual conditions of facilities, results of school health checks, or health certificates issued by competent medical establishments to students. They arrange the lessons and choose the appropriate teaching methods to ensure that all students are learning and training with the right content, meeting the requirements of quality and competencies specified in the program.

The physical education program is an integral part of improving the quality of physical education in schools. Therefore, the content of the learning program must be built scientifically, with a close link between the theory and practice of education and the current socio-economic conditions. In addition, the reference to experiences in building physical education programs of some countries in the region and the world should also be considered.

Development trends of the Physical Education program indicate some similarities, at least in countries like Singapore, Laos, China, Japan, and Poland. Physical Education curricula program at the primary level in Vietnam remains in close relation and shows many similarities to those of the countries mentioned above (Lý et al., 2013; Haddad & Tan, 2008).

In all those countries, physical education is a compulsory subject in general education in all countries. The physical education program at the primary level aims to enhance students' health, helps students form and develop the essential elements that lay the foundation for the harmonious development of physical and mental qualities and abilities. The curriculum content has two parts, including sports and physical exercises. First, the content equips students with basic movements and postures to create basic skills in walking, running, jumping, crawling, climbing, push-ups. Second, the range uses sports,

age-appropriate games to help students develop holistic fitness, improve excitement in practice, and form life skills and health habits (Lý et al., 2013; Haddad & Tan, 2008).

Besides the similarities, there is a difference in organizing the implementation of physical education content between countries. In Vietnam, the total number of hours in physical education for the whole school year is 70 lessons divided into 35 weeks, two periods per week (1 period 35 minutes) including time for assessment of academic achievement; Singapore: Students study 3 periods/week (1 period 30 minutes). In Laos: Physical education curriculum for primary schools (total 330 periods/school year) (Lý et al., 2013; Haddad & Tan, 2008). In China: Grades 1 to 2 have four periods/week, a total of 144 periods/year, Grades 3 to 6 have three periods/week, full of 108 periods/year; Japan: primary school students study physical education three periods/week, total 105 periods/school year (Lý et al., 2013), whereas in Poland: Grades 1 to 3 have three periods/week (1 period 45 minutes), Grades 4 to 6 have four periods/week (1 period 45 minutes), two lessons of 45 minutes intertwined in a daily schedule, and the remaining two classes are allowed to be transferred to the extracurricular system of educational activities. All studies, including extracurricular hours, are required (Bronikowski, 2014; Kolanowska & Edukacji, 2018).

Analysis of the differences in the organization and implementation of physical education programs between countries shows that the duration of physical education programs for primary school students in Vietnam is relatively modest compared to other countries. The short teaching time (35 minutes per lesson) is a challenge for PE teachers in Vietnam in choosing the suitable teaching method to achieve the program's goals, especially the physical development goals.

Maths:

Vietnam's general education program identifies that learning math creates opportunities and enriches the lives of all people. The Math program provides students with the knowledge and skills needed in the circuits of knowledge: Numbers, Algebra, and Some analytical factors; Geometry and Measurement; Statistics and Probability. In addition, it helps students develop the computational skills necessary to apply in their personal and professional lives every day; create a connection between mathematical ideas,

mathematics, and practice, between mathematics and other subjects and educational activities (Bộ Giáo dục và Đào tạo, 2018d).

In the general education program, Math is a compulsory subject from grades 1 to 12; Math program content is designed by the Ministry of Education and Training and is applied to all schools across the country. Contents were built around the interaction between three circuits of knowledge of Number, Algebra, and Some factors of analysis; Geometry and Measurement; Statistics and Probability. Depending on the level of study, there will be requirements for different levels of development in skills.

Math education programs in elementary schools were built with the following contents:

- Numbers, Algebra, and Some analytical factors: Natural numbers, fractions, decimals, number estimation, rounding, and Algebra rules.

- Geometry and Measurement: Geometry is intuitive and uses units of measurement (length, angle, area, volume, mass, temperature, time, velocity, currency).

- Statistics and Probability: Random, data representation, and data interpretation.

According to the math program (Bộ Giáo dục và Đào tạo, 2018d), these educational contents are designed to help students achieve the following goals:

a) Contribute to the formation and development of mathematical competencies with the required requirements: simple levels of thinking can be performed; raise and answer questions when arguing and solving simple problems; can select math operations and arithmetic formulas to present, express (speak or write) the contents, ideas, ways to solve problems; using mathematical language in combination with a common language, body movements to express mathematical contents in simple situations; Use simple math learning tools and means to perform simple math learning tasks.

b) Having basic and essential basic mathematical skills and knowledge about:

- Numbers and calculations: Natural numbers, fractions, decimals, and calculations on those sets of numbers.

- Geometry and Measurement: Observing, recognizing, describing shapes and features (at the visual level) of some flat shapes and cubes in practice; create some simple geometric models; calculate many geometric quantities; develop spatial imagination;

solves several simple, practical problems associated with Geometry and Measurement (with standard metrics).

- Statistics and Probability: Some simple statistical and probability factors; solve simple, practical problems associated with many statistical factors and likelihood.

c) Along with other educational subjects and activities such as Ethics, Nature, and Society, Experimental activities contribute to helping students understand some careers in society.

The execution duration of the Math program for each class is specified as follows: Grade 1 has 105 periods/school year, three periods/week (1 period 35 minutes); Grades 2 to 5 have 175 periods/school year, five periods/week (1 period 35 minutes).

The time allocated for educational content was estimated (in %) in each class as follows:

Circuit of knowledge / *Grade*	*Numbers, Algebra and Some analytical factors*	*Geometry and Measurement*	*Statistics and Probability*	*Practice and experience*
1	80%	15%	0%	5%
2	75%	17%	3%	5%
3	70%	22%	3%	5%
4	75%	16%	4%	5%
5	50%	40%	5%	5%
Primary school	69%	23%	3%	5%

Evaluation of student results is done two times/school year (at the end of semester one and the school year). There are two more assessments for grades 4 and 5 in the middle of the first semester and the middle of the second semester. The evaluation form used is quantitative assessment. Students take a paper-based test designed with content consistent with the teaching method used in the classroom. After that, the test was corrected, commented on by the teacher, and scored on a 10-point scale.

English:

Vietnam's general education program defines English as one of the instrumental subjects that not only helps students to form and develop their communication skills in

English but also contributes to the formation and development of joint force; to live and work more effectively, to learn well in other subjects and to learn for a lifetime (Bộ Giáo dục và Đào tạo, 2018c).

English is a compulsory subject in the general education program for students from grades 3 to 12. On December 26, 2018, the Ministry of Education and Training issued an English familiarization program to meet the learning needs and familiarize themselves with students' English in grades 1 and 2. The program's content is compiled to help students initially have the most superficial awareness of English, get acquainted, explore, experience to form skills in using English, help students confidently enter the 3rd grade English subject, and develop a passion for the subject. The form of application as an elective subject, the course organization process depends on the actual conditions of each school (Bộ Giáo dục và Đào tạo, 2018a).

Content English general education program was developed by the Ministry of Education and Training and is applied to all schools across the country. Teaching content in the English general education curriculum is designed in a multi-component structure, including a system of topics; communication skills (listening, speaking, reading, writing) related to issues; language knowledge (phonetics, vocabulary, grammar).

Contents of topics, language skills, and language knowledge suggested in teaching English in elementary schools are:

a. Subject: Colour, animal, toy, school, family, place, daily activities, classroom activities, school supplies, body part, day of the week, clothing, vehicles, fun activities, indoor rooms, fruits, food, emotions, sense, games.

b. Language skills

- Listening: Listening comprehension and non-verbal responses or simple answers, possibly only at the word level, in simple conversational conversations in the classroom and in simply learned situations or topics, listening to and following simple instructions in English in the classroom. Listening to understand words and phrases closely related to student activity in familiar contexts and topics.

- Speaking: Answering simply in question-and-answer situations within familiar topics. Students participate in activities and games in class and can provide some instruction at first. Students listen and repeat simple phrases, sentences, and age-

appropriate songs in lesson content. Students speak familiar, specific, and simple words in context.

- Read: Read simple words and sentences with illustrations. Students listen and read along, identify words, and understand their meaning in the topic they studied.

- Writing: Highlight, rewrite words, complete words in the specific context.

c. Language knowledge

- Phonetics: vowels, consonants, and some consonant combinations; word stress, sentence stress, and basic intonation.

- Vocabulary: Simple words and phrases indicating specific concepts, things, and phenomena associated with familiar situations and topics in their lives.

- Grammar: The content of grammar teaching includes structures for the development of communication skills such as narration, questions, imperative statements, affirmative sentences, negative sentences, simple sentences, simple present tenses, present continuous tense, simple past tense, simple future tense, modal verbs, singular nouns, plural nouns, pronounced pronouns, designating pronouns, questionable pronouns, base adjectives possessive, possessive pronoun, adverb, number, ordinal number, common preposition, a common noun, article.

Each school decides the implementation of the English content in general education programs. Based on the actual conditions of the facilities and teachers, the school will arrange and choose the appropriate teaching methods to ensure that students are learning, practicing the right content, and meeting the requirements of force is specified in the program.

The duration of the English program is specified for each class: Grade 1 and grade 2 have 70 lessons per school year, teaching two periods per week (1 period 35 minutes); Grades 3 to 5 have 140 periods/school year, teaching four periods/week (1 period 35 minutes). All primary school English teachers have a college or bachelor's degree in English. Every year, they are tested to assess their English proficiency according to the Ministry of Education and Training regulations.

Inspection and evaluation activities are carried out in two forms: regular assessment and periodic assessment. Regular assessment is done continuously through classroom teaching activities. Periodic assessments are made at the end of the first semester and at the

end of the second semester. The assessment is designed with content consistent with the teaching methods used in the classroom, including speaking tests (conversation, monologue) and writing tests in an integrated form of skills and language knowledge, a combination between test form and essay. After that, the test was corrected, commented on by the teacher, and scored on a 10-point scale.

1.5. The idea of integrating other subjects into physical education

Currently, integrated education is a teaching strategy that is being implemented quite popularly in countries with advanced education globally, with a diverse form of integration. The perspective of integrated education aims to form and develop in students the necessary competencies, including applying knowledge to solve practical situations effectively. It also means to ensure that each student can apply knowledge learned in school to new, complex, and unexpected circumstances, thereby becoming a responsible citizen, a capable worker (Hà, 2015).

Integrated education is considered an effective teaching method that optimizes educational purposes for students in the early stages of education. The main goal of integrated education in kindergarten and primary school is to support children's comprehensive physical, intellectual, cultural, moral, emotional, and spiritual development, thereby helping them best prepare to live in harmony with people and nature (Rokita & Rzepa, 2002; 2005; Cichy & Rzepa, 2007).

The early years of education are crucial for children's development, the beginning of each individual's formation, and physical, mental, and social development. Most children love to play activities, so exciting games and exercises are considered important factors affecting the child's development during this period. For example, a review study by Lai et al., (2018) aimed to investigate the impact of non-digital games in studies of the development of children aged 4 to 9 years old. The results showed that non-digital games could stimulate the cognitive growth of preschool children. The researchers have also noticed that play affects the formation of intentionality, development of children's thinking, imagination, language, psychology, and emotional life. Through games, education aims to help students be more creative in problem-solving and form the qualities and wills necessary in life, such as purpose, discipline, courage, yield, helping each other during

play. These findings show that movement plays are inseparable elements in the integrated education process for children.

Through the positive effects of physical activities and exercises on children's development, educators began to consider the impact of integrating physical activities into the daily curriculum and integrating other learning content into the physical education classroom. Early findings show that integration positively affects student motivation, participation, and learning and helps students become more active in physical activity (Education, 2010; Rasberry et al., 2011).

The early results allow educators to be more confident in integrating movement into the child's classroom, implementing many integrated strategies. The following findings will give us more insight into the integration of movement with subject content.

Derri et al. (2010) conducted a study examining the effect of physical education and language integration on preschool children's oral and written speech. Sixty-seven preschool children (34 girls and 33 boys), ages 4 to 6, were randomly divided into two groups. Group A participated in a 5- week movement and language program in the gym, while group B participated in the same program, in class, without the movement integration. The programs were applied four times per week for forty minutes each time during the regular school program. A knowledge test with 19 tasks/criteria was constructed for the pre-, post-, and retention test measurement of children's oral and written speech. Results revealed that children of group A outperformed group B children both in the post-test and the retention test while controlling for the effects of the pre-test scores. The authors have concluded that an integrated physical education program may assist in developing the language skills of preschool children.

Mavilidi et al. (2018) conducted a study that examined the effects of the Thinking While Moving in English (TWM-E) program on on-task behavior, academic achievement, and cognitive outcomes. This feasibility trial involved 55 Grade 4 students from two classes of one primary school, who were randomly assigned to the control (n= 26) or TWM-E (n= 29) conditions. TWM-E uses an innovative instructional approach, which integrates physical activity into English lessons. The advantage of TWM-E over school-based physical activity interventions is the use of the existing English curriculum in learning activity design, which enables teachers to meet subject syllabus requirements and

physical activity outcomes simultaneously. The program ran for 4-weeks with 3×40 min lessons per week. The TWM-E lessons were performed outside the classroom, whereas the control group remained in their class for their lessons, which was the regular classroom routine. The study results show that the Thinking While Moving in English (TWM-E) intervention resulted in significant intervention effects for on-task behaviors and academic achievements in spelling. The TWM-E program was well-received and enjoyed by both the students and the teachers. The program successfully integrated physical activity into the existing English curriculum, providing a feasible strategy for meeting academic and physical activity outcomes within the current school context.

DeFrancesco and Casas (2002) conducted a study on the effect of embedding math skills into physical education lessons on the math achievement of second-grade students. Two cluster second-grade classes from a public elementary school were selected to participate in this study. Each class consisted of 28 students heterogeneously grouped by reading level. The math teachers of the two classes participating in this study developed pre and post instructional math tests specifically for this investigation. These tests consisted of math concepts, questions, and problems that paralleled the math portion of the standardized achievement test used by the state of Florida, the Florida Comprehensive Assessment Test (FCAT). The pre and post-tests consisted of 20 math problems covering addition, subtraction, charting, and symmetry. Students were allowed 45 minutes to complete each test. No significant differences were found between the pre-instructional math test scores of the two-second grade classes (PE + Math: M = 13.81; Control: M = 13.62). The duration of this investigation was four weeks. Following the pre-instructional math test, each class received math instruction for one hour every day and met for PE two times each week for 30 minutes. Both classes had comparable physical education activities, but the experimental group incorporated math concepts, and the control group did not. The post-test was administering after four weeks. There were no statistical differences between the two classes (PE + Math: M = 15.23; Control = M = 14.10). However, some outcomes of practical importance were revealed. First, the two classroom math teachers were not teaching their classes parallel with the physical education teacher. Therefore, the math concepts were not reinforced and practiced simultaneously in the math and physical education classes. When one math teacher introduced the concept of symmetry to her class,

she was surprised that her students already knew it because they had been introduced to it previously in their physical education class.

A literature review study by Marttinen et al. (2017) was conducted to assess the degree to which integration of core content into physical education or integration of physical activity into the classroom is successful. The results of this literature review show that only seven studies have examined the effectiveness of the integration of core academic subjects in physical education. Thus, it is not clear what strategies are deemed effective for teachers to adopt. There is a big push for Science, Technology, Engineering, and Math (STEM) education in the western world, and maybe this is an ideal avenue to deliver more maths and science education to students through physical education integration. Of the 23 studies included in this literature review, nine focused primarily on mathematics integration with either physical education or physical activity and several science-based integration interventions. This raises the question of why math is the leading subject to be integrated into classrooms and physical education. It may be that this subject is the most logical to integrate into physical education and classrooms due to the fact that teachers constantly give directions involving numbers and sequences. Furthermore, the sustainability of these interventions and papers reviewing integration needs to be considered when making suggestions. Without examining the long-term efficacy of integration, it is not reasonable to assume that reciprocal benefits exist.

In an effort to improve teaching and learning methods, researchers from the Wroclaw University of Health and Sport Sciences, Poland, have successfully developed and after experimentally checked, researched, and later applied into an educational program called Eduballs/Brainballs. This is an innovative teaching program based on an interdisciplinary model of physical education teaching (Cone et al., 2009; Kulinna, 2008). The main teaching method is to use games and exercises with the educational balls Eduballs/Brainballs to integrate the teaching of different subjects with physical education in preschool and elementary school. The purpose of the program is to educate children to develop in both physical and academic achievements with "Children learn while playing" idea (Rokita & Rzepa, 2002; Rokita & Rzepa, 2005; Rokita & Cichy, 2013; Rokita et al., 2018b).

There have been many pedagogical experiments in natural conditions to determine the impact of physical activities performed with the educational balls on the cognitive development of preschool and elementary students (Rokita, 2008; Cichy, 2010; Krysmann, 2012; Kaczmarczyk, 2013; Rokita & Cichy, 2013, Rokita & Cichy, 2014; Cichy et al., 2015; Wawrzyniak et al., 2015; Wawrzyniak, 2016; Korbecki, 2019; Cichy et al., 2020; Sara Wawrzyniak et al., 2021; Sara Wawrzyniak et al., 2022). These studies have shown that children participating in pedagogical experiments with the Eduballs significantly improved their language skills (reading and writing) (Rokita, 2008; Cichy, 2010). Children in the experimental groups achieved significantly better mathematical scores than children in the control group (Kaczmarczyk, 2013; Cichy et al., 2020). Dyslexic children participating in EDUball research significantly improved their writing and reading skills. The educational balls should be considered a therapeutic teaching aid for dyslexic children (Krysmann, 2012; Cichy et al., 2022). Children participating in physical education with Eduballs performed significantly better in graphomotor tasks than children participating in PE without them (Wawrzyniak, 2016; Wawrzyniak et al., 2021); Educational calls have a positive impact on children's physical fitness, motor skills, eye-hand coordination and spatial awareness (Rokita, 2008; Rokita & Cichy, 2013, Rokita & Cichy, 2014; Cichy et al., 2015; Wawrzyniak, 2016; Wawrzyniak et al., 2015; Korbecki, 2019; Wawrzyniak et al., 2021).

Integrating subject content into physical education classes or physical activities into classrooms is a dual benefit instructional method in both subjects, helping students achieve academic achievement and enhance overall health (Thompson & Robertson, 2015; Vazou et al., 2021; Mavilidi & Vazou, 2021). Such examples involving a method called Brain Break interactive school breaks, with short 2-5 minutes activities displayed on the Interactive Boards in the classroom setting, also proved positive, at least in terms of improving the attitudes of early-stage primary school children (Mok et al., 2020; Glapa et al., 2018) drawing the further trend lines in increasing physical activity and combining it with cognitive stimulation in the schooling process of the youngest. Furthermore, in a context where time for physical activities and physical education at school is reduced for reinforcement for other content (Hardman, 2008), the movement integration approach may be seen as the necessary strategy for help kids meet the recommendation that they engage

in 60 minutes of physical activity per day. And it was one of the ideas that we wanted to investigate in the presented research study.

II PURPOSE OF STUDY

The purpose of the study was to evaluate the impact of Brainball program in physical education classes on English skills, math skills, motor skills, and physical fitness of 7-year-old pupils in Vietnam.

III RESEARCH QUESTIONS

1. What are the levels of English, math skills, fundamental motor skills, and physical fitness of the 7-year-old pupils in Vietnam?

2. Does introducing Brainball intervention bring better effects on the 7-year-old pupils' level of English, math and motor skills, and physical fitness than the traditional lesson program in Vietnam?

3. Does introducing Brainball intervention cause different effects in 7-year-old boys and girls in Vietnam?

IV RESEARCH METHODOLOGY

Chapter describes the research materials and methods used in this study, the analysis and discussion processes of the validity and reliability of each test or measurement, and the tools used.

4.1 Research sample

The research materials were second-grade students at Long Xuyen Global International School, An Giang Province (a province in the Mekong Delta region of Southern Vietnam with 3,406 km² and about 1,908,352 people [2019]). A total of 55 pupils (23 boys and 32 girls) aged seven years participated in this study. The Long Xuyen Global International School was chosen to experiment with the BRAINballs program on purpose because this is a school located in the heart of the city with many modern technological investments to support the teaching and learning of the students. At the same time, it is also one of the leading schools in applying many advanced teaching methods to improve the quality of education and develop an educational environment in a dynamic and modern way so that students can maximize their creativity and thinking ability. English is one of the formal subjects in the school's curriculum, taught at all levels. Classes are taught by experienced Vietnamese and foreign teachers. For physical activities, the school has many activities to serve the playing and practicing needs of students. Physical education is taught twice a week (at the elementary level with a 35-minute lesson plan for each session). It is taught by experienced teachers who have a degree in physical education. In addition, students can also participate in training with extracurricular activities and clubs such as football, volleyball, basketball, and swimming.

4.2 Research design, methods and techniques

The study was conducted in the school year 2019-2020 at an elementary school in An Giang Province. A total of 55 pupils (23 boys and 32 girls) aged seven years participated in the study. The study design was a pedagogical experiment with the use of the technique of parallel groups. The pedagogical experiment involved two groups: 28 pupils (12 boys, 16 girls) in the experimental group and 27 pupils (11 boys and 16 girls) in the control group – the groups (control and experimental) were assigned to the research program by random selection. The teaching process was conducted in both groups (experimental and control) based on the same curriculum specified by Vietnam's Ministry

of Education and Training (Bộ Giáo dục và Đào tạo, 2006a; Bộ Giáo dục và Đào tạo, 2018b). All physical education classes in the experimental group were taken twice a week for 35 minutes, including the educational ball tasks. In the control group, physical education classes were also taken twice a week for 35 minutes and conducted with a traditional curriculum (without Brainballs). In both groups (experimental and control), physical education classes were conducted by the same PE teacher. The teacher had a physical education degree and ten years of teaching experience at the school. In addition, before the pedagogical experience, teachers participated in a training workshop on teaching methods with Brainballs organized by the Wroclaw University of Health and Sport Sciences and An Giang University. This was an activity to help teachers better understand educational balls, as well as how to organize and perform games and exercises with Brainballs in physical education classes.

The empirical, experimental factor has been conducted by applying games, exercises, and tasks with educational balls to integrate the teaching of maths and English in PE classes (experimental group). Based on games and exercises with Brainballs designed by Professor Rokita and colleagues at Wroclaw University of Health and Sports Sciences, Poland, as well as discussions with classroom teachers, the PE teacher designed develop a teaching plan that is appropriate to the school's curriculum and activities (see Appendix).

Based on the purpose of the study to understand the impact of the Brainball program on the development of primary school students in Vietnam, the study conducted tests on the fundamental motor skills, physical fitness, math and English skills of students in two groups (experimental and control) at two stages: at the beginning of the school year (September/2019) and the end of the first semester (January/2020), and for estimating long-terms effects third time in September/2020. Fundamental motor skills and physical fitness tests were conducted at the training ground during physical education classes. Math and English tests were taken in the classroom during regular school hours. In addition, prior to taking the tests, information about the test and how to perform it has been approved by the principal, teachers, and parents of students. Information about this research was provided to the principals, teachers, parents or guardians, and the children themselves before they voluntarily participated. Before participating, parents or guardians signed a consent form for their children to participate in the study. The study was approved

by the University Ethics Committee for Research Involving Human Subjects (2009), and all procedures and manipulations were carried out in accordance with the principles of the Declaration of Helsinki.

4.3 Variables and their indicators

Each student's personal information, including full name, date of birth, and gender, was collected before the tests but was kept coded so no one outside the research team could track the names of particular pupils. Details regarding the purpose of measurement, the equipment used, the testing method and score applied, as well as the validity and reliability of each measurement have been provided in this section.

4.3.1 Dependent variables

a. Math and English skills level

The study used test questions designed by local Vietnamese experts and school teachers with extensive teaching experience to assess students' Maths and English levels. The test questions have been designed with diverse content suitable for the curriculum following the Vietnamese national curricula for this age group. The purpose of the testing was accurately assessing the level of students at different times. It can determine students' level at the beginning of the school year, and there are advanced sections to assess students' level at the end of the school year (Appendix).

- Math test: The test was designed to include four parts to assess students' abilities according to each of the following skills (as in the Vietnamese national curricula):

1) Ability to recognize two-digit numbers, read and write two-digit numbers.
2) Ability to apply comparison and calculation skills with two-digit numbers.
3) Ability to recognize knowledge about quadrilateral, triangle, rectangular, geometric thinking ability, creative thinking capacity, aesthetic capacity.
4) Computational capacity, ability to communicate, ability to observe and record data obtained from observation.

The difficulty of the test was designed according to the level of increase in each question. Each question has a different score depending on the difficulty of the question. The duration of the test is 35 minutes. The scale used to evaluate the results is a 10-point scale prescribed by the Vietnamese Ministry of Education and Training (Table 2).

- English test: The test has been designed with four main contents to evaluate the skills as follows (as in the Vietnamese national curricula):

1) Recognize and read specific nouns, verbs according to topics learned in specific communication contexts.
2) Answer simple questions and respond with one or two words in a familiar and specific context.
3) Give out some familiar commands when participating in some group activities during class.

The test sorted the questions according to increasing difficulty. The duration of the test is 35 minutes. The scale used to evaluate the results is a 10-point scale prescribed by the Vietnamese Ministry of Education and Training (Table 2).

Table 2. Criteria for grading student learning results (Bộ Giáo dục và Đào tạo, 2007; Bộ Giáo dục và Đào tạo, 2006b)

Qualification	***Number Grade***	***Letter Grade***	***4.0 Scale***
Very Good	8,5 - 10	A	4
Good	7,0 - 8,4	B	3
Average	5,5 - 6,9	C	2
Passable	4,0 - 5,4	D	1
Failure	< 4,0	F	0

b. Physical fitness level

In order to assess the differences in the level of physical fitness of students in the use of Brainballs, the study used physical fitness tests developed by the International Standard Physical Fitness Test Committee (Pilicz et al., 2004). Seven of the eight tests on the International Physical Fitness Test were performed including 50 m sprint (s), toe touch (cm), standing long jump (cm), 4 x 10 m sprint (s), hand strength (kg), bent arm hang (s), sit-ups (num.). The "600m run" test was rejected because it didn't get the parents' consent. Measurements are conducted in a natural environment and with the help of teachers and students.

1) 50 m sprint.

Purpose of the test: To measure the power of fast and speed.

Equipment used: Stopwatch, marker, command flag.

Execution: At the command “on your marks”, the pupil doing the exercise stands still in front of the starting line with one leg put forward (a so-called standing start). Then, at the "start" signal, he runs to the finish as quickly as possible.

Scoring: the better time of two runs counts, measured with an accuracy of 0.1 s.

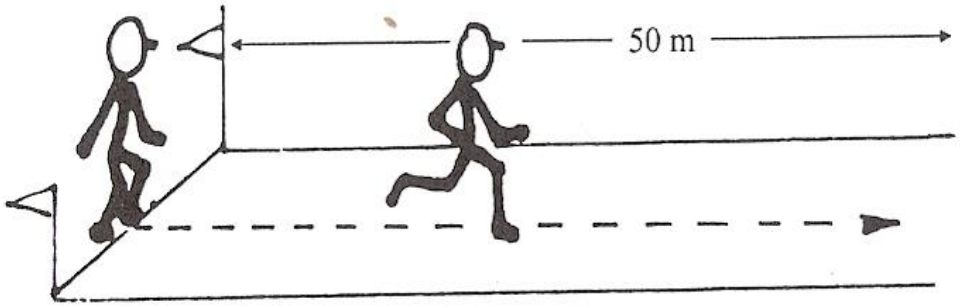


Figure 1. 50 m sprint (Larson, 2012)

2) Standing long jump.

Purpose of the test: To measure lower body dynamic strength

Equipment used: 1 tape measure, marker.

Execution: Person doing the exercise stands in a small astride with feet parallelly on the beam or before the starting line, bends the trunk, bends the legs (semi-sit) with concurrent spar of both hands low to the back, followed by hands spar to the front and at the same time takes off vigorously and jumps as far as possible. The jump length is measured from the setline (beam) to the nearest footstep left by the jumper’s heel.

Score: The longer jump out of the two performed constitutes the test result, which is put down with accuracy up to 1 cm.

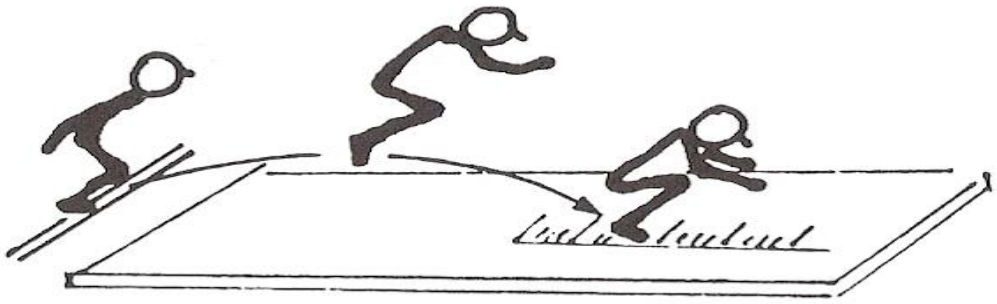


Figure 2. Standing long jump (Larson, 2012)

3) Hand strength.

Purpose of the test: To measure maximum hand strength.

Equipment used: A hand dynamometer with an adjustable grip (figure 3).

Execution: During this test person doing the exercise stands in a small astride and holds a hand dynamometer, checked in advance, with a more dexterous hand in a comfortable way, i.e., in such a way so that the fingers and the palm would be wrapped around it tightly. Both arms are hung down loosely along the trunk, while one hand with dynamometer is held in some distance from the body. Person does the exercise squashes dynamometer with maximum power.

Score: Two tests are done with the stronger hand and better result is taken into account.

Figure 3. Hand dynamometer (GRIP –D, TKK-5401, Takei – Japan)

4) Bent arm hang

Purpose of the test: To measure arm strength.

Equipment used: A horizontal bar mounted at an accessible height, a time measurer, a mattress for landing (jumping down).

Execution: The task is to remain as long as possible, hanging with arms bent in elbow joints. Upon starting the test, the person doing the exercise holds the bar with fingers directed downwards and the thumb from the bottom upwards, at the shoulders' breadth, so that his chin would be above the bar. The test starts when the person doing the exercise hangs on the bar unaided and ends when his eyes go below the bar.

Score: The test is to be performed one time, and the result is measured in seconds.

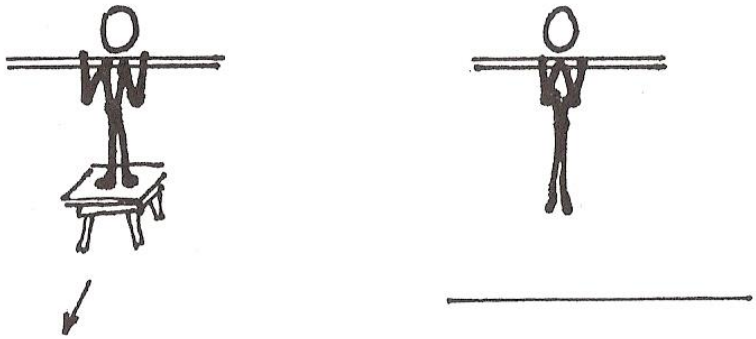


Figure 4. Bent arm hang (Larson, 2012)

5) 4 x 10 m sprint

Purpose of the test: To assess speed-of-movement, agility, and coordination.

Equipment used: A time measurer, two wooden blocks of 5 x 5 x 5 cm, even and non-slippery ground with two lines with a 10 m distance between them.

Execution: The person performing the exercise stands in a position with one leg forward (standing start) in front of the starting line and waits for the start signal. He starts running after the signal to the second line. Two blocks are placed behind it. The person doing the test lifts one block, runs back with the block to the starting line, puts the blocks behind the line, runs again to the ending line, and lifts the second block, which he carries over and puts in the place as the first one. If the block is thrown and not laid behind the line, the test is considered invalid, and it should be repeated.

Score: The better time results are recorded from the two performed tests with accuracy to 0,1s.

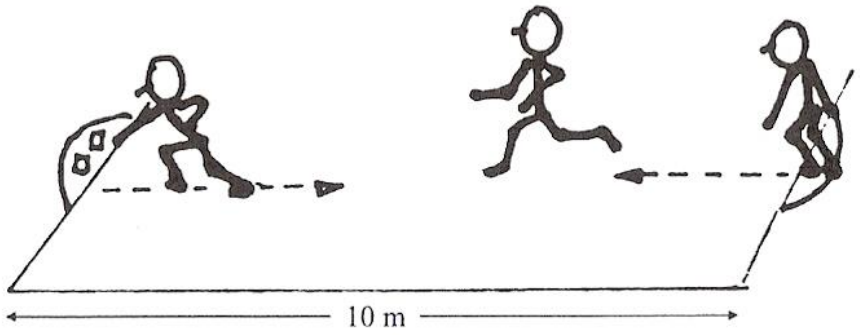


Figure 5. 4 x 10 m sprint (Larson, 2012)

6) Sit-ups

Purpose of the test: To assess abdominal strength.

Equipment used: A time measurer, a hard mattress.

Execution: The person doing the exercise lays down on the back on a mattress with legs bent in knee joints at an angle of 90 degrees. Clasped hands are placed on the neck. A partner knees next to the laying person's feet and presses them down so that the whole soles would touch the ground. When both of them are ready to start the test, the person performing the exercise raises the trunk at an agreed signal and sits touching the knees with the elbows and then immediately (without any break) returns to laying on his back, followed by another sit. This activity is repeated at a maximum speed of 30 seconds. The back must each time return to the initial position in order to allow the clasped hands and the head to have contact with the ground. Using elbows to push oneself away from the mattress is not allowed. The person performing the exercise does the test without stopping.

Score: The sit-ups done during 30 seconds are counted. Their number constitutes the test result.

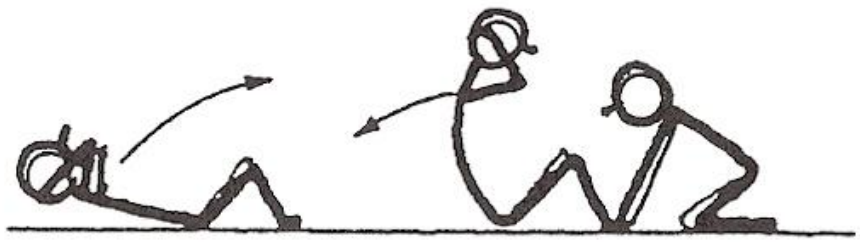


Figure 6. Sit-ups (Larson, 2012)

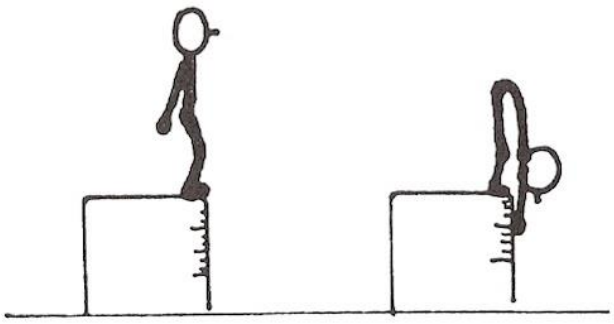
7) Forward bend

Purpose of the test: To measure flexibility of the hip joint.

Equipment used: A stool or a stable gym bank with attached ruler.

Execution: The easiest way of measuring is to place the scale in such a way so that the 0 point is at the stool or the bank's level, with negative values marked upwards every one centimeter and positive values - downwards. Person doing the exercise stands without shoes on the stool or the bank with toes even with the stool's edge. Feet put together, legs straight in knee-joints. From this position person doing the exercise bends forward with a continuous movement in order to reach the furthest with his fingers. Such a position of a maximum bend must be kept for two seconds. If person doing the exercise reaches the level he is standing on while bending with a continuous movement, he scores 0. For every centimeter below the stool or bench level he scores one plus point. For every centimeter short to reach the standing level – a minus point. The test is invalid if during bending the legs are bent in knee-joints. Any vigorous movements during bends are not permitted, either.

Score: Two trials are carried out and better result is recorded.



Classification standards in the MTSF [35]

Fitness level	Number of points
High	481 and more
Average	320-480
Low	319 and less

Figure 7. Forward bend (Larson, 2012)

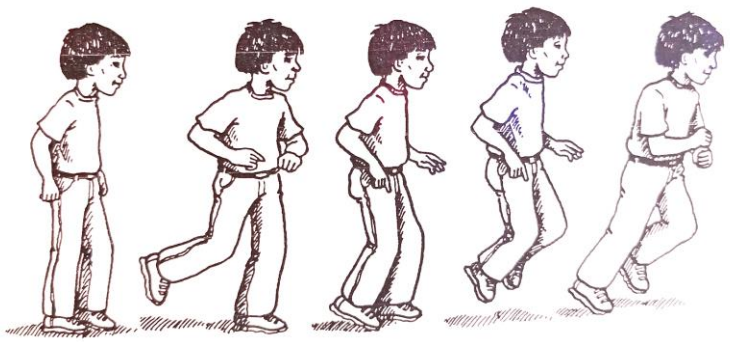
c. Fundamental motor skills

In order to determine the level of fundamental movement skills in students, the Test of Gross Motor Development - Second Edition (TGMD-2) was used. The TGMD-2 consists of two subtests: one that assesses the performance of locomotor skills (run, gallop, hop, leap, jump and slide), and the second subtest assesses the performance of object control skills (strike, dribble, catch, kick, throw, and underhand roll). Each skill is evaluated based on some performance criteria. Each subtest includes 24 performance criteria. The participant has to perform the task twice. For each trial, a score of 1 is given, if the criterion is performed correctly, and a score of 0, if performed incorrectly. Test materials used for administering the TGMD-2 were 8- to 10-inch playground ball, one basketball, one soccer ball, one 4-inch lightweight ball, one tennis ball, one softball, one 4- to 5-inch square beanbag, tape, two traffic cones, one plastic bat, and one batting tee (Ulrich, 2000).

1) Locomotor Subtest

Skill	Materials	Directions	Performance Criteria
1. Run	60 feet of clear space, and two cones	Place two cones 50 feet apart. Make sure there is at least 8 to 10 feet of space beyond the second cone for a safe stopping distance. Tell the child to run as fast as he or she can from one cone to the other when you say "Go." Repeat a second trial.	1. Arms move in opposition to legs, elbows bent
			2. Brief period where both feet are off the ground
			3. Narrow foot placement landing on heel or toe (i.e., not flat footed)
			4. Nonsupport leg bent approximately 90 degrees (i.e., close to buttocks)

Skill	Materials	Directions	Performance Criteria
2. Gallop	25 feet of clear space, and tape or two cones	Mark off a distance of 25 feet with two cones or tape. Tell the child to gallop from one cone to the other. Repeat a second trial by galloping back to the original cone.	1. Arms bent and lifted to waist level at takeoff
			2. A step forward with the lead foot followed by a step with the trailing foot to a position adjacent to or behind the lead foot
			3. Brief period when both feet are off the floor
			4. Maintains a rhythmic pattern for four consecutive gallops

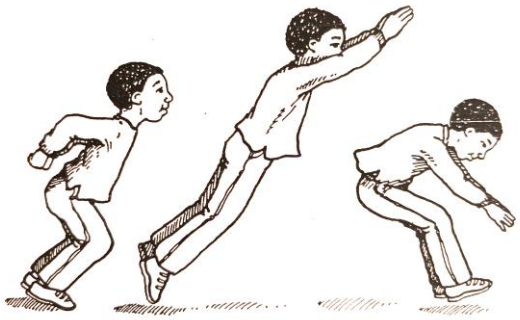


Skill	Materials	Directions	Performance Criteria
3. Hop	A minimum of 15 feet of clear space	Tell the child to hop three times on his or her preferred foot (established before testing) and then three times on the other foot. Repeat a second trial.	1. Nonsupport leg swings forward in pendular fashion to produce force
			2. Foot of nonsupport leg remains behind body
			3. Arms flexed and swing forward to produce force
			4. Takes off and lands three consecutive times on preferred foot
			5. Takes off and lands three consecutive times on nonpreferred foot

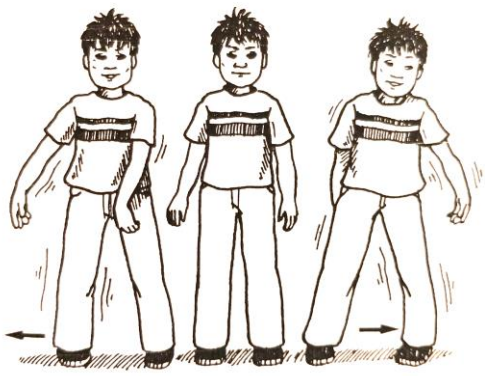
Skill	Materials	Directions	Performance Criteria
4. Leap	A minimum of 20 feet of clear space, a beanbag, and tape	Place a beanbag on the floor. Attach a piece of tape on the floor so it is parallel to and 10 feet away from the beanbag. Have the child stand on the tape and run up and leap over the beanbag. Repeat a second trial.	1. Take off on one foot and land on the opposite foot
			2. A period where both feet are off the ground longer than running
			3. Forward reach with the arm opposite the lead foot

Skill	Materials	Directions	Performance Criteria
5.Horizontal jump	A minimum of 10 feet of clear	Mark off a starting line on the floor. Have the child start behind the line. Tell the child to	1. Preparatory movement includes flexion of both knees with arms extended behind body
			2. Arms extend forcefully forward

	space and tape	jump as far as he or she can. Repeat a second trial.	and upward reaching full extension above the head
			3. Take off and land on both feet simultaneously
			4. Arms are thrust downward during landing

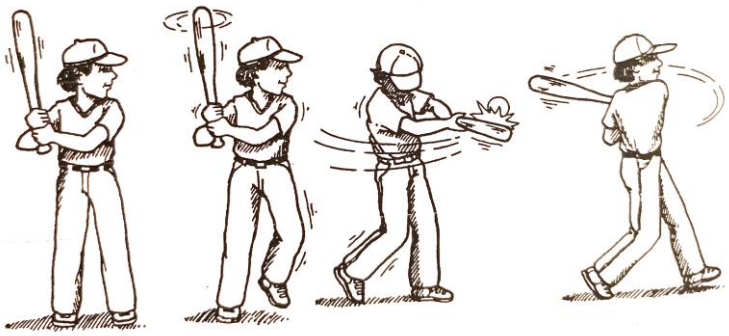


Skill	Materials	Directions	Performance Criteria
6. Slide	A minimum of 25 feet of clear space, a straight line, and two cones	Place the cones 25 feet apart on top of a line on the floor. Tell the child to slide from one cone to the other and back. Repeat a second trial.	1. Body turned sideways so shoulders are aligned with the line on the floor
			2. A step sideways with lead foot followed by a slide of the trailing foot to a point next to the lead foot
			3. A minimum of four continuous step-slide cycles to the right
			4. A minimum of four continuous step-slide cycles to the left



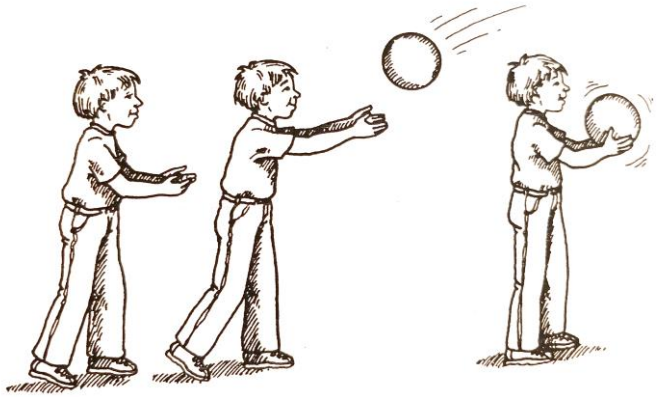
2) Object Control Subtest

Skill	Materials	Directions	Performance Criteria
1. Striking a stationary ball	A 4-inch lightweight ball, a plastic bat, and a batting tees	Place the ball on the batting tee at the child's belt level. Tell the child to hit the ball hard. Repeat a second trial.	1. Dominant hand grips bat above nondominant hand
			2. Nonpreferred side of body faces the imaginary tosser with feet parallel
			3. Hip and shoulder rotation during swing
			4. Transfers body weight to front foot
			5. Bat contacts ball



Skill	Materials	Directions	Performance Criteria
2.Stationary dribble	An 8- to 10-inch playground ball for children ages 3 to 5; a basketball for children ages 6 to 10; and a flat, hard surface	Tell the child to dribble the ball four times without moving his or her feet, using one hand, and then stop by catching the ball. Repeat a second trial.	1. Contacts ball with one hand at about belt level
			2. Pushes ball with fingertips (not a slap)
			3. Ball contacts surface in front of or to the outside of foot on the preferred side
			4. Maintains control of ball for four consecutive bounces without having to move the feet to retrieve it

Skill	Materials	Directions	Performance Criteria
3.Catch	A 4-inch plastic ball, 15 feet of clear space, and tape	Mark off two lines 15 feet apart. The child stands on one line and the tosser on the other. Toss the ball underhand directly to the child with a slight arc aiming for his or her chest. Tell the child to catch the ball with both hands. Only count those tosses that are between the child's shoulders and belt. Repeat a second trial.	1. Preparation phase where hands are in front of the body and elbows are flexed 2. Arms extend while reaching for the ball as it arrives 3. Ball is caught by hands only Skill Illustration



Skill	Materials	Directions	Performance Criteria
4.Kick	An 8- to 10-inch plastic, playground, or soccer ball; a beanbag; 30 feet of clear space; and tape	Mark off one line 30 feet away from a wall and another line 20 feet from the wall. Place the ball on top of the bean- bag on the line nearest the wall. Tell the child to stand on the other line. Tell the child to run up and kick the ball hard toward the wall. Repeat a second trial.	1. Rapid continuous approach to the ball
			2. An elongated stride or leap immediately prior to ball contact
			3. Non kicking foot placed even with or slightly in back of the ball
			4. Kicks ball with instep of preferred foot (shoelaces) or toe

Skill	Materials	Directions	Performance Criteria
5.Overhand throw	A tennis ball, a wall, tape, and 20 feet of clear space	Attach a piece of tape on the floor 20 feet from a wall. Have the child stand behind the 20-foot line facing the wall. Tell the child to throw the ball hard at the wall. Repeat a second trial.	1. Windup is initiated with downward movement of hand/arm
			2. Rotates hip and shoulders to a point where the nonthrowing side faces the wall
			3. Weight is transferred by stepping with the foot opposite the throwing hand
			4. Follow-through beyond ball release diagonally across the body toward the nonpreferred side

Skill	Materials	Directions	Performance Criteria
6.Underhand roll	A tennis ball for children ages 3 to 6; a softball for children ages 7 to 10; two cones; tape; and 25 feet of clear space	Place the two cones against a wall so they are 4 feet apart. Attach a piece of tape on the floor 20 feet from the wall. Tell the child to roll the ball hard so that it goes between the cones. Repeat a second trial.	1. Preferred hand swings down and back, reaching behind the trunk while chest faces cones 2. Strides forward with foot opposite the preferred hand toward the cones 3. Bends knees to lower body 4. Releases ball close to the floor so ball does not bounce more than 4 inches high

4.3.2. Independent variables

In this study, the independent variable is the Brainballs method, including the program of tasks, exercises, and activities using a set of 100 balls. We will look at whether the use of educational balls Brainballs in PE classes varies significantly in the dependent variables.

Brainballs is an educational program for preschool and elementary students that have been successfully researched and tested by researchers from the Department of Team Sports Games at the Wroclaw University of Health and Sports Sciences, which has received acceptance and approval from the National Ministry of Education in Poland. A set of educational balls was entered in the official list of didactic aids for use in schools and designated for general and integrated education at the level of the primary school (order number: 1566/2003 – based on ordinance of the Ministry of National Education and Sport – Diary Acts of 2002, No. 69, item 635). Educational balls were also given a positive recommendation from the Parliament Commission for Sport (Rokita & Cichy, 2013).

Researchers found that children like moving activities and the attraction of exercises, games, especially games with balls. So, they modified the traditional balls by adding letters in the alphabet, numbers, and mathematical symbols on the surface of the balls (Rokita & Cichy, 2013). In this way, educational balls were created with the first name "Edubal", after ten years of research, being changed to "Eduball". In 2018, the English version of the educational balls named "Brainball" was started. Despite the different names, the idea of Edubal/Eduball/Brainball is the same; Children learn while playing! (Rokita et al., 2018b).

The Brainballs set includes 100 balls used in team sports games (basketball, soccer) with five colors (yellow, green, blue, red, and orange) with black letters (uppercase and lowercase letters), numbers from 0 to 9, mathematical symbols representing addition (+), subtraction (-), multiplication (*) and division (:), bigger symbols (>), smaller (<), parentheses () and symbols (@) are drawn on their surfaces, and the balls have been resized and weighed suitable for the student's age (Rokita et al., 2018b).

The main teaching method of the program is to use games and exercises that have been designed based on the natural forms of movement (running, jumping, throwing, catching...) playing with Eduball/Brainballs in the physical education classes. Through games, students can easily grasp basic movements, motor skills, and physical development. Numbers, letters, and signs, as well as the color of educational balls, allow teachers to integrate

instruction with a variety of content in different subjects such as Language (Polish, English, and Spanish), Mathematics, History, Geography, Biology (Rokita et al., 2018b; Rokita & Rzepa, 2002; Rokita & Rzepa, 2005).

The Brainball intervention program included 40 PE lessons – an example of a lesson plan in Appendix.

Table 3. Implementation schedule of physical education program with the use of Brainballs

Lesson	Date	Subject/Topic	Objective
1	27/8/2019	Game "Corners", "Ball Hunters"	- To classify objects (set, subsets) - To learn the counting sequence - Improve social interactions, and certain motor skills
2	29/8/2019		
3	03/9/2019	Game "What color is it", "Letters"	- To develop logical thinking - To practice the order and pronunciation of the letters of the alphabet. - Improve social interactions, and certain motor skills
4	05/9/2019		
5	10/9/2019	Game "Letter races"	- To practice the order and pronunciation of the letters of the alphabet and improve certain motor skills and physical skills
6	12/9/2019		
7	17/9/2019	Game "Numbers", "From 0 to 9"	- To learn about number names and practice counting - To practice the other of digits in an increasing and decreasing number sequence - Improve certain motor skills
8	19/9/2019		
9	24/9//2019	Game "Even and odd numbers"	To practice the distinction between even and odd digits and improve certain motor skills
10	26/9/2019		

11	01/10/2019	Game "The drill", "Vowels and consonants"	- To practice the distinction between vowels and consonants. - To develop language skills - Improve certain motor skills
12	03/10/2019		
13	08/10/2019	Game "Proper nouns"	- To learn the rules of proper nouns, develop concentration and attention and improve fundamental movement skills
14	10/10/2019		
15	15/10/2019	Game "Attractive digits", "Pair up"	- To improve students' knowledge of the digit order in an increasing number sequence - To practice the distinction between even and odd digits - Improve certain motor skills
16	17/10/2019		
17	22/10/2019	Game "Watch out"	- To improve students' knowledge of the digit order in an increasing number sequence - Improve certain motor skills
18	24/10/2019		
19	29/10/2019	Game "Where are you my partner"	- To practice the order of the letters of the alphabet, develop perceptive and focus and improve the ability to work in a team
20	31/10/2019		
21	05/11/2019	Game "Double Tag"	To practice the distinction between even and odd digits and improve certain motor skills
22	07/11/2019		
23	12/11/2019	Game "The moving ABC", "ABC"	- To improve students' knowledge of the letter order in the alphabet, develop perceptive and focus and improve the ability to work in a team
24	14/11/2019		

25	19/11/2019	Game “Math races”	- To improve number recognition, solve problems involving the four mathematical operations (addition, subtraction, multiplication and division), and improve locomotor and object control skills
26	21/11/2019		
27	26/11/2019	Game “Alphabet”	To practice the order of the letters of the English alphabet, develop perceptiveness and focus, and improve on working cooperatively with others
28	28/11/2019		
29	03/12/2019	Game “Number Tag”, “The group games”	- To learn mathematical operation with the number “5” - To compose numbers equal to, greater than, or less than 100 - Develop orientation in space and time and improve speed
30	05/12/2019		
31	10/12/2019	Game “Who is called”	- To improve knowledge of the letters, enrich vocabulary and improve certain motor skills.
32	12/12/2019		
33	17/12/2019	Game “Compare sets”	To practice the use of mathematical signs (<, >, =) and compare numbers, develop the ability to work in a team, and improve certain motor skills
34	19/12/2019		
35	24/12/2019	Game “Words”	To enrich vocabulary (nouns, verbs, adjectives) and improve certain fundamental movement skills
36	26/12/2019		
37	02/01/2020	Game “Operations in the air”	To practice simple mathematical operations and improve orientation in space
38	07/01/2020		

39	09/01/2020	Game “Letter Tag”	To develop the skills of forming words beginning with a certain letter and improve certain motor skills
40	14/01/2020		

4.4. Organization of research

Organization and procedure of research and intervention is described in figure 8.

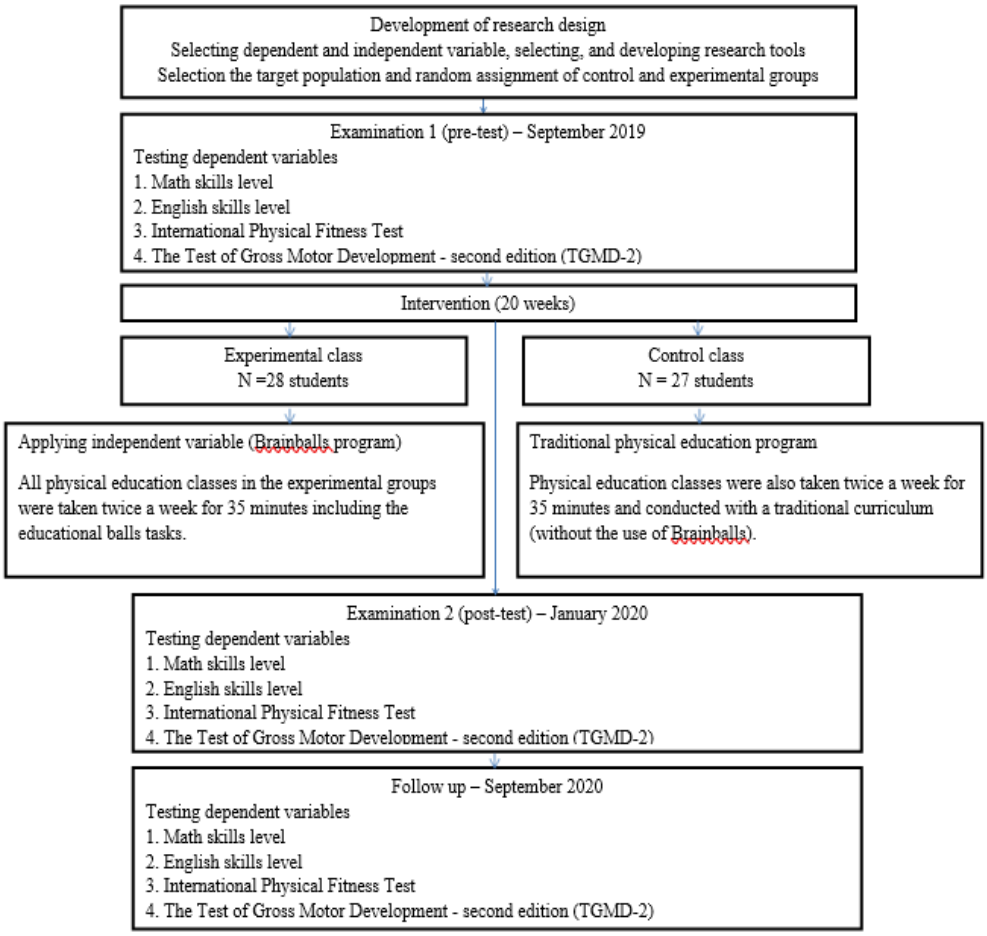


Figure 8. Visualization of the experimental research design

4.5. Statistical analysis

Statistical analysis of results was performed by STATISTICA statistical package 13.0 (Stat. Krakow). Students' test results from the experimental and control classes related to gender and repeat measurement were analyzed by basic statistics such as arithmetic mean, standard deviation, minimum (MIN), and maximum (MAX). A variance analysis (ANOVA) for repeated measurements was performed to verify the differences in the

relationship between the results in math skills, English skills, and physical fitness, gross motor skills of students according to gender, group, and repeat the measurement. Levene's test of uniformity of variance was used to confirm the homogeneity of variance in the samples tested. Newmana-Keulsa's Post hoc test was applied to confirm the importance of the differences between groups. Statistical significance was set at $p<0.05$.

V RESULTS

5.1. The physical fitness level of pupils from experimental and control groups at the first, second, and follow-up examinations

50-meter running (s)

The results of the analysis of variance for the repeated measurements in the 50-meter running test showed that the acceleration and speed of pupils from the experimental group after one school year improved significantly compared to pupils from the control group, ($F(2,102)=5.71$, $p=0.0044$) (Figure 9). However, the results of the Post hoc test showed that the acceleration and speed of pupils from the experimental group and the control group did not have significant differences in the first, second, and follow-up examinations ($p>0.05$) (Tables 4, 5, Appendix).

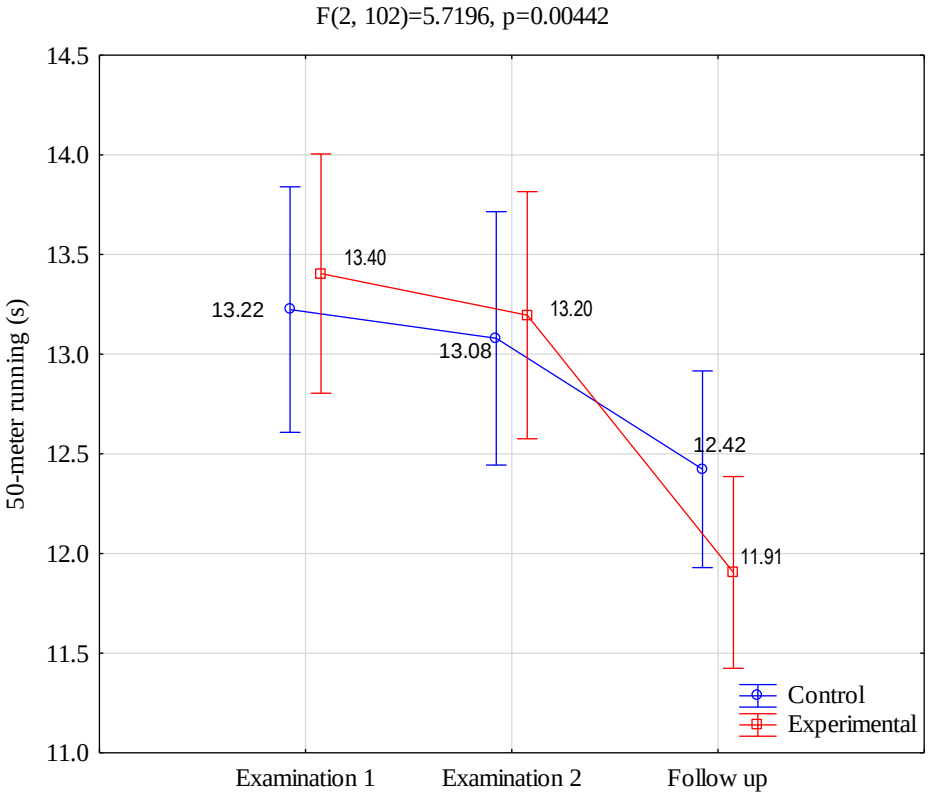


Figure 9. The results of the 50-meter running in pupils from the experimental and control groups in the first, second, and follow-up examinations.

Comparing the results obtained on the level of the 50-meter running separately in pupils from experimental and control groups at first, second, and follow-up examinations showed that the acceleration and speed of pupils from the experimental and control groups

did not significantly improve after 20 weeks of intervention (from the first to the second examination). However, the acceleration and speed of pupils in both groups improved significantly at the follow-up examination (eight months after the intervention), separately in the experimental group (p=0.0001) and the control group (p=0.0001) (Table 5, Appendix).

The analysis of variance for the repeated measurements in the 50-meter running test showed that there were no significant differences in the development of acceleration and speed between boys from the experimental group and boys from the control group. There were also no significant differences in the development of acceleration and speed between girls from the experimental group and girls from the control group (F(2, 102)=1.5161, p=0.2244) (Figure 10). The results of the Post hoc test showed that there were no significant differences in the 50-meter running of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations (p>0.05) (Tables 6, Appendix).

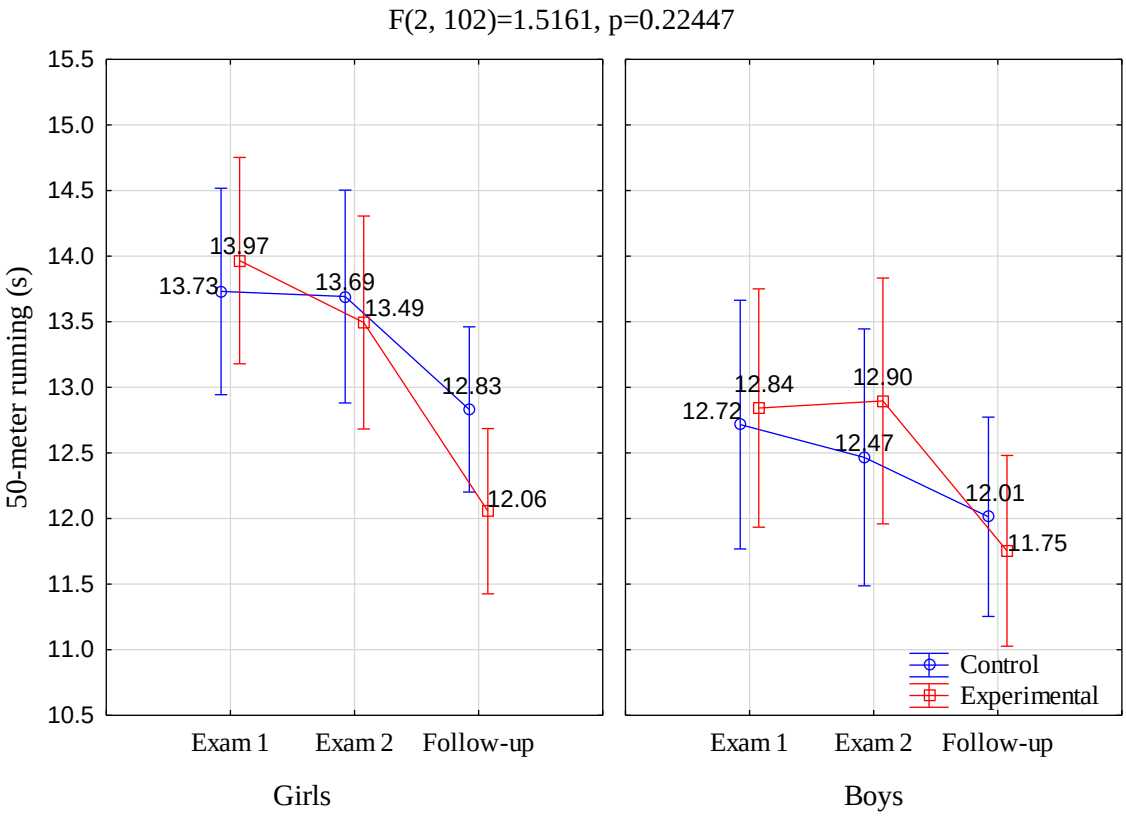


Figure 10. The results of the 50-meter running in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations.

Toe touch (cm)

The results of the analysis of variance for the repeated measurements in the Toe touch test showed that the flexibility of the lower back and hamstring muscles of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(2, 102)=4.47$, $p=0.0137$) (Figure 11). The Post hoc test results showed that there was a significant difference in the Toe touch test between pupils from the experimental group and pupils from the control group at the first examination ($p=0.036$). However, there were no significant differences at second and follow-up examinations ($p>0.05$) (Tables 7, 8, Appendix).

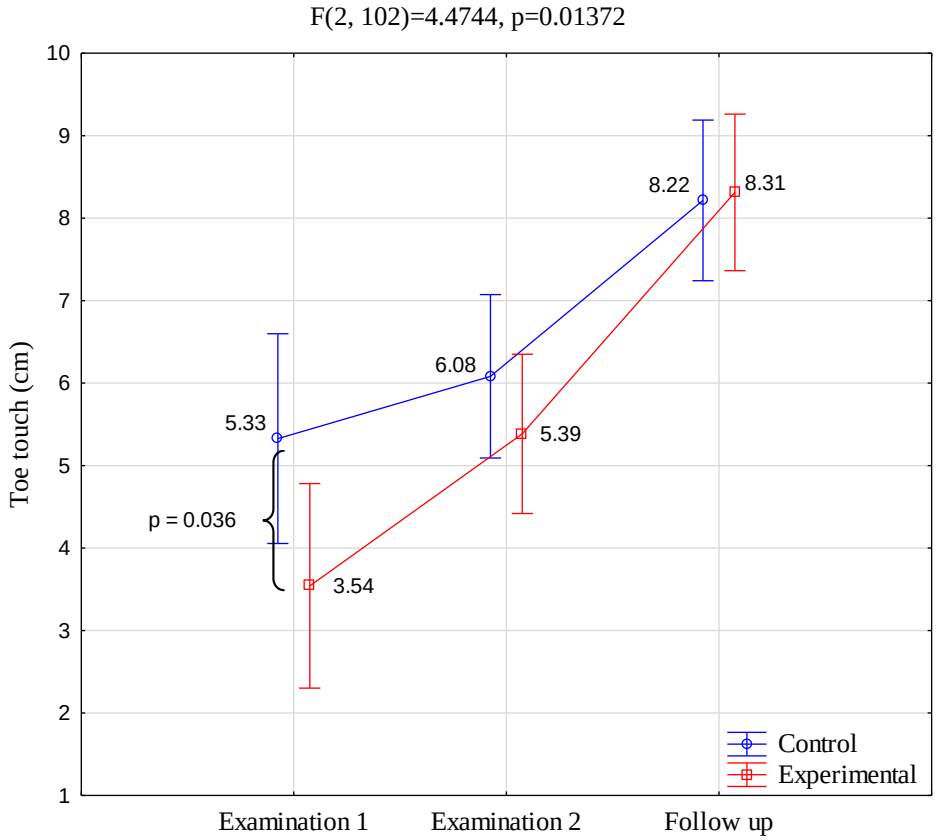


Figure 11. The results of the Toe touch in pupils from the experimental and control groups in the first, second, and follow-up examinations**.**

Comparing the results obtained on the level of the Toe touch separately in pupils from experimental and control groups at the first, second, and follow-up examinations showed that the flexibility of the lower back and hamstring muscles of pupils from the experimental group improved significantly after 20 weeks of intervention ($p<0.0001$) and

at follow-up, eight months after the intervention (p<0.0001). The flexibility of the lower back and hamstring muscles of pupils from the control group did not improve significantly after the 20 weeks of intervention (p>0.05) but improved significantly at follow-up, eight months after the intervention (p<0.0001) (Table 8, Appendix).

Analysis of variance for repeated measurements in the toe touch test revealed that there were no significant differences in the development of lower back and hamstring flexibility between boys from the experimental group and boys from the control group. There were also no significant differences in the development of lower back and hamstring flexibility between girls from the experimental group and girls from the control group (F(2, 102)=0.9868, p=0.3762) (Figure 12). The results of the Post hoc test showed that there were no significant differences in the Toe touch of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations (p>0.05) (Tables 9, Appendix).

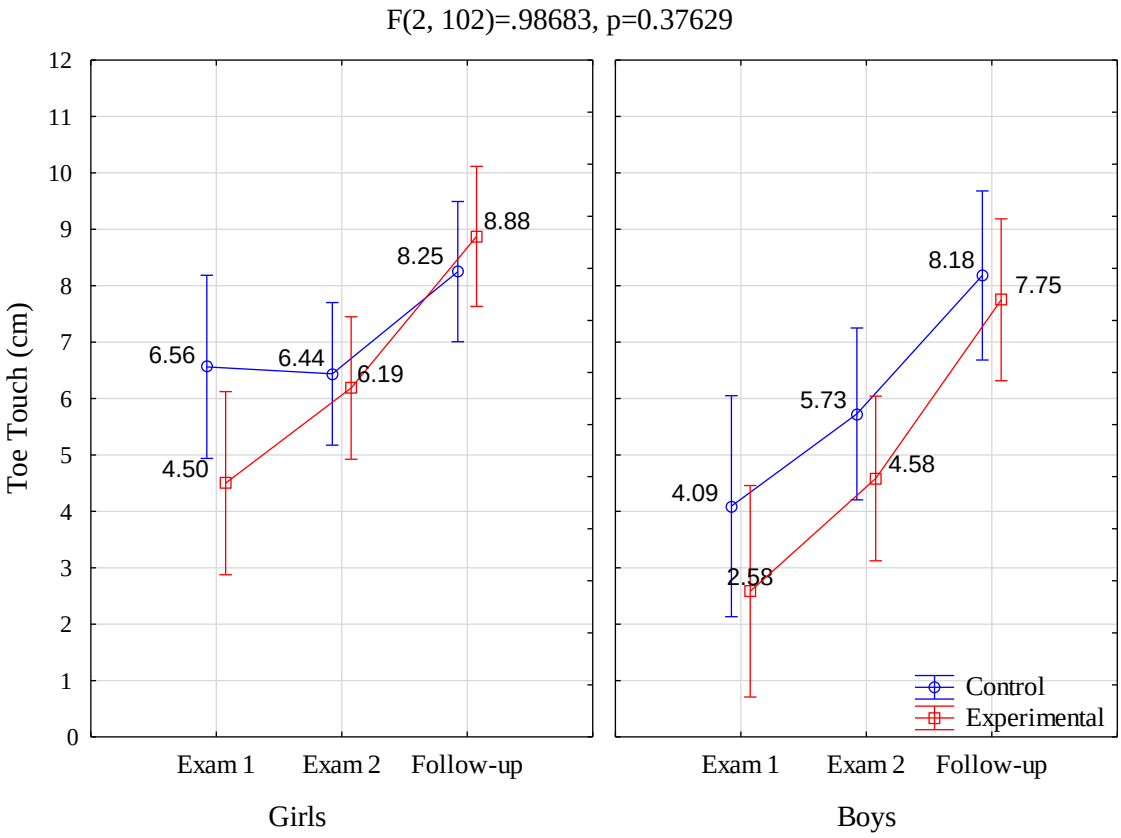


Figure 12. The results of the Toe touch in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

Standing long jump (cm)

The results of the analysis of variance for the repeated measurements in the Standing long jump test showed that the explosive leg power of pupils from the experimental group after one school year improved significantly compared to pupils from the control group (F(2,102)=5.1121, p=0.0076) (Figure 13). However, the Post hoc test results showed that the explosive leg power of pupils from the experimental group and the control group did not have significant differences in the first and second examinations (p>0.05). There was a significant difference in explosive leg power between the pupils of the experimental group and the control group at the follow-up examination (eight months after the intervention) (p=0.018) (Tables 10, 11, Appendix).

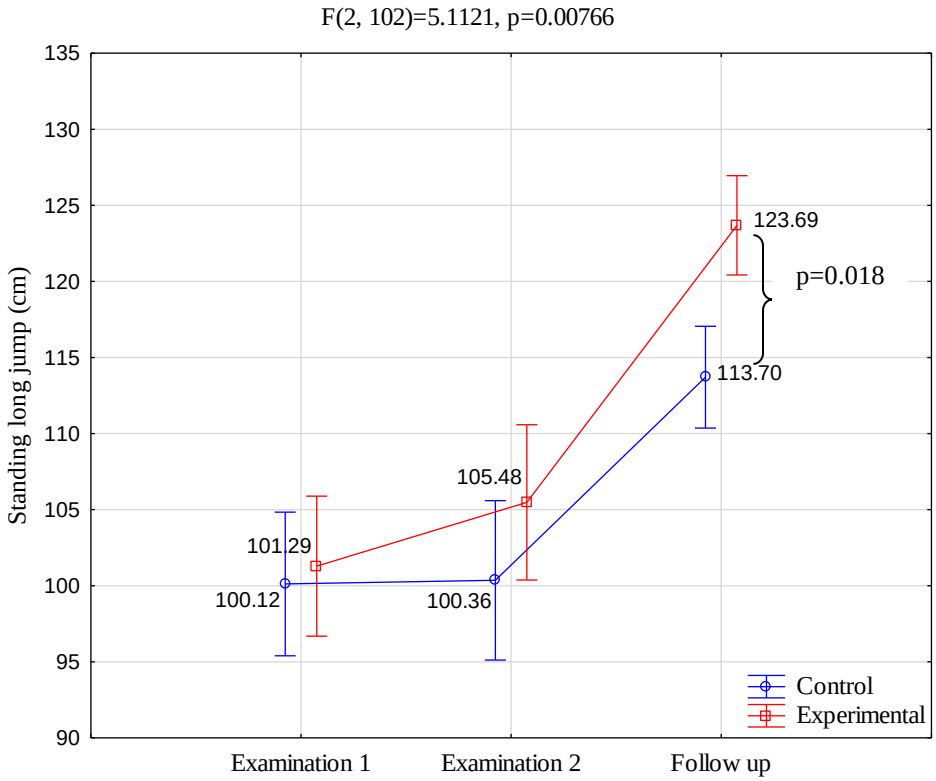


Figure 13. The results of the standing long jump in pupils from the experimental and control groups in the first, second, and follow-up examinations.

Comparing the results obtained on the level of the standing long jump separately in pupils from experimental and control groups at the first, second, and follow-up examinations showed that the pupils from the experimental and control groups did not significantly improve in the explosive leg power after 20 weeks of intervention (from the

first to the second examination). However, the explosive leg power of pupils in both groups improved significantly at follow-up examination (eight months after the intervention), separately in the experimental group ($p<0.0001$) and the control group ($p<0.0001$) (Table 11, Appendix).

The analysis of variance for the repeated measurements in the standing long jump test showed that there were no significant differences in the development of explosive leg power between boys from the experimental group and boys from the control group. There were also no significant differences in the development of explosive leg power between girls from the experimental group and girls from the control group ($F(2, 102)=0.8917$, $p=0.4131$) (Figure 14). The results of the Post hoc test showed that there were no significant differences in the standing long jump of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations ($p>0.05$) (Tables 12, Appendix).

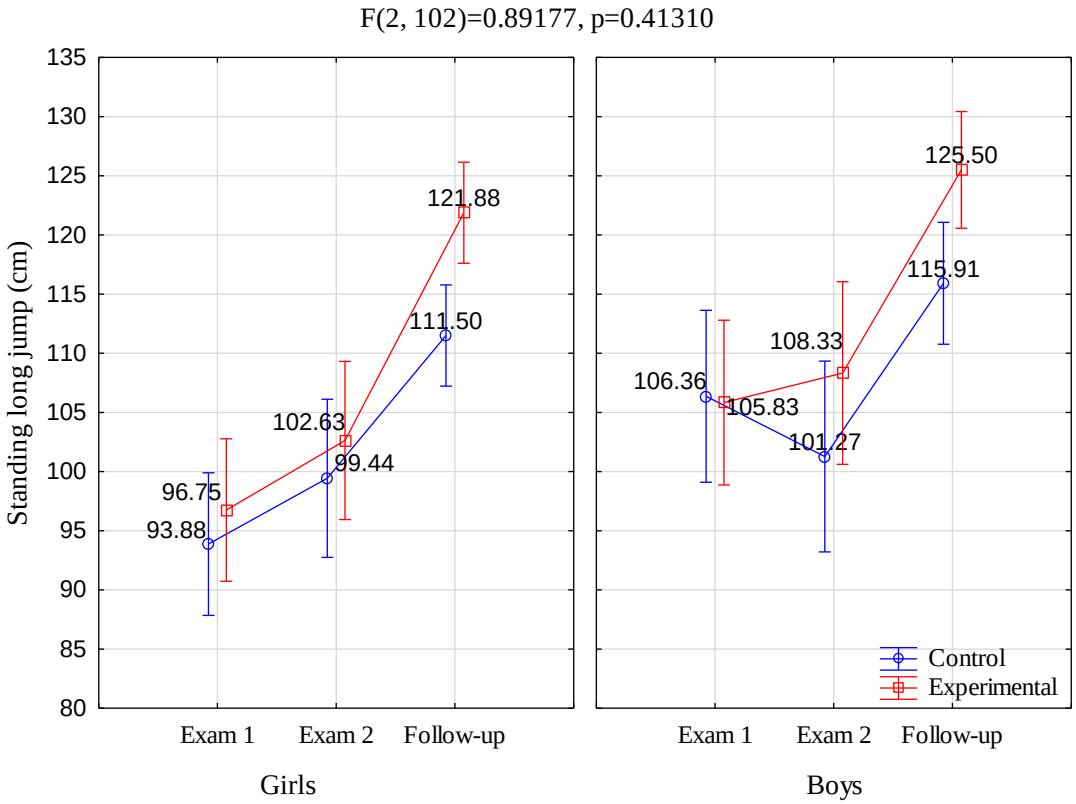


Figure 14. The results of the standing long jump in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

4 x 10 m sprint (s)

The results of the analysis of variance for the repeated measurements in the 4 x 10 m sprint test showed that the speed and agility of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(2, 102)=3.5158$, $p=0.0333$) (Figure 15). However, the results of the Post hoc test showed that the speed and agility of pupils from the experimental group and the control group did not have significant differences in the first, second, and follow-up examination ($p > 0.05$) (Tables 13, 14, Appendix).

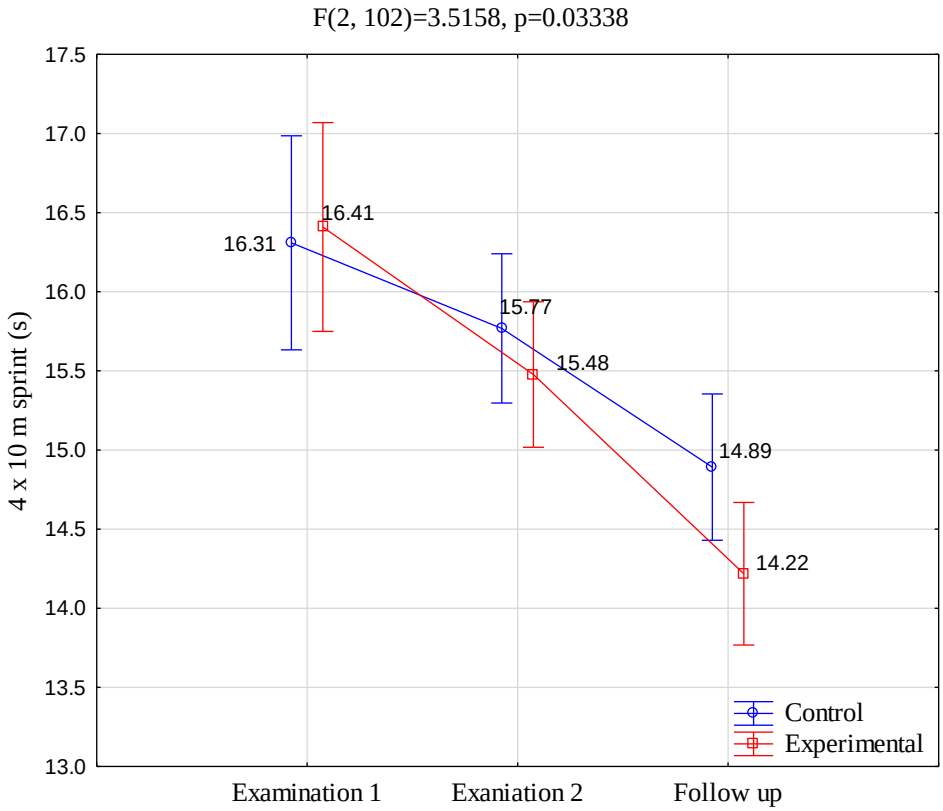


Figure 15. The results of the 4 x 10 m sprint in pupils from the experimental and control groups in the first, second, and follow-up examinations

Comparing the results obtained on the level of 4 x 10 m sprint separately in pupils from experimental and control groups at the first, second and follow-up examinations showed that the speed and agility of pupils from the experimental group significantly improved after 20 weeks of intervention ($p<0.0001$) and at follow-up examination (eight months after the intervention) ($p<0.0001$). The speed and agility of pupils from the control

group did not significantly improve after the 20 weeks of intervention ($p>0.05$) but significantly improved at follow-up examination (eight months after the intervention) ($p<0.0001$) (Table 14, Appendix).

The analysis of variance for the repeated measurements in the 4 x 10 m sprint test showed that there were no significant differences in the development of speed and agility between boys from the experimental group and boys from the control group. There were also no significant differences in the development of speed and agility between girls from the experimental group and girls from control groups ($F(2, 102)=0.4784$, $p=0.6211$) (Figure 16). The results of the Post hoc test showed that there were no significant differences in the 4 x 10 m sprint of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations ($p>0.05$) (Tables 15, Appendix).

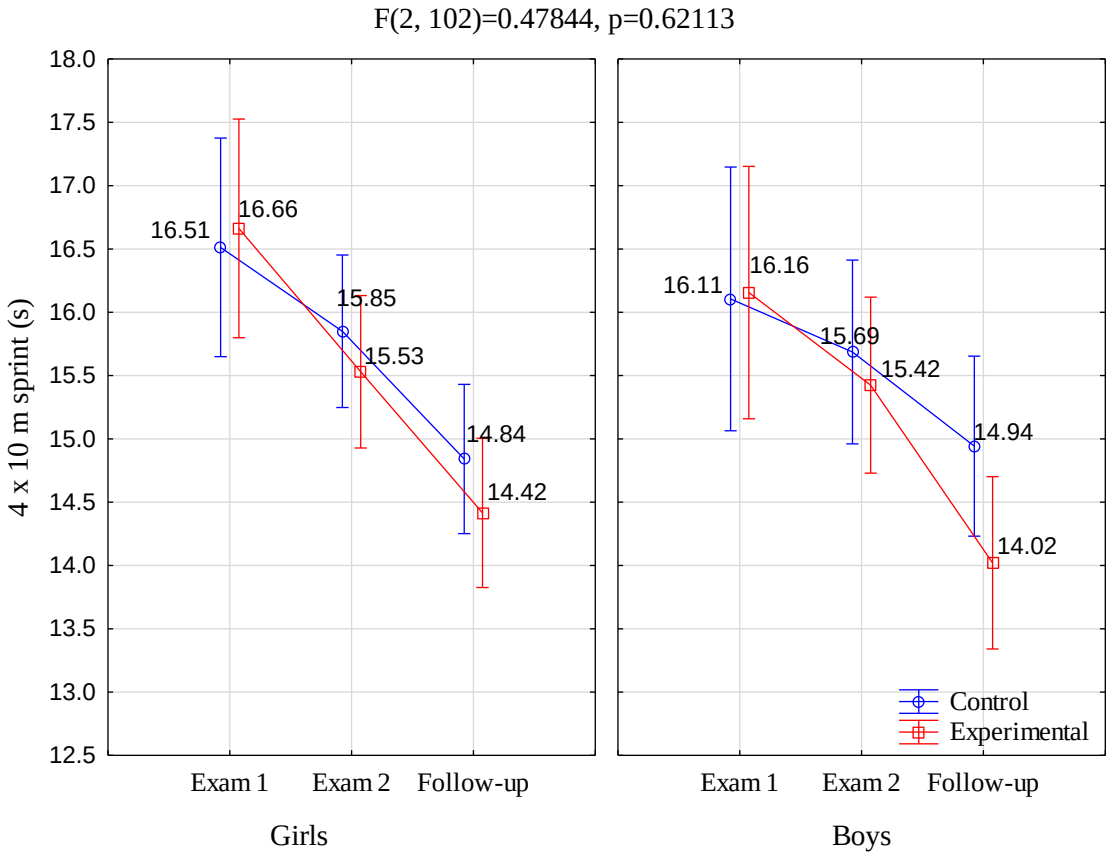


Figure 16. The results of the 4 x 10 m in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

Hand strength (kg)

The results of the analysis of variance for the repeated measurements in the Hand strength test showed that the grip strength of pupils from the experimental group after one school year improved significantly compared to pupils from the control group, ($F(2, 102)=3.8974$, $p=0.0233$) (Figure 17). However, the results of the Post hoc test showed that the grip strength of pupils from the experimental group and the control group did not have significant differences in the first, second, and follow-up examinations ($p>0.05$) (Tables 16, 17, Appendix).

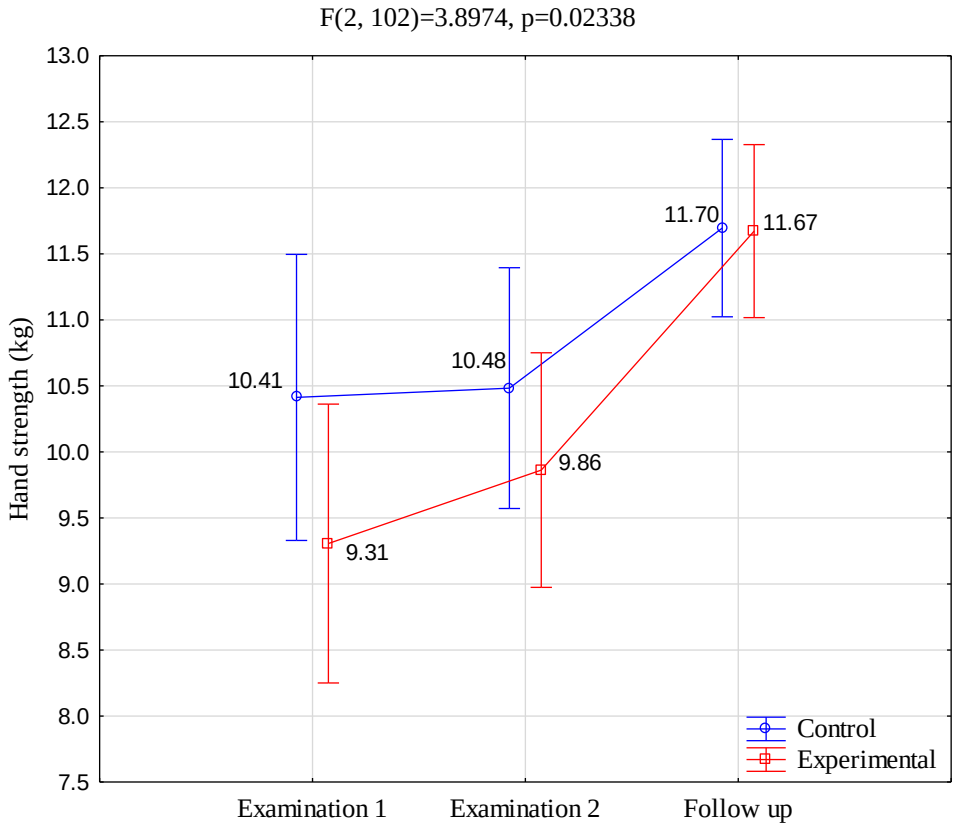


Figure 17. The results of the Hand strength in pupils from the experimental and control groups in the first, second, and follow-up examinations.

Comparing the results obtained on the level of Hand strength separately in pupils from experimental and control groups at the first, second, and follow-up examinations showed that the grip strength of pupils from the experimental group and the control group did not improve significantly after 20 weeks of intervention (from the first to the second examination). However, the grip strength of pupils in both groups improved significantly at

follow-up examination (eight months after the intervention), separately in the experimental group ($p<0.0001$) and in the control group ($p=0.001$) (Table 17, Appendix).

The analysis of variance for the repeated measurements in the Hand strength test showed that the level of the grip strength of boys and girls from the experimental group after one school year improved significantly compared to boys and girls from the control group ($F(2, 102)=3.8614$, $p=0.0241$) (Figure 18). However, the results of the Post hoc test showed that there were no significant differences in the Hand strength of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations ($p>0.05$) (Tables 18, Appendix).

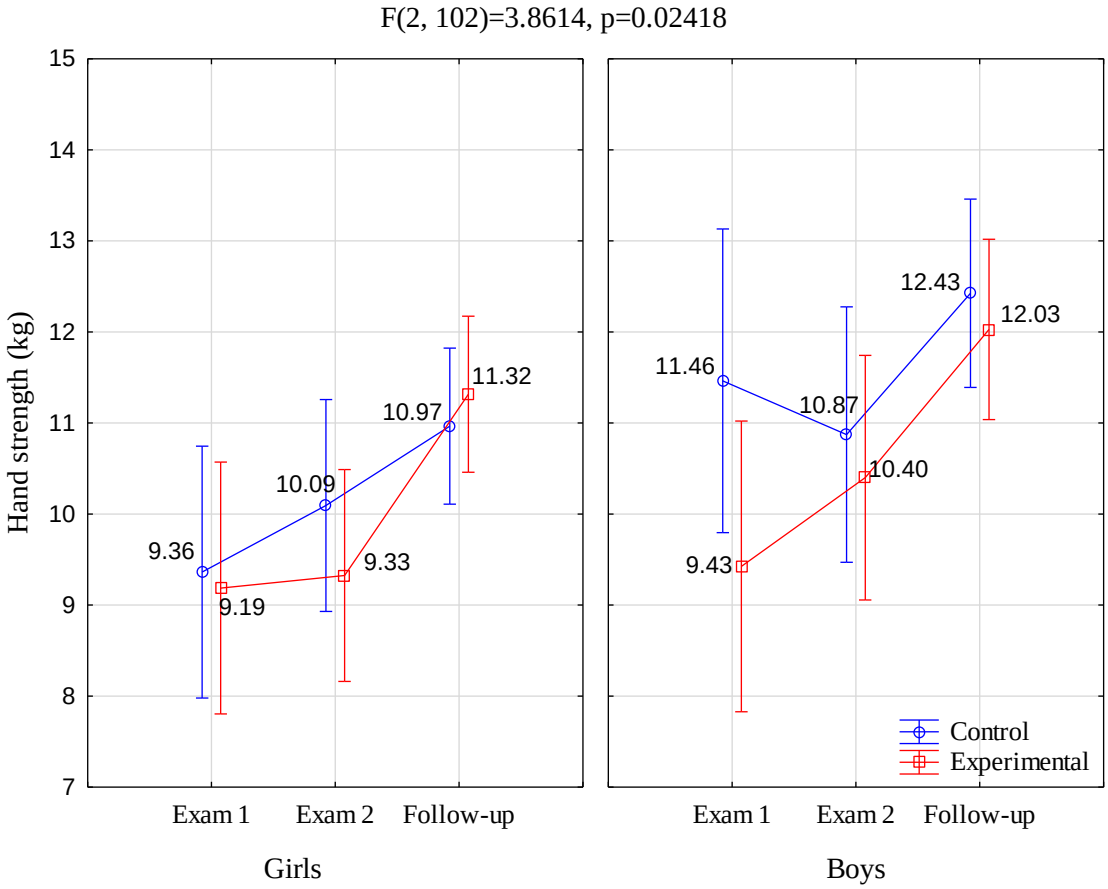


Figure 18. The results of the Hand strength in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

Bent arm hang (s)

The analysis of variance for the repeated measurements in the bent arm hang test showed that there were no significant differences in the strength and endurance development of pupils from experimental and control groups after one school year (F(2, 102)=0.3755, p=0.6878) (Figure 19). The results of the Post hoc test also showed that the strength and endurance of pupils from the experimental group and the control group did not have significant differences in the first, second, and follow-up examination (p>0.05) (Tables 19, 20, Appendix).

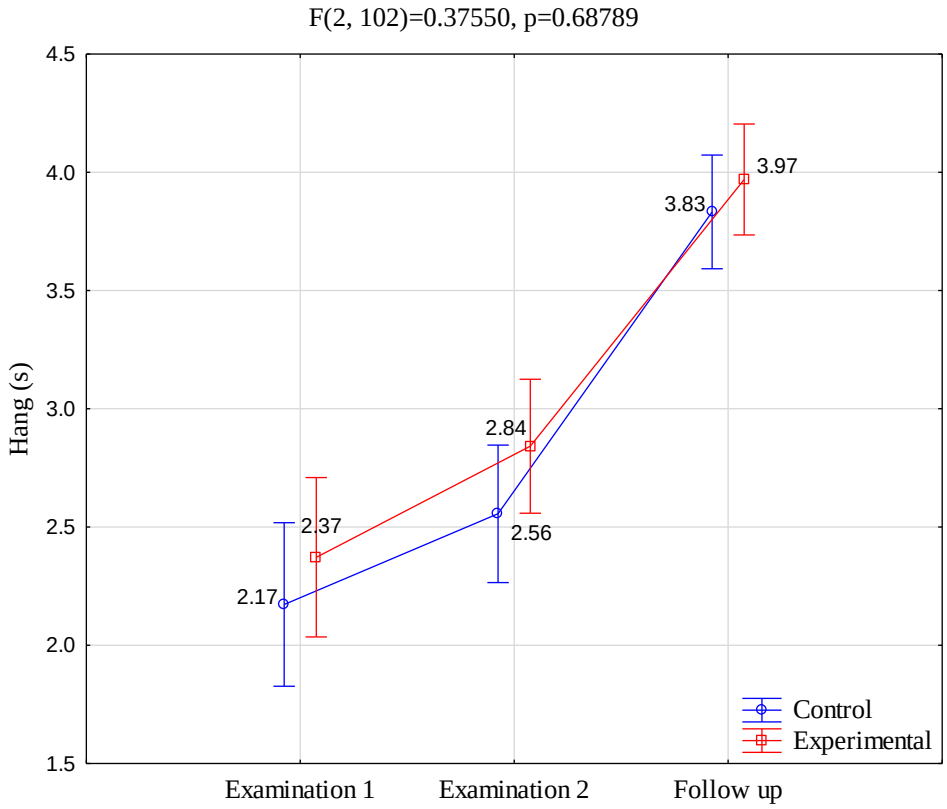


Figure 19. The results of the Bent arm hang in pupils from the experimental and control groups in the first, second, and follow-up examinations.

Comparing the results obtained on the level of Bent arm hang separately in pupils from experimental and control groups at the first, second, and follow-up examinations showed that the strength and endurance of pupils from the experimental group significantly improved after 20 weeks of intervention (from the first to the second examination) (p=0.002) and at follow-up examination (eight months after the intervention) (p<0.0001). The strength and endurance of pupils from the control group did not significantly improve

after the 20 weeks of intervention (p>0.05) but significantly improved at follow-up examination (eight months after the intervention) (p<0.0001) (Table 20, Appendix).

The analysis of variance for the repeated measurements in the bent arm hang test showed that there were no significant differences in the development of strength and endurance between boys from the experimental group and boys from the control group. There were also no significant differences in the development of strength and endurance between girls from the experimental group and girls from control groups (F(2, 102)=1.2038, p=0.3042) (Figure 20). The results of the Post hoc test showed that there were no significant differences in the bent arm hang of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations (p>0.05) (Tables 21, Appendix).

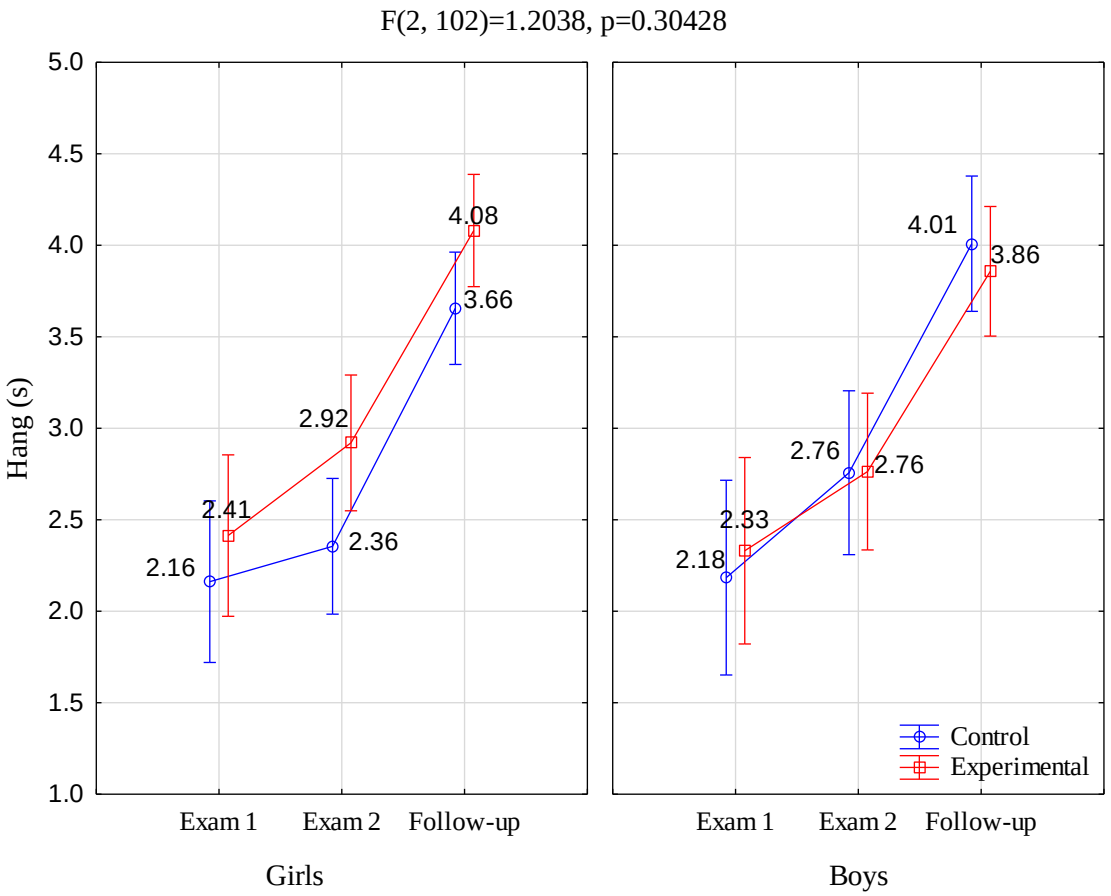


Figure 20. The results of the Bent arm hang in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

Sit-ups (num.)

The analysis of variance for the repeated measurements in the Sit-ups test showed that there were no significant differences in the development of abdominal strength of pupils from experimental and control groups after one school year (F(2, 102)=0.5850, p=0.5589) (Figure 21). The results of the Post hoc test also showed that the abdominal strength of pupils from the experimental group and the control group did not have significant differences in the first, second, and follow-up examinations (p>0.05) (Tables 22, 23, Appendix).

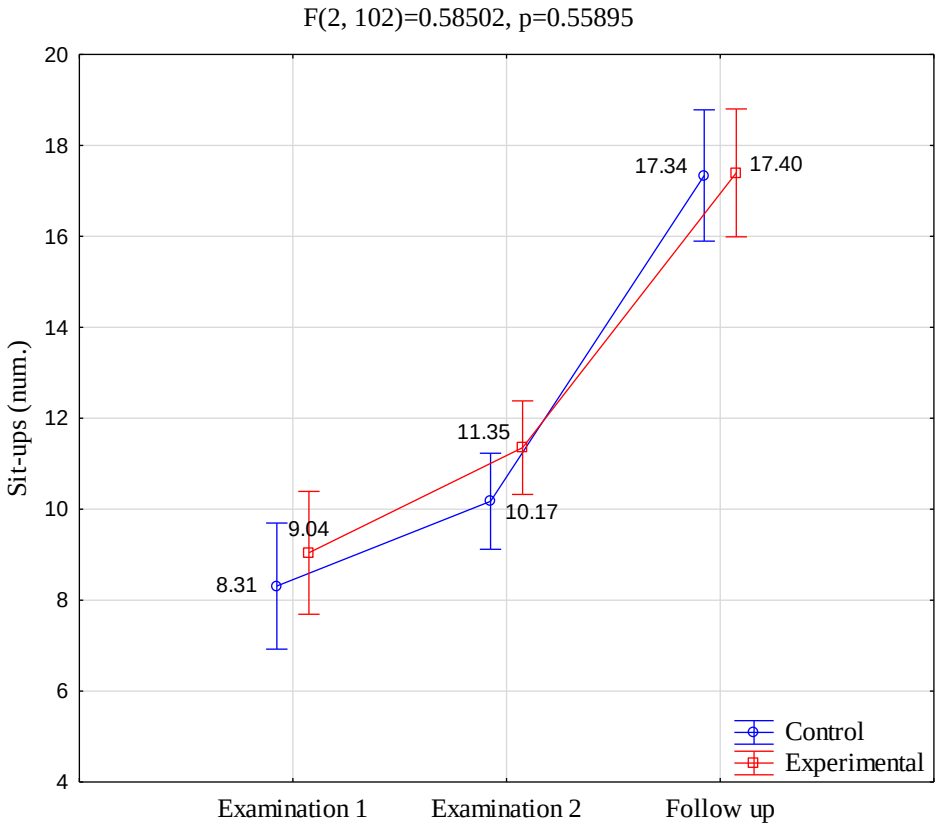


Figure 21. The results of the Sit-ups in pupils from the experimental and control groups in the first, second, and follow-up examinations.

Comparing the results obtained on the level of Sit-ups separately in pupils from experimental and control groups at the first, second, and follow-up examinations showed that the abdominal strength of pupils from the experimental group significantly improved after 20 weeks of intervention (from the first to the second examination) (p=0.021) and at follow-up examination (eight months after the intervention) (p<0.0001). The abdominal

strength of pupils from the control group did not significantly improve after 20 weeks of intervention ($p>0.05$) but significantly improved at follow-up examination (eight months after the intervention) ($p<0.0001$) (Table 23, Appendix).

The analysis of variance for the repeated measurements in the Sit-ups test showed that there were no significant differences in the development of abdominal strength between boys from the experimental group and boys from the control group. There were also no significant differences in the development of abdominal strength between girls from the experimental group and girls from control groups ($F(2, 102)=2.3495$, $p=0.1005$) (Figure 22). The results of the Post hoc test showed that there were no significant differences in the Sit-ups of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations ($p>0.05$) (Tables 24, Appendix).

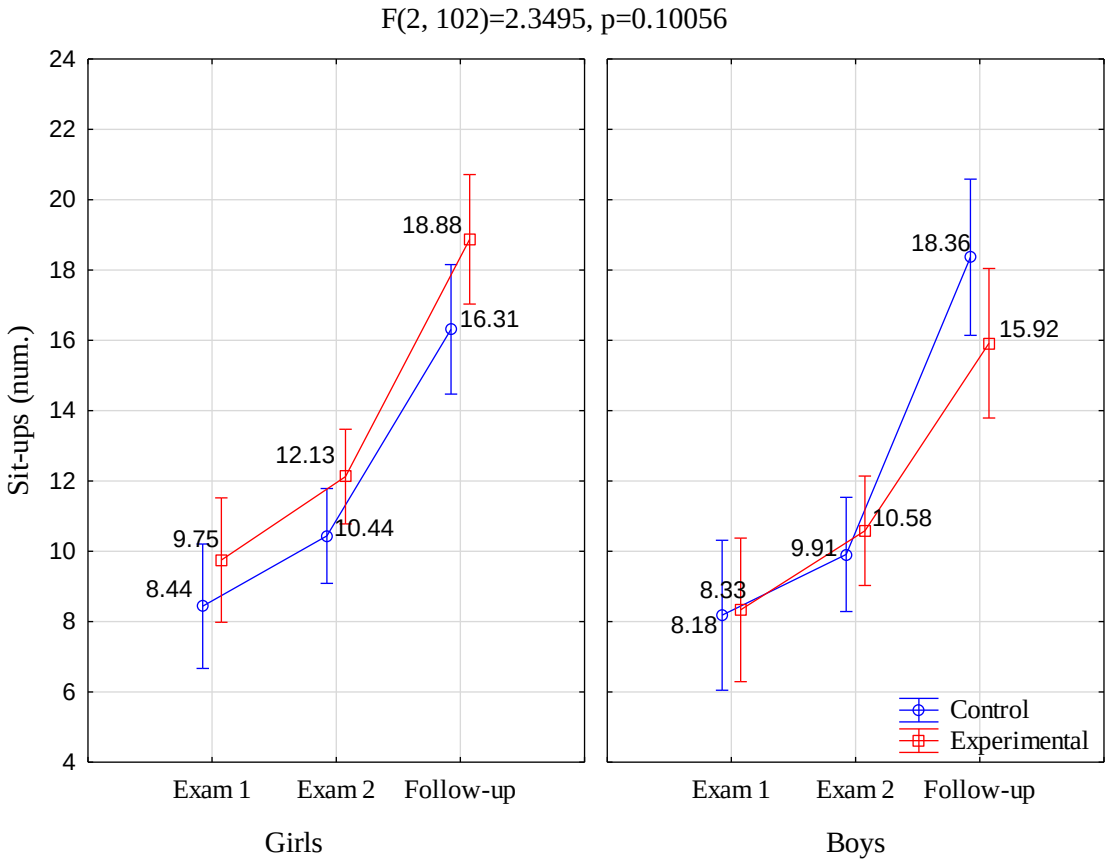


Figure 22. The results of the Sit-ups in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

5.2. Gross motor skills level of pupils from experimental and control groups in the first and follow-up examinations

The results of gross motor test skills have been collected only twice. Due to the global pandemic situation and also a local restriction in the education system in Vietnam, it was impossible to collect the post-test results in due time. But luckily, the restriction on the education system ended in time to organize the third examination; therefore, it was decided to collect scores at the follow-up term. This is why there are only two sets of results presented in this section.

Run skills

The results of the analysis of variance for the repeated measurements in the Run skills test showed that the level of the Run skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(1, 51)=12.066$, $p=0.0010$) (Figure 23). However, the results of Post-hoc testing showed that there were no significant differences in the Run skills between pupils from the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 25, 26, Appendix).

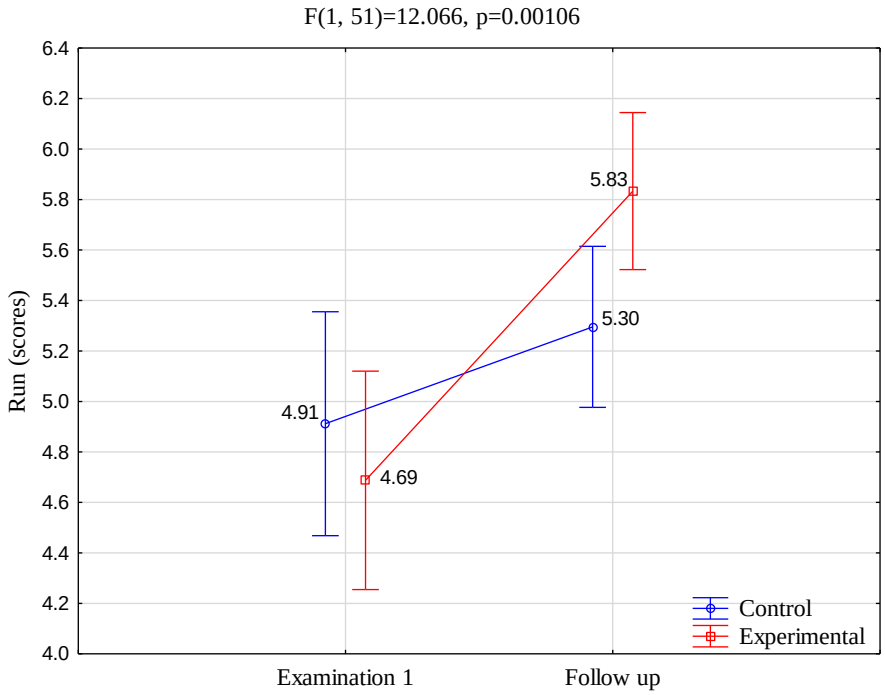


Figure 23. The results of the Run skills in pupils from the experimental and control groups in the first and follow-up examinations.

Comparing the results obtained on the level of the Run skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the pupils from the experimental group significantly improved the level of Run skills after one school year ($p<0.0001$). In comparison, the pupils from the control group did not significantly improve the level of Run skills after one school year ($p>0.05$) (Table 26, Appendix).

The analysis of variance for the repeated measurements in the Run skills test showed no significant differences in the level of development of Run skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Run skills performance between girls from the experimental group and girls from control groups ($F(1, 51)=1.8711$, $p=0.1773$) (Figure 24). The results of the Post-hoc test showed that there were no significant differences in the Run skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 27, Appendix).

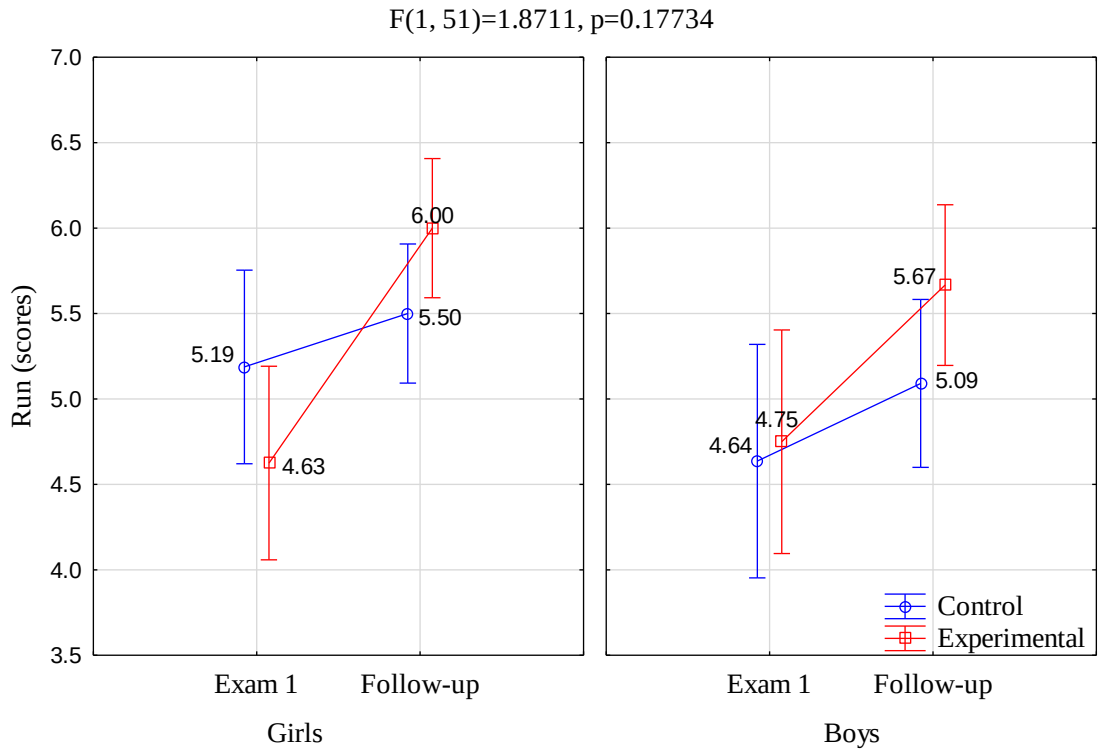


Figure 24. The results of the Run skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Gallop skills

The results of the analysis of variance for the repeated measurements in the Gallop skills test showed that the level of the Gallop skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(1, 51)=8.6404$, $p=0.0049$) (Figure 25). However, the results of the Post-hoc test showed that there were no significant differences in the Run skills between students from the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 28, 29, Appendix).

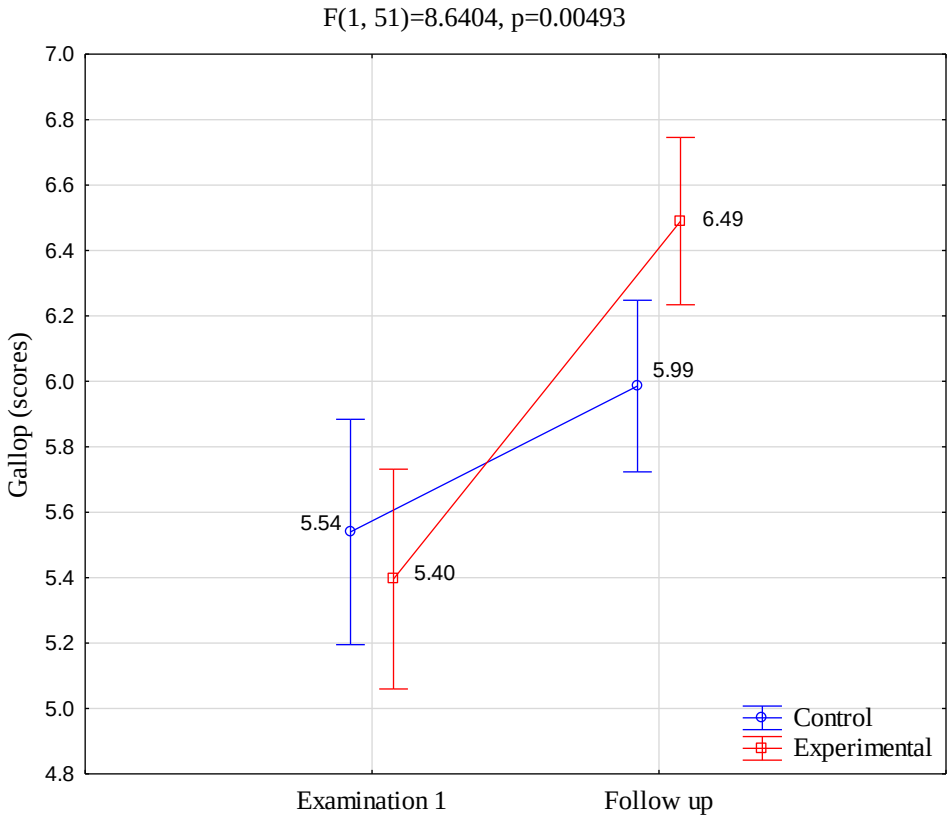


Figure 25. The results of the Gallop skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Gallop skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Gallop skills improved significantly after one school year separately in the experimental group ($p<0.0001$) and the control group ($p=0.030$) (Table 29, Appendix).

The analysis of variance for the repeated measurements in the Gallop skills test showed no significant differences in the level of development of Gallop skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Gallop skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.2154, p=0.6445) (Figure 26). The results of the Post-hoc test showed that there were no significant differences in the Gallop skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 30, Appendix).

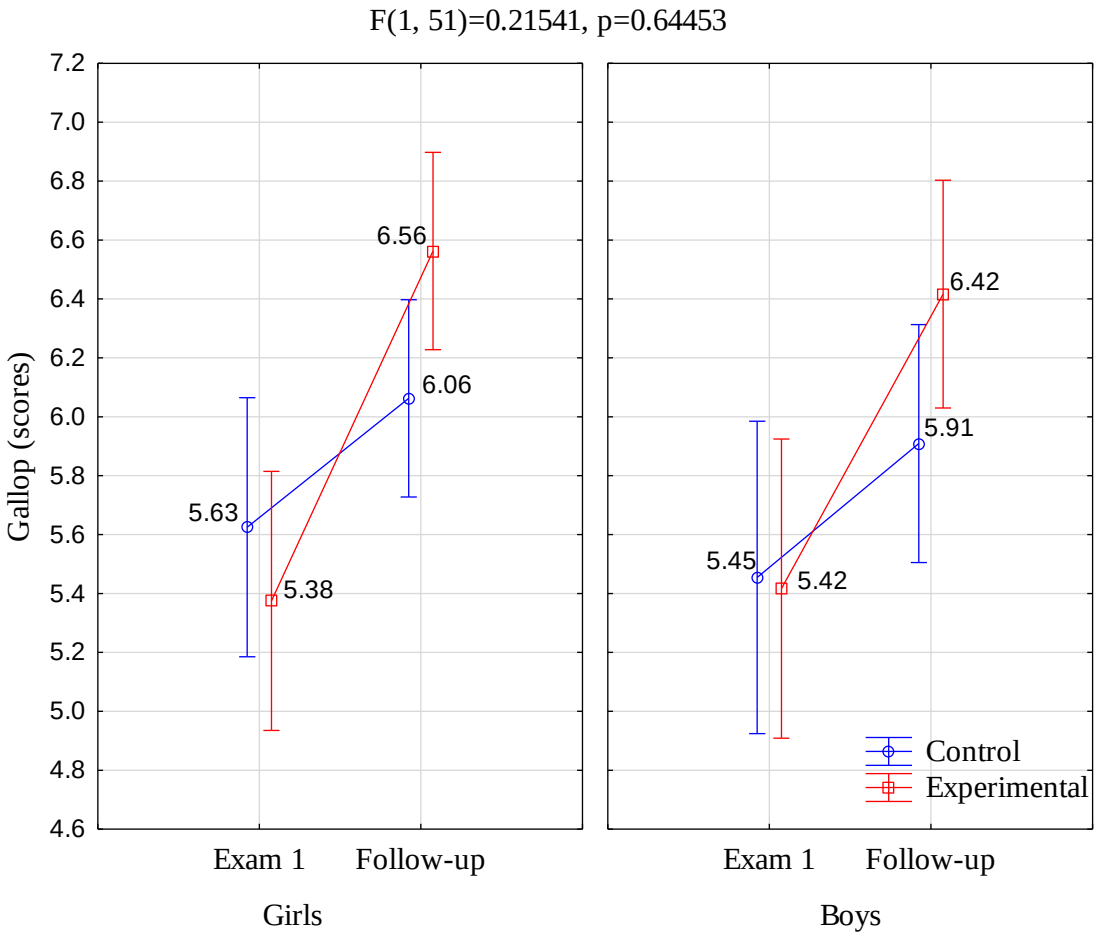


Figure 26. The results of the Gallop skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Hop skills

The analysis of variance for the repeated measurements in the Hop skills test showed no significant differences in the level of development of Hop skills performance between experimental and control groups (F(1, 51)=0.29374, p=0.59020) (Figure 27). The results of the Post-hoc test showed that there were no significant differences in the Hop skills between students from the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 31, 32, Appendix).

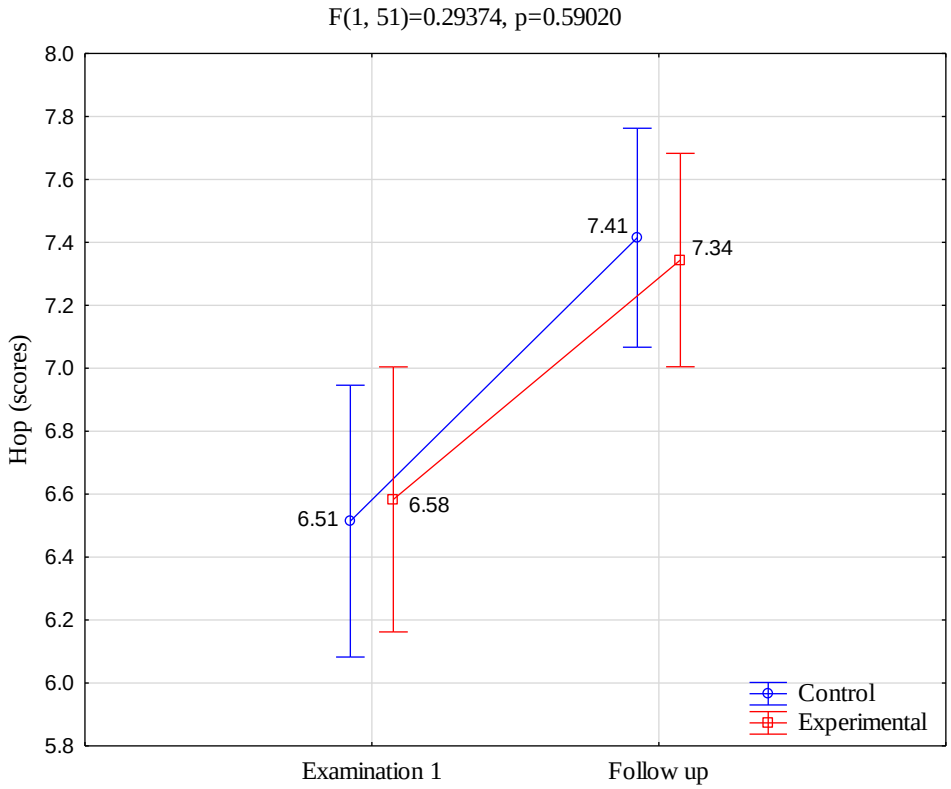


Figure 27. The results of the Hop skills in pupils from the experimental and control groups in the first and follow-up examinations.

Comparing the results obtained on the level of the Hop skills separately in students from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Hop skills improved significantly after one school year separately in the experimental group (p=0.001) and the control group (p<0.0001) (Table 32, Appendix).

The analysis of variance for the repeated measurements in the Hop skills test showed no significant differences in the level of development of Hop skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Hop skills performance between girls from the experimental group and girls from control groups (F(1, 51)=2.2763, p=0.1375) (Figure 28). The results of the Post-hoc test showed that there were no significant differences in the Hop skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 33, Appendix).

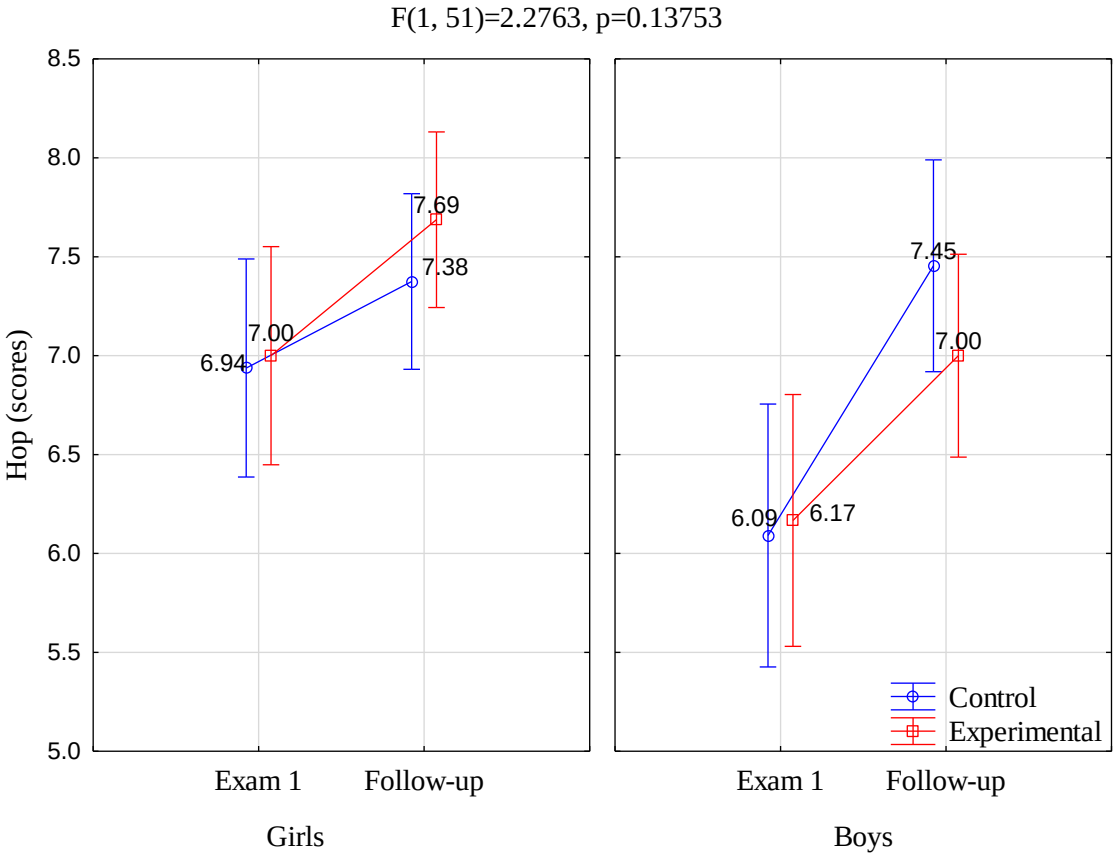


Figure 28. The results of the Hop skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Leap skills

The analysis of variance for the repeated measurements in the Leap skills test showed no significant differences in the level of development of Leap skills performance between experimental and control groups (F(1, 51)=1.9056, p=0.1734) (Figure 29). The results of the Post-hoc test showed that there were no significant differences in the Leap skills between pupils from the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 34, 35, Appendix).

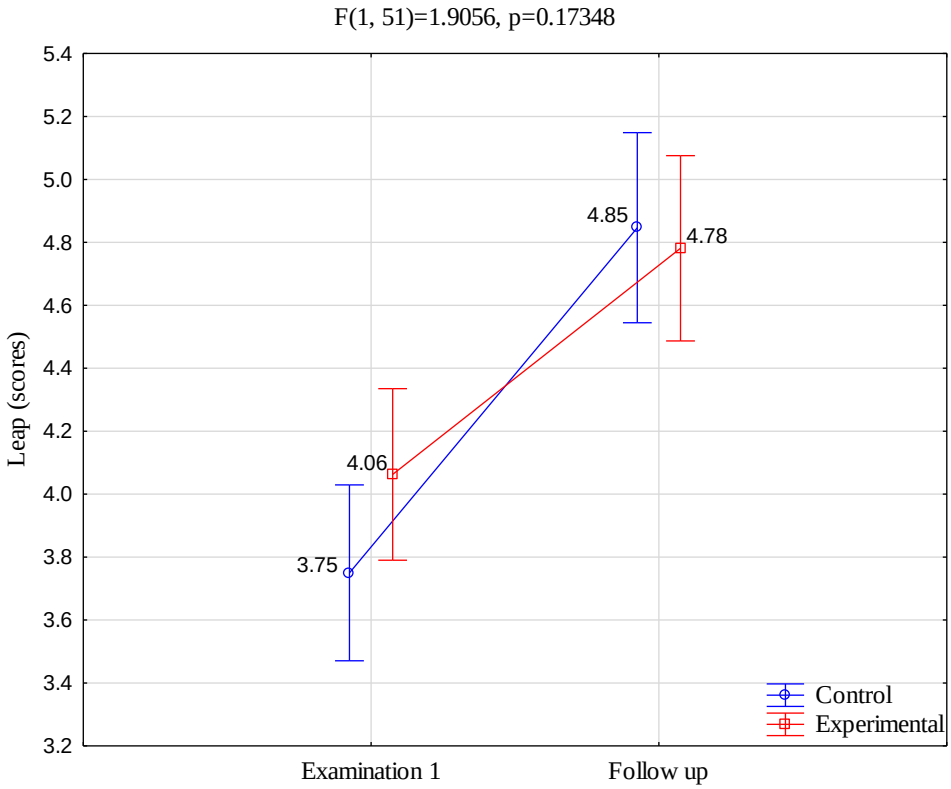


Figure 29. The results of the Leap skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Leap skills separately in students from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Leap skills improved significantly after one school year separately in the experimental group (p=0.002) and the control group (p<0.0001) (Table 35, Appendix).

The analysis of variance for the repeated measurements in the Leap skills test showed no significant differences in the level of development of Leap skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Leap skills performance between girls from the experimental group and girls from control groups (F(1, 51)=1.2799, p=0.2632) (Figure 30). The results of the Post-hoc test showed that there were no significant differences in the Leap skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 36, Appendix).

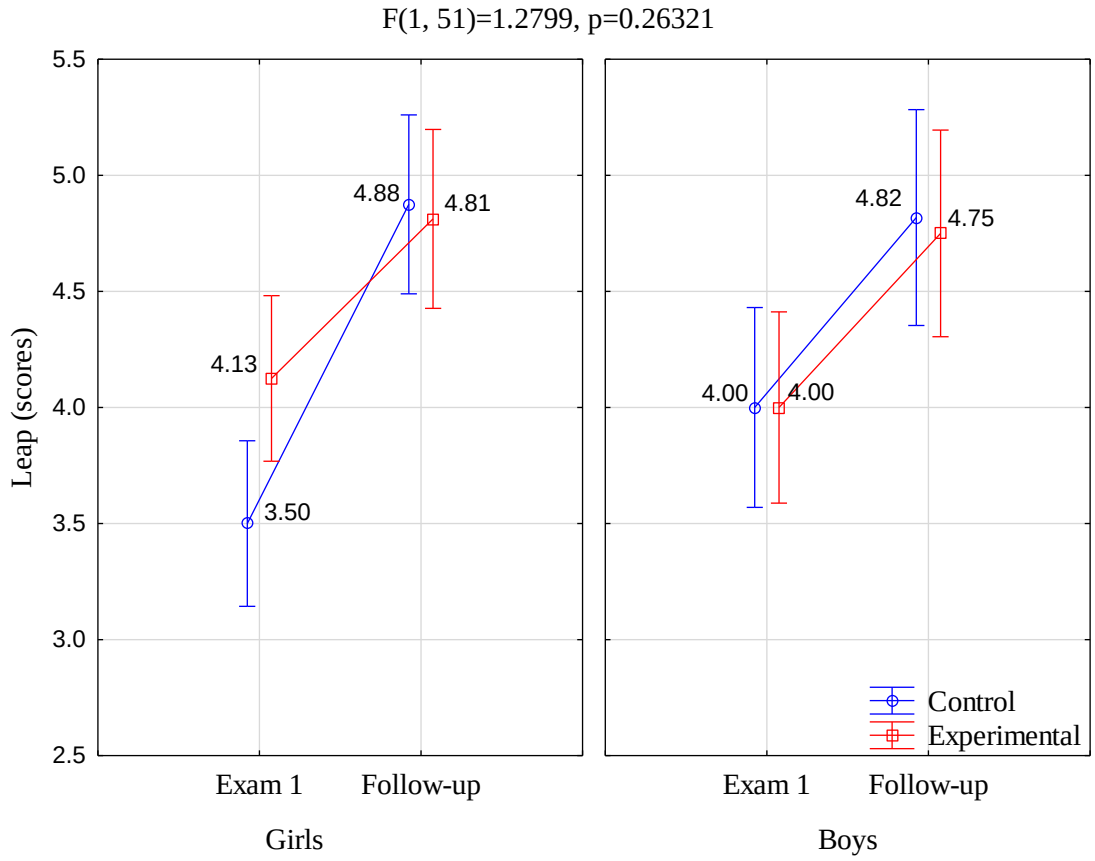


Figure 30. The results of the Leap skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Jump skills

The analysis of variance for the repeated measurements in the Jump skills test showed no significant differences in the level of development of Jump skills performance between experimental and control groups (F(1, 51)=0.4324, p=0.5137) (Figure 31). The results of the Post-hoc test showed that there were no significant differences in the Jump skills between pupils from the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 37, 38, Appendix).

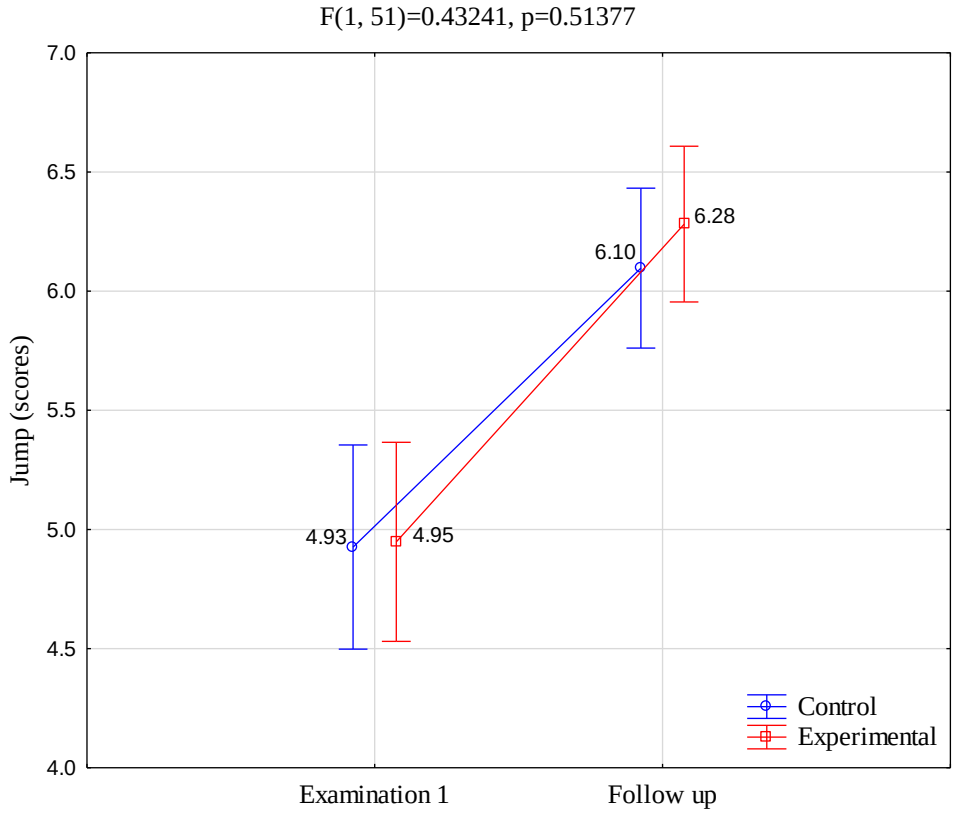


Figure 31. The results of the Jump skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Jump skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Leap skills improved significantly after one school year separately in the experimental group (p<0.0001) and the control group (p<0.0001) (Table 38, Appendix).

The analysis of variance for the repeated measurements in the Jump skills test showed no significant differences in the level of development of Jump skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Jump skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.4324, p=0.5137) (Figure 32). The results of the Post-hoc test showed that there were no significant differences in the Jump skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 39, Appendix).

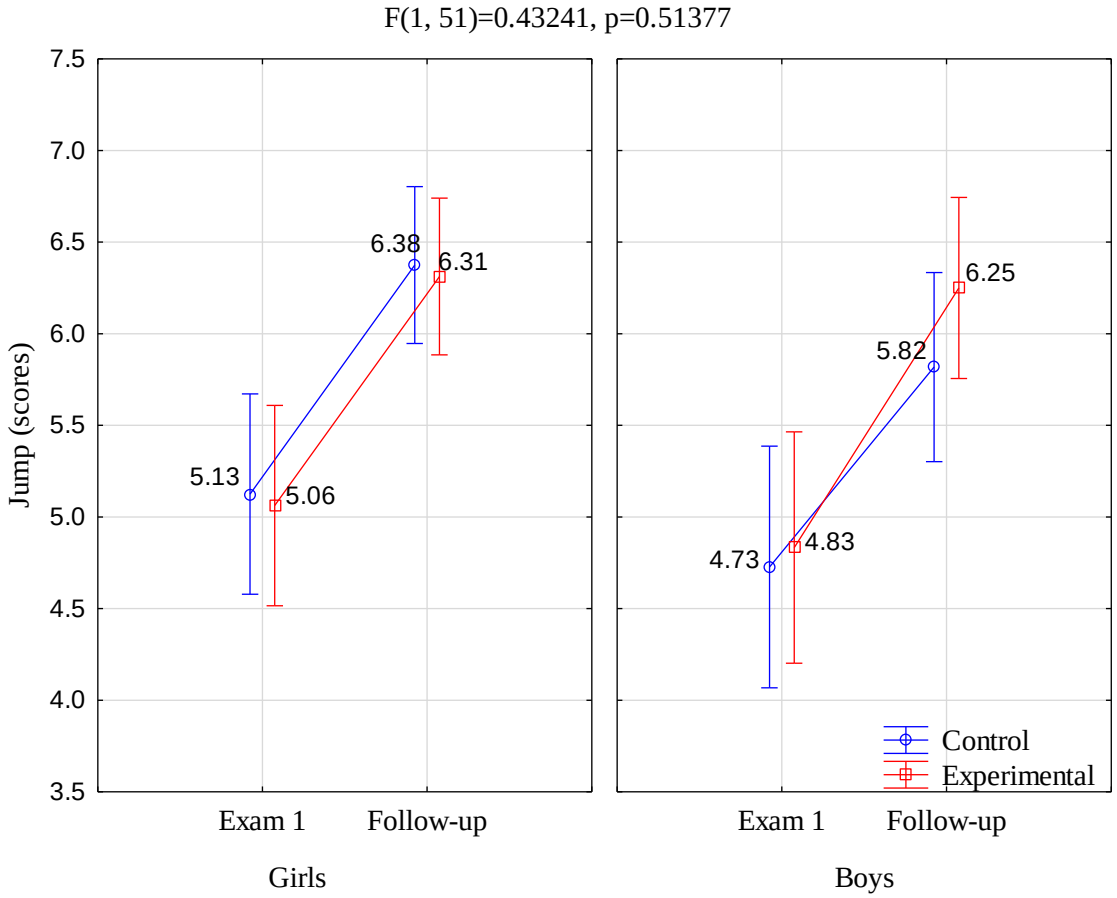


Figure 32. The results of the Jump skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Slide skills

The results of the analysis of variance for the repeated measurements in the Slide skills test showed that the level of the Slide skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(1, 51)=7.2742$, $p=0.0094$) (Figure 33). However, the results of the Post-hoc test showed that there were no significant differences in the Slide skills between pupils from the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 40, 41, Appendix).

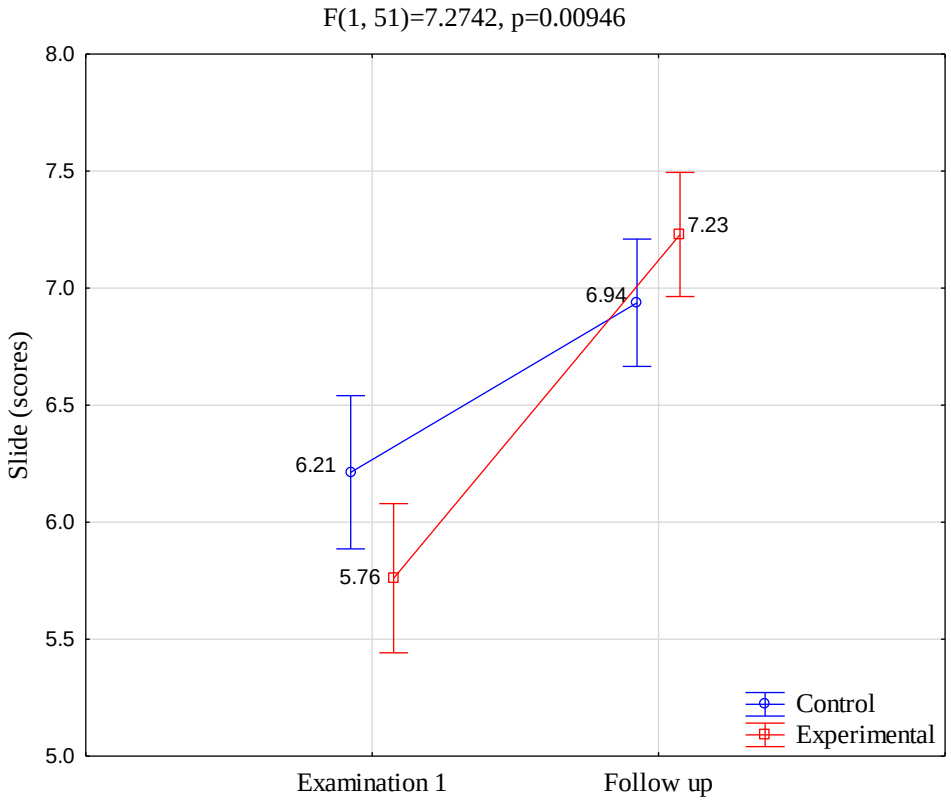


Figure 33. The results of the Slide skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Slide skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Slide skills improved significantly after one school year separately in the experimental group ($p<0.0001$) and the control group ($p=0.002$) (Table 41, Appendix).

The analysis of variance for the repeated measurements in the Slide skills test showed no significant differences in the level of development of Slide skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Slide skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.1869, p=0.6673) (Figure 34). The results of the Post-hoc test showed that there were no significant differences in the Slide skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 42, Appendix).

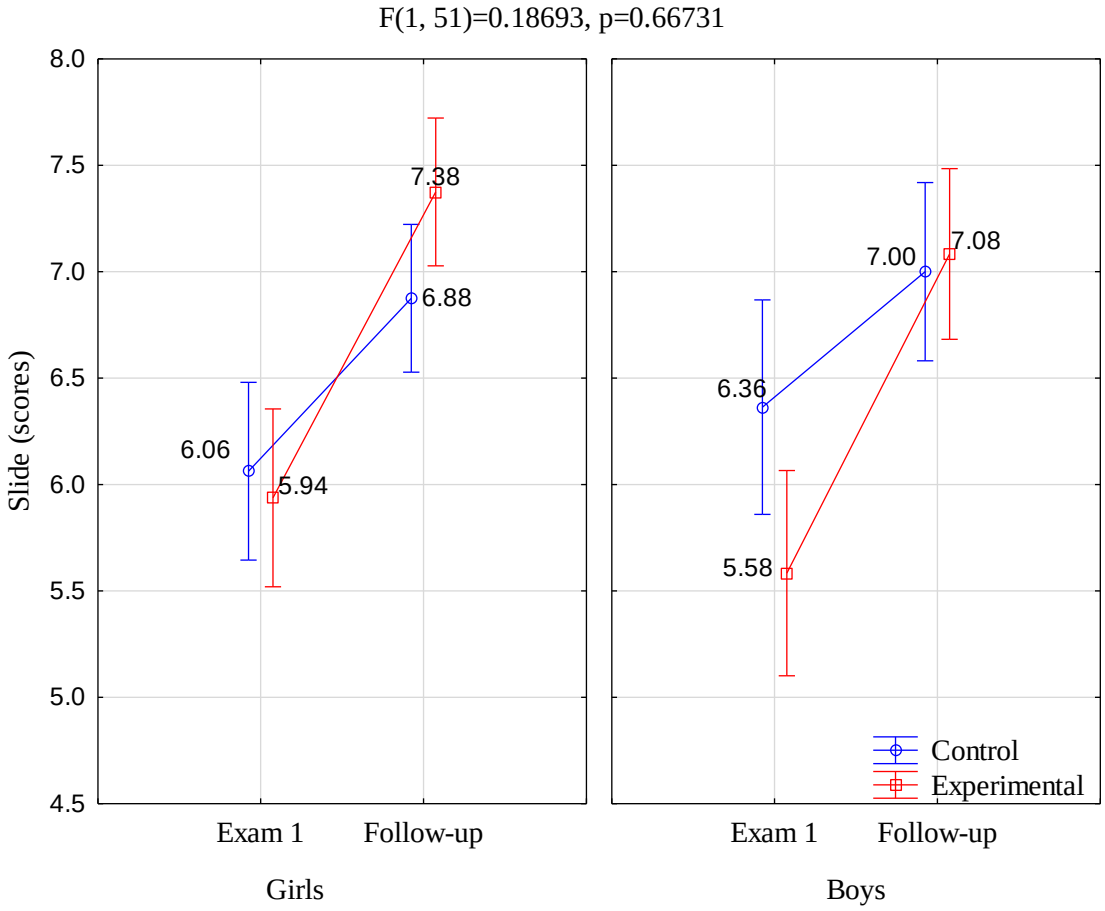


Figure 34. The results of the Slide skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Locomotor skills

The results of the analysis of variance for the repeated measurements in the Locomotor skills test showed that the level of the Locomotor skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(1, 51)=14.142$, $p=0.0004$) (Figure 35). However, the results of the Post-hoc test showed that there were no significant differences in the Locomotor skills between pupils from the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 43, 44, Appendix).

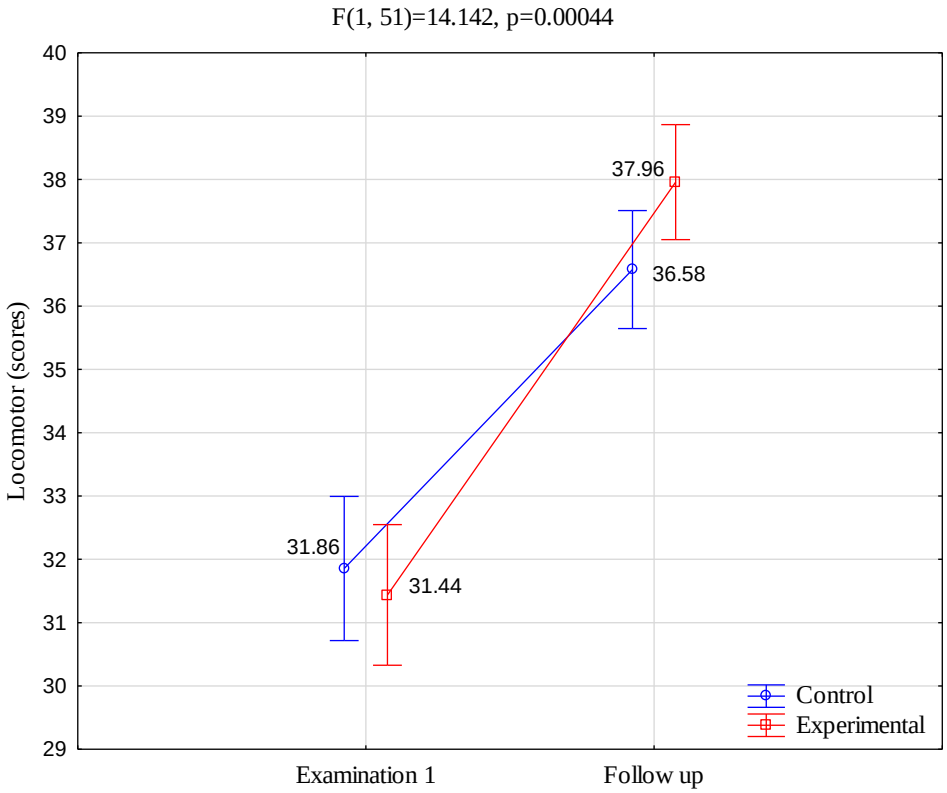


Figure 35. The results of the Locomotor skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Locomotor skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Locomotor skills improved significantly after one school year separately in the experimental group ($p<0.0001$) and the control group ($p<0.0001$) (Table 44, Appendix).

The analysis of variance for the repeated measurements in the Locomotor skills test showed no significant differences in the level of development of Locomotor skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Locomotor skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.17607, p=0.6765) (Figure 36). The results of the Post-hoc test showed that there were no significant differences in the Locomotor skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 45, Appendix).

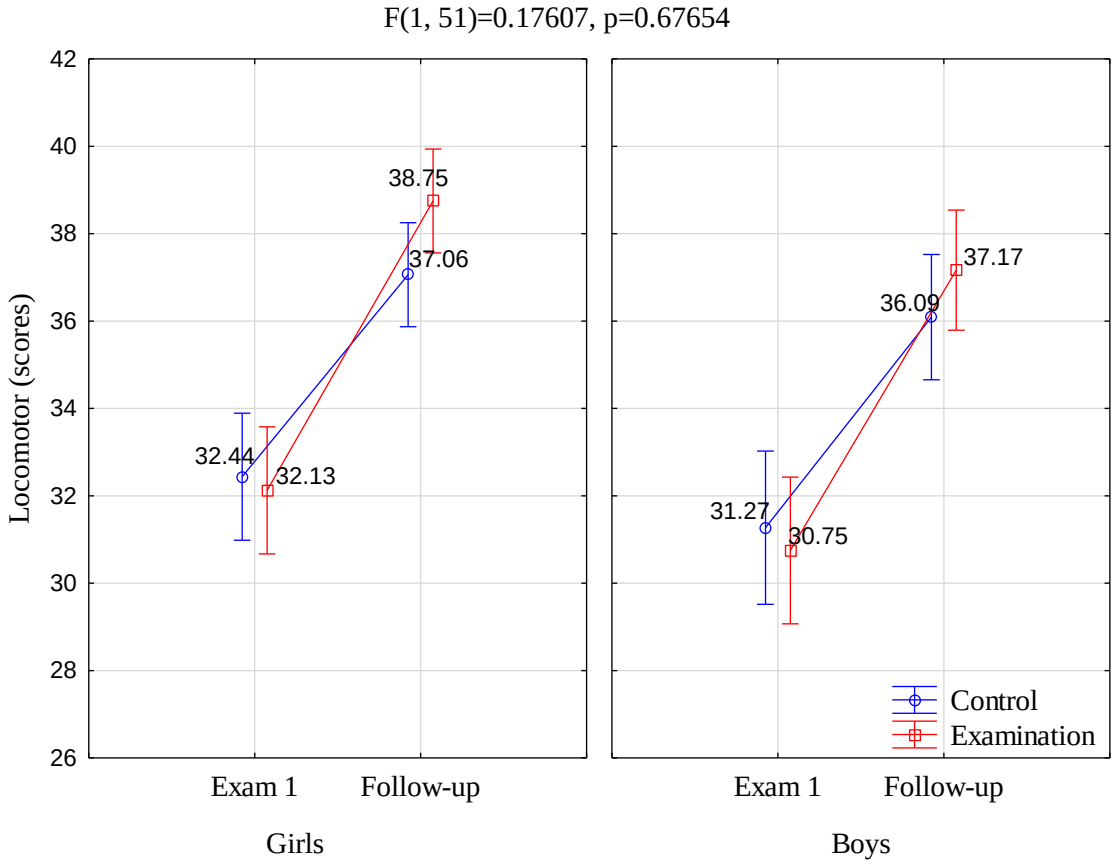


Figure 36. The results of the Locomotor skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Strike skills

The results of the analysis of variance for the repeated measurements in the Strike skills test showed that the level of the Strike skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(1, 51)=10.086$, $p=0.0025$) (Figure 37). However, the results of the Post-hoc test showed that there were no significant differences in the Strike skills between pupils from the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 46, 47, Appendix).

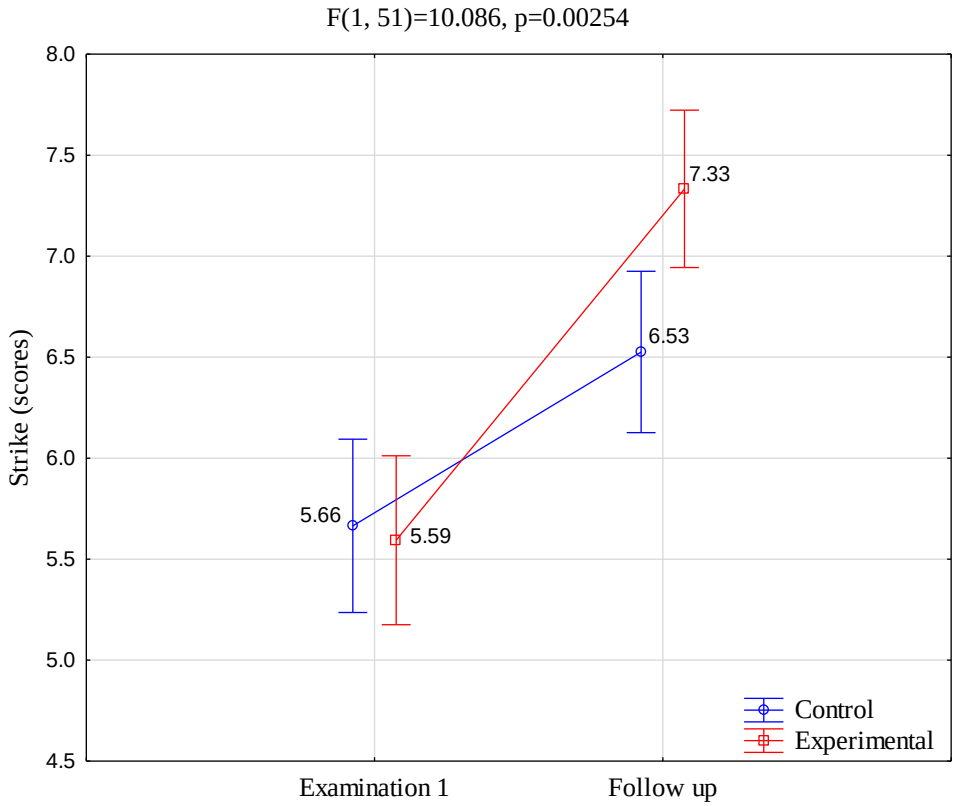


Figure 37. The results of the Strike skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Strike skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Strike skills improved significantly after one school year separately in the experimental group ($p<0.0001$) and the control group ($p<0.0001$) (Table 47, Appendix).

The analysis of variance for the repeated measurements in the Strike skills test showed no significant differences in the level of development of Strike skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Strike skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.2166, p=0.6436) (Figure 38). The results of the Post-hoc test showed that there were no significant differences in the Strike skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 48, Appendix).

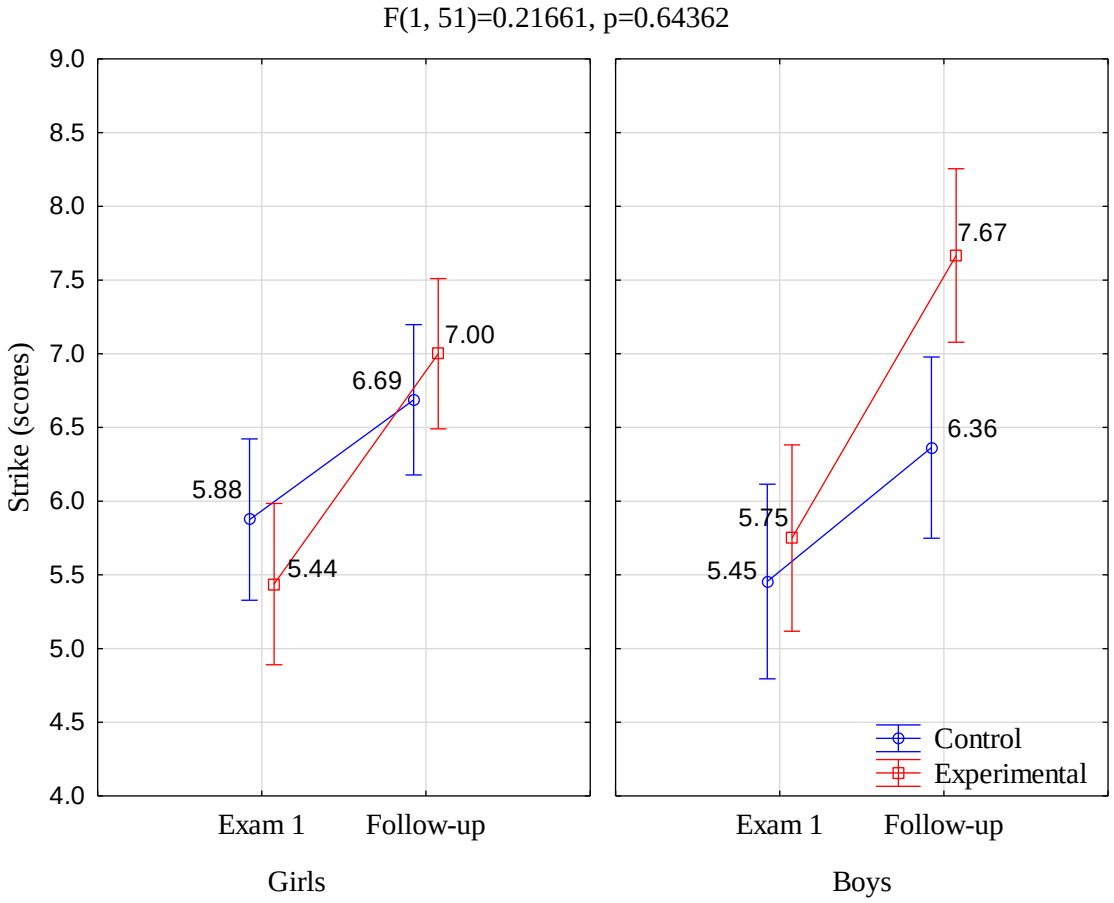


Figure 38. The results of the Strike skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Dribble skills

The analysis of variance for the repeated measurements in the Dribble skills test showed no significant differences in the level of development of Dribble skills performance between experimental and control groups (F(1, 51)=0.0232, p=0.8793) (Figure 39). The results of the Post-hoc test showed that there were no significant differences in the Dribble skills between pupils from the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 49, 50, Appendix).

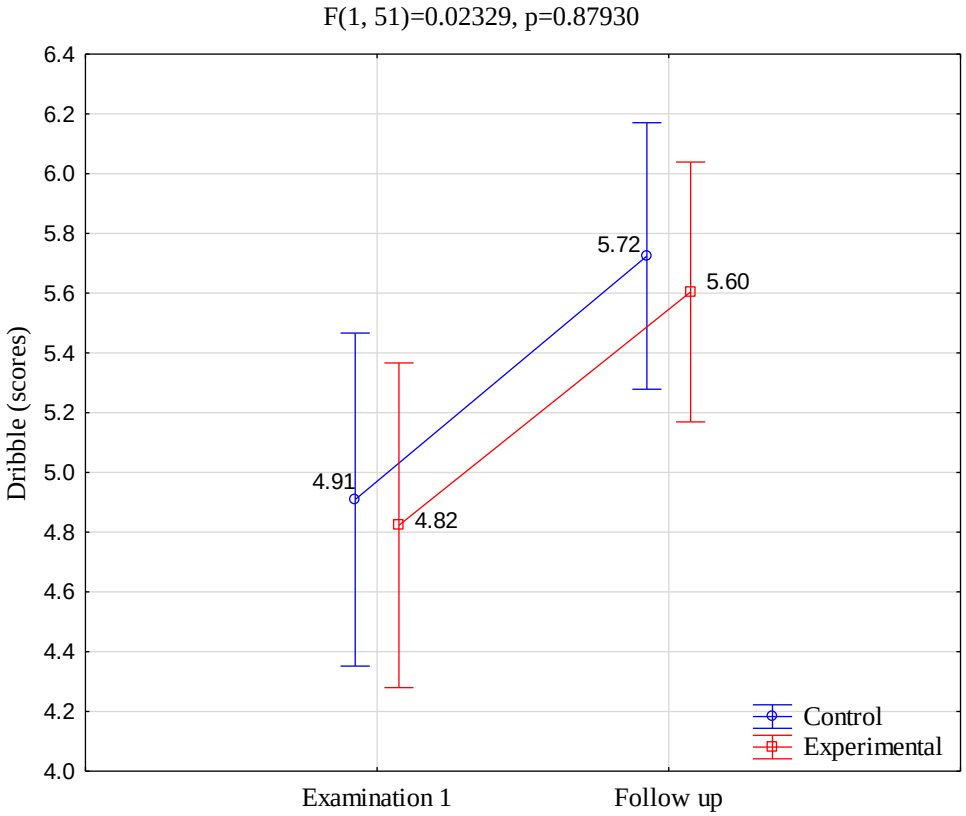


Figure 39. The results of the Dribble skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Dribble skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Dribble skills improved significantly after one school year separately in the experimental group (p<0.0001) and the control group (p<0.0001) (Table 50, Appendix).

The analysis of variance for the repeated measurements in the Dribble skills test showed no significant differences in the level of development of Dribble skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Dribble skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.9343, p=0.3382) (Figure 40). The results of the Post-hoc test showed that there were no significant differences in the Dribble skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 51, Appendix).

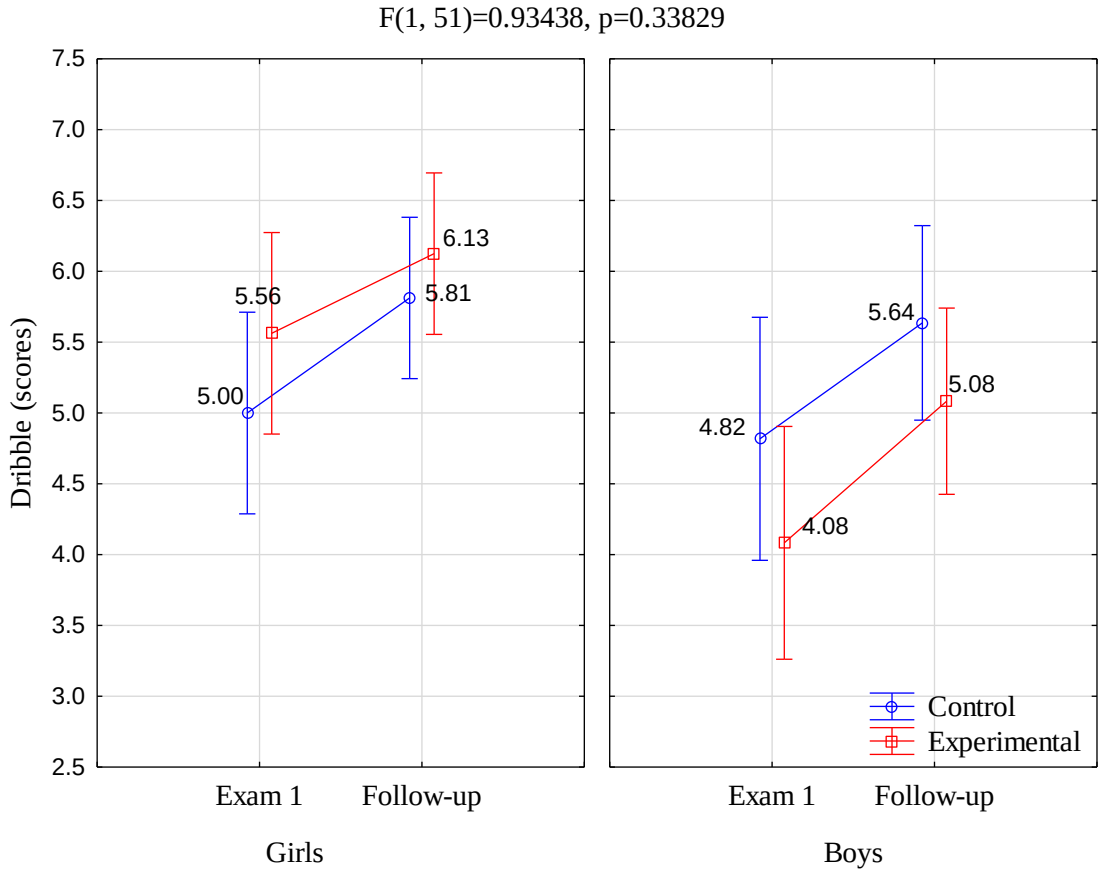


Figure 40. The results of the Dribble skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Catch skill

The analysis of variance for the repeated measurements in the Catch skills test showed no significant differences in the level of development of Catch skills performance between experimental and control groups (F(1, 51)=0.4779, p=0.4925) (Figure 41). The results of the Post-hoc test showed that there were no significant differences in the Catch skills between pupils from the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 52, 53, Appendix).

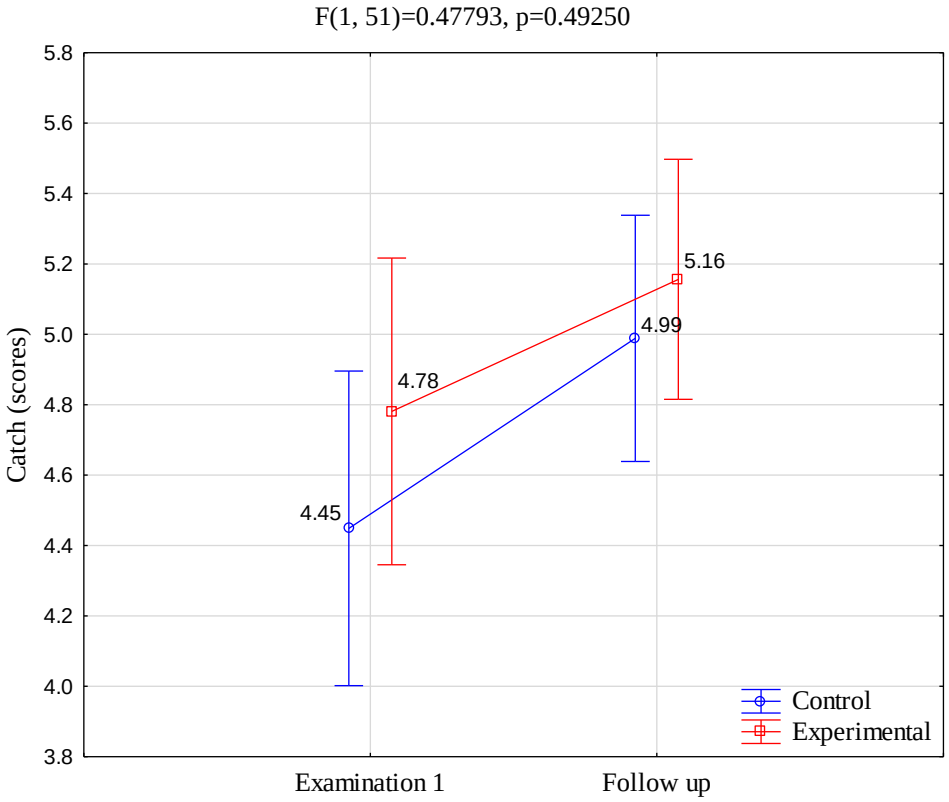


Figure 41. The results of the Catch skill in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Catch skills in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the pupils from the control group significantly improved the level of Catch skills after one school year (p=0.009). In comparison, the pupils from the experimental group did not significantly improve the level of catching skills after one school year (p>0.05) (Table 53, Appendix).

The analysis of variance for the repeated measurements in the Catch skills test showed no significant differences in the level of development of Catch skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Catch skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.0278, p=0.8681) (Figure 42). The results of the Post-hoc test showed that there were no significant differences in the Catch skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 54, Appendix).

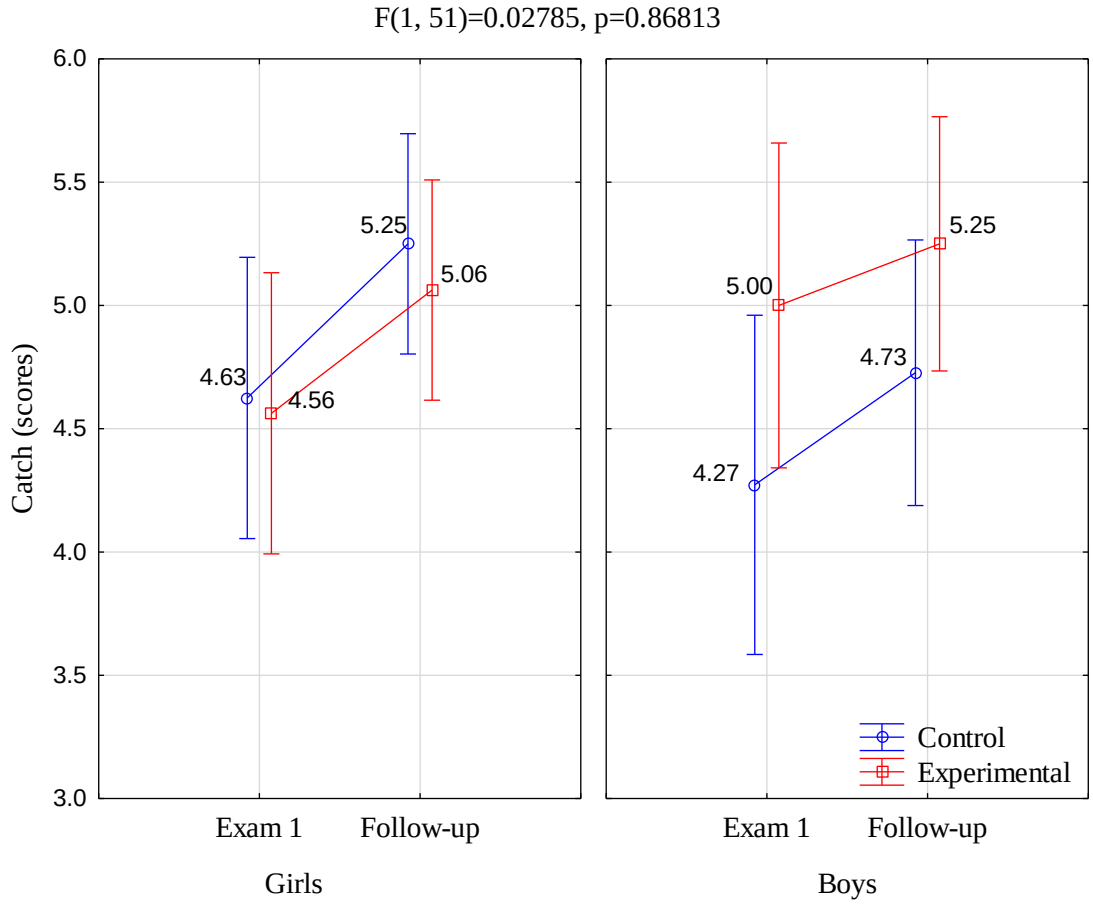


Figure 42. The results of the Catch skill in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Kick skill

The results of the analysis of variance for the repeated measurements in the Kick skills test showed that the level of the Kick skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(1, 51)=5.0719$, $p=0.0286$) (Figure 43). However, the results of the Post-hoc test showed that there were no significant differences in the Kick skills between pupils from the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 55, 56, Appendix).

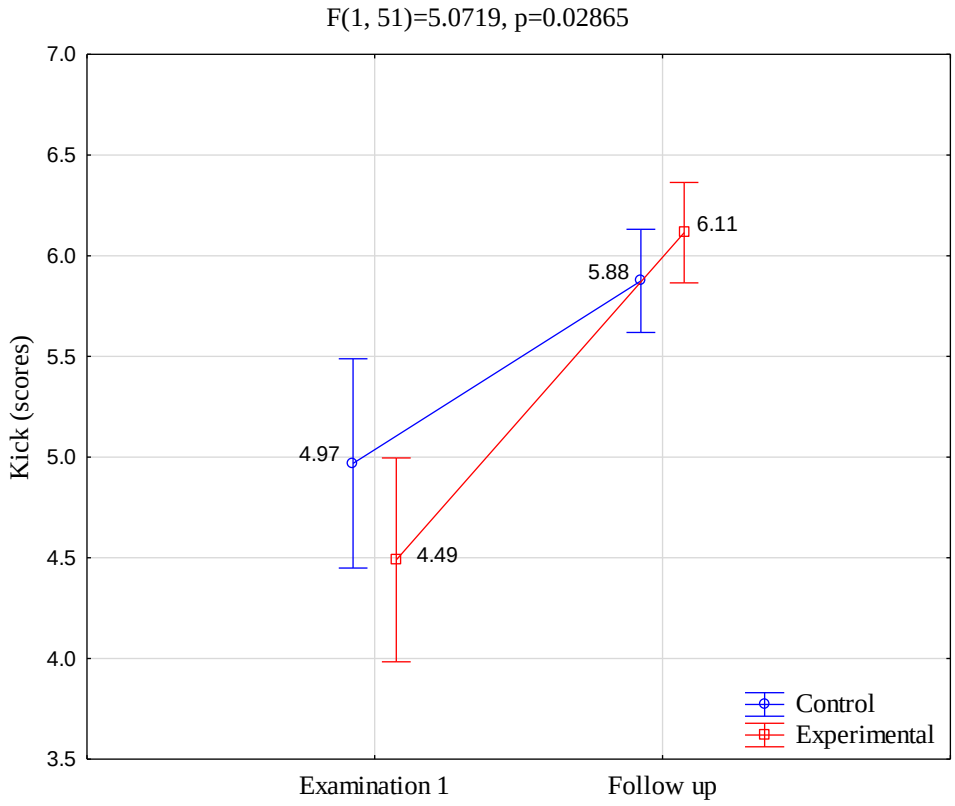


Figure 43. The results of the Kick skill in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Kick skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Kick skills improved significantly after one school year separately in the experimental group ($p<0.0001$) and the control group ($p=0.001$) (Table 56, Appendix).

The analysis of variance for the repeated measurements in the Kick skills test showed no significant differences in the level of development of Kick skills performance between boys from the experimental group and boys from the control group. However, the Kick skills of girls from the experimental group after one school year improved significantly compared to girls from the control group (F(1, 51)=5.0719, p=0.0286) (Figure 44). The results of the Post-hoc test showed that there were no significant differences in the Kick skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 57, Appendix).

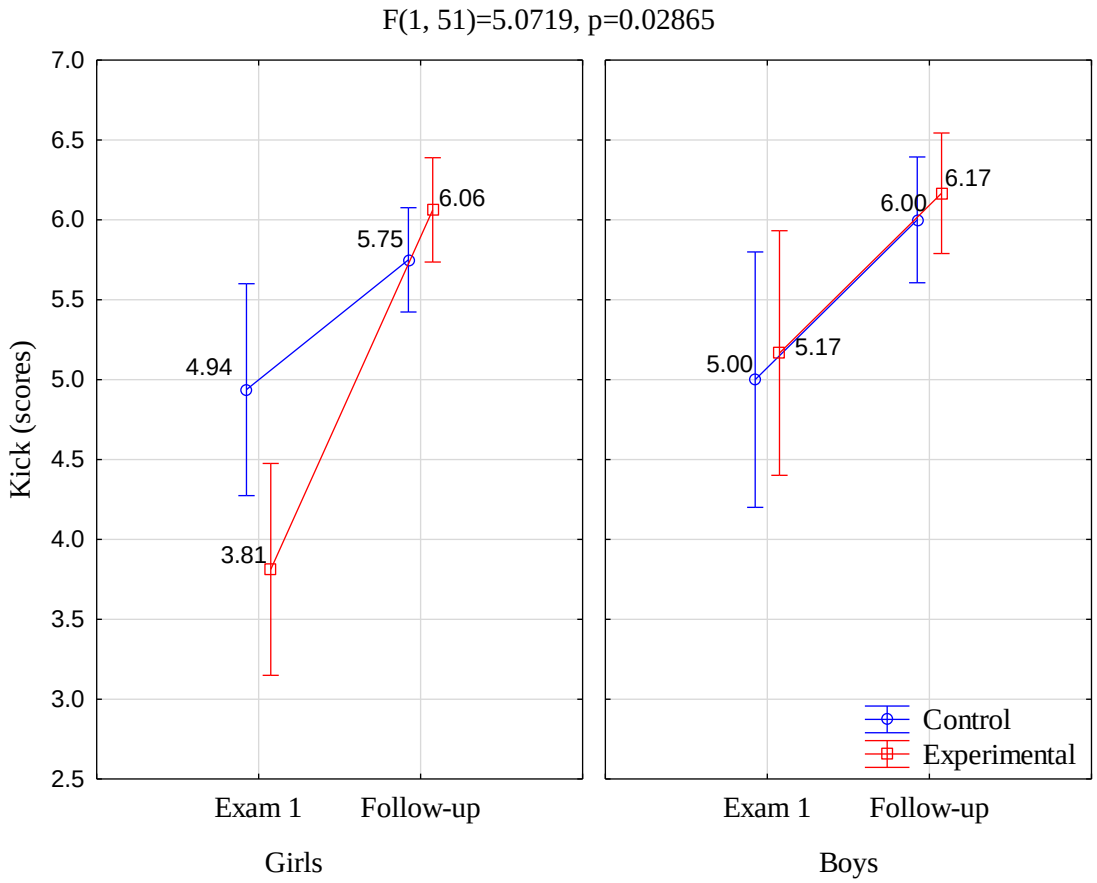


Figure 44. The results of the kick skill in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Throw skills

The analysis of variance for the repeated measurements in the Throw skills test showed no significant differences in the level of development of Throw skills performance between experimental and control groups (F(1, 51)=0.0840, p=0.7730) (Figure 45). The results of the Post-hoc test showed that there were no significant differences in the Throw skills between pupils from the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 58, 59, Appendix).

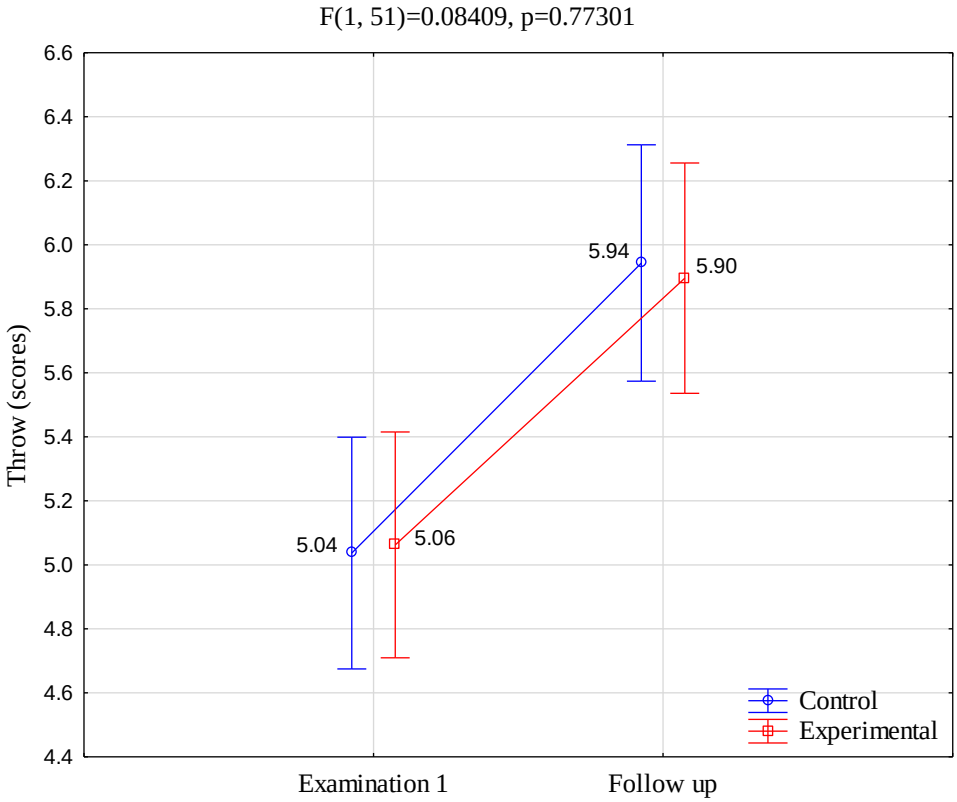


Figure 45. The results of the Throw skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Throw skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Throw skills improved significantly after one school year separately in the experimental group (p<0.0001) and the control group (p=0.001) (Table 59, Appendix).

The analysis of variance for the repeated measurements in the Throw skills test showed no significant differences in the level of development of Throw skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Throw skills performance between girls from the experimental group and girls from control groups (F(1, 51)=1.0726, p=0.3052) (Figure 46). The results of the Post-hoc test showed that there were no significant differences in the Throw skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 60, Appendix).

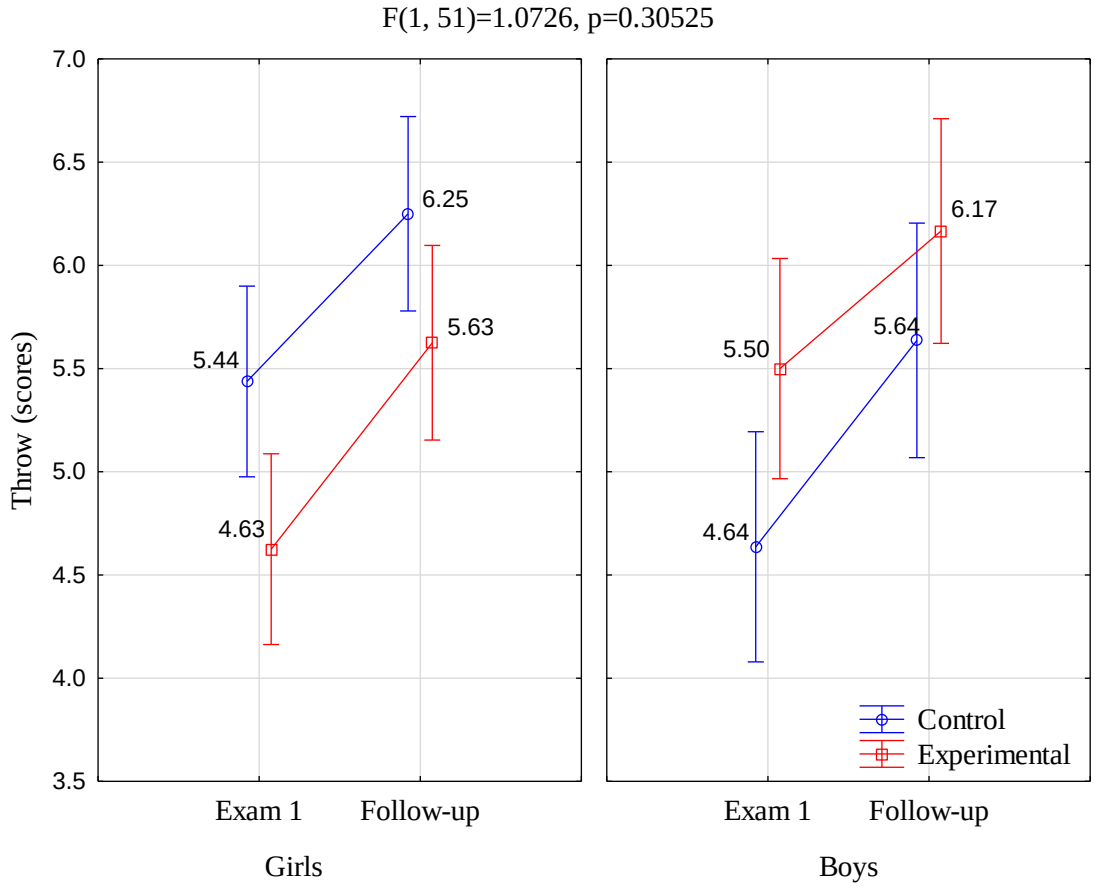


Figure 46. The results of the Throw skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Roll skills

The results of the analysis of variance for the repeated measurements in the Roll skills test showed that the level of the Roll skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group ($F(1, 51)=5.7919$, $p=0.0197$) (Figure 47). However, the results of the Post-hoc test showed that there were no significant differences in the Roll skills between pupils from the experimental group and the control group at the first and follow-up examinations ($p>0.05$) (Tables 61, 62, Appendix).

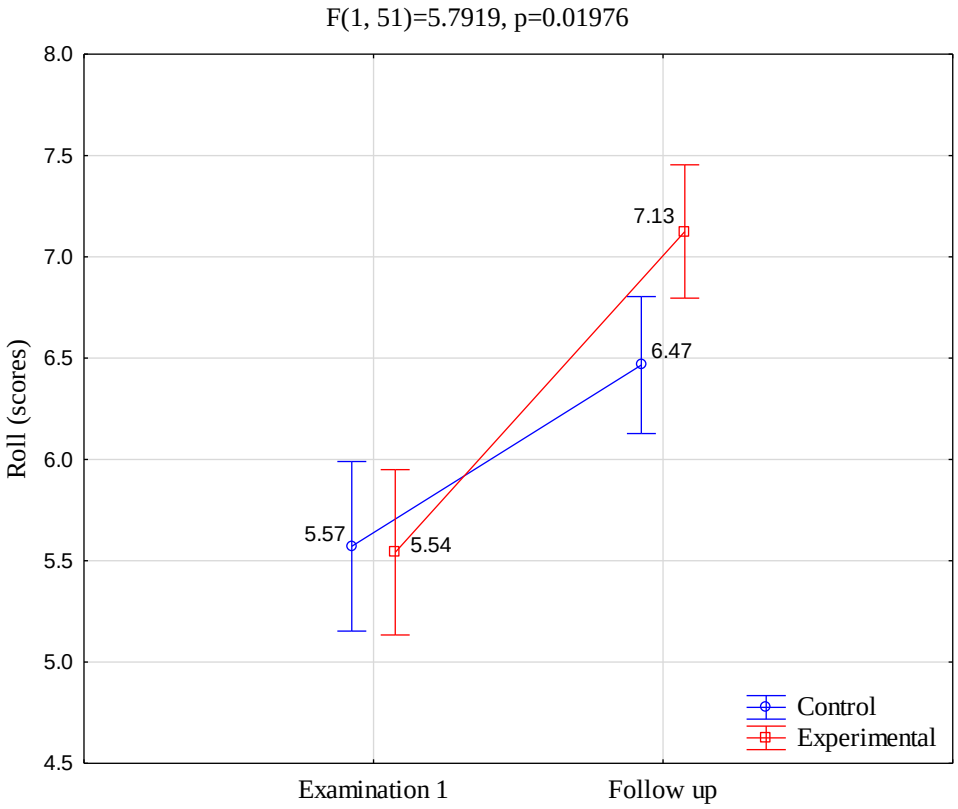


Figure 47. The results of the Roll skill in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Roll skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Roll skills improved significantly after one school year separately in the experimental group ($p<0.0001$) and the control group ($p=0.001$) (Table 62, Appendix).

The analysis of variance for the repeated measurements in the Roll skills test showed no significant differences in the level of development of Roll skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Roll skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.7695, p=0.3844) (Figure 48). The results of the Post-hoc test showed that there were no significant differences in the Roll skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 63, Appendix).

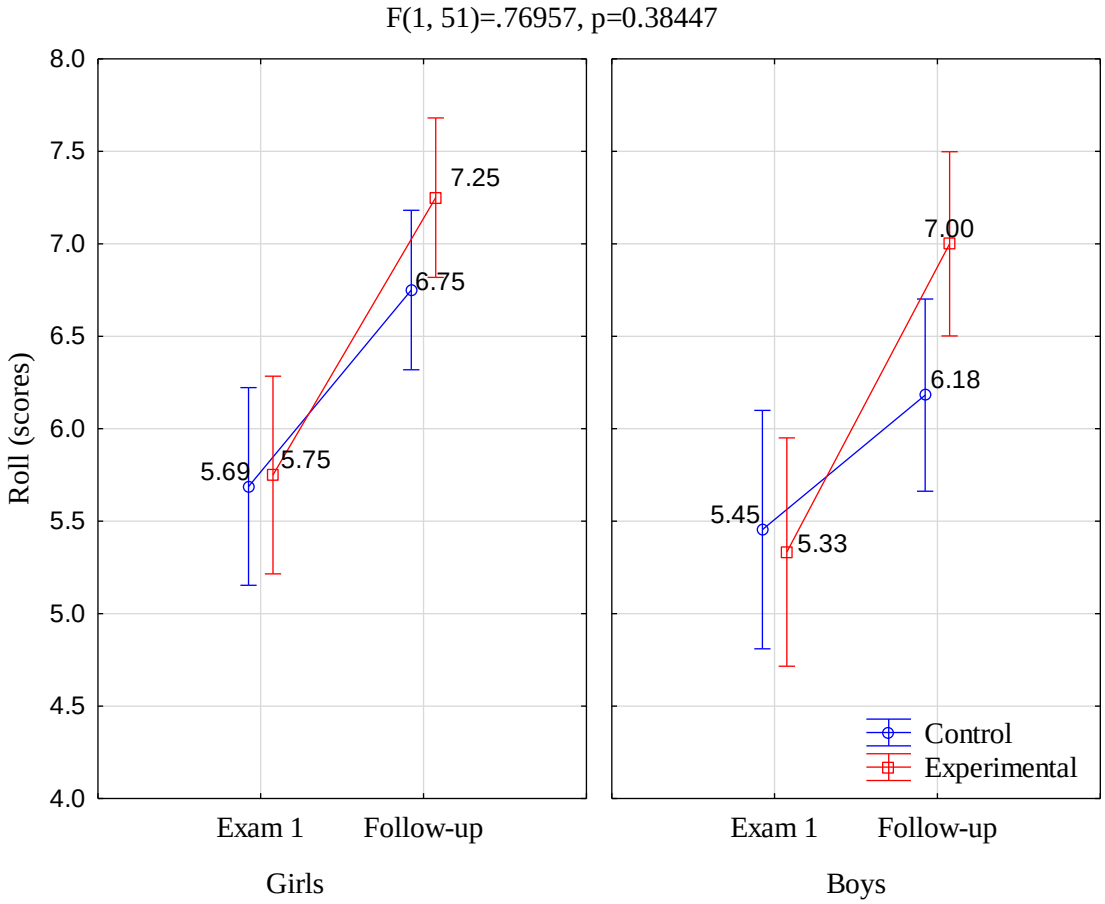


Figure 48. The results of the Roll skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Object control skills

The results of the analysis of variance for the repeated measurements in the Object control skills test showed that the level of the Object control skills of pupils from the experimental group after one school year improved significantly compared to pupils from the control group (F(1, 51)=19.127, p=0.00006) (Figure 49). However, the results of the Post-hoc test showed that there were no significant differences in the Object control skills between pupils from the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 64, 65, Appendix).

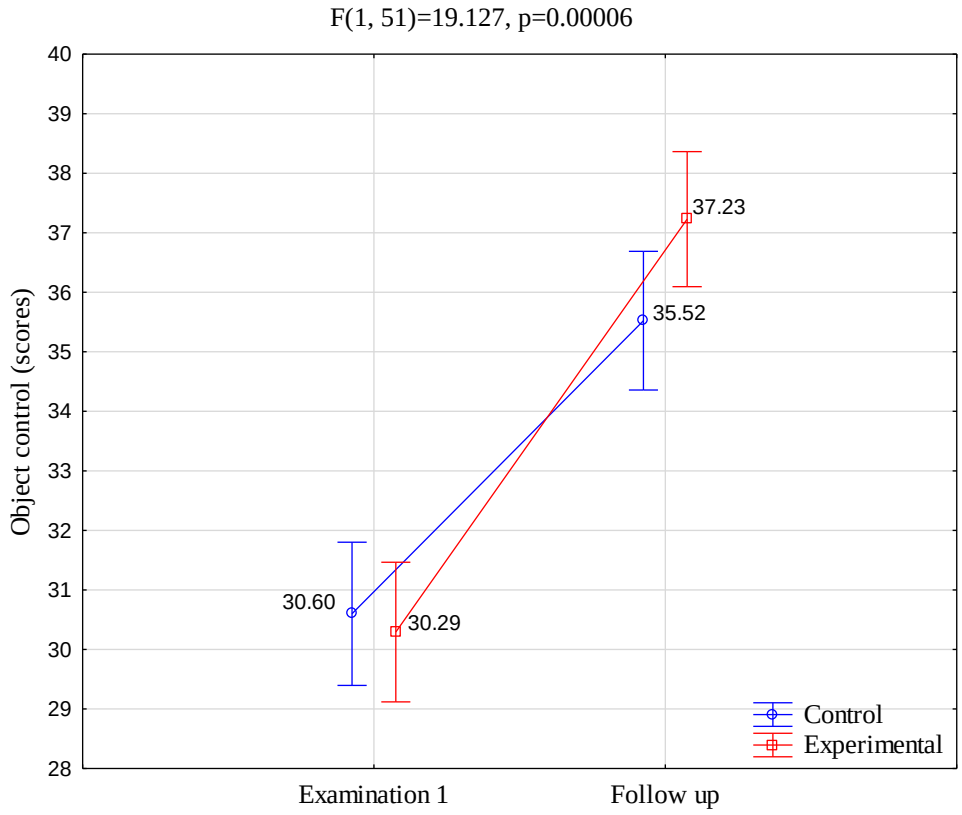


Figure 49. The results of the Object control skills in pupils from the experimental and control groups in the first and follow-up examinations

Comparing the results obtained on the level of the Object control skills separately in pupils from experimental and control groups at the first and follow-up examinations, the results showed that the level of the Object control skills improved significantly after one school year separately in the experimental group (p<0.0001) and the control group (p<0.0001) (Table 65, Appendix).

The analysis of variance for the repeated measurements in the Object control skills test showed no significant differences in the level of development of Object control skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Object control skills performance between girls from the experimental group and girls from control groups (F(1, 51)=0.8447, p=0.3623) (Figure 50). The results of the Post-hoc test showed that there were no significant differences in the Object control skills of 7-year-old boys and girls between the experimental group and the control group at the first and follow-up examinations (p>0.05) (Tables 66, Appendix).

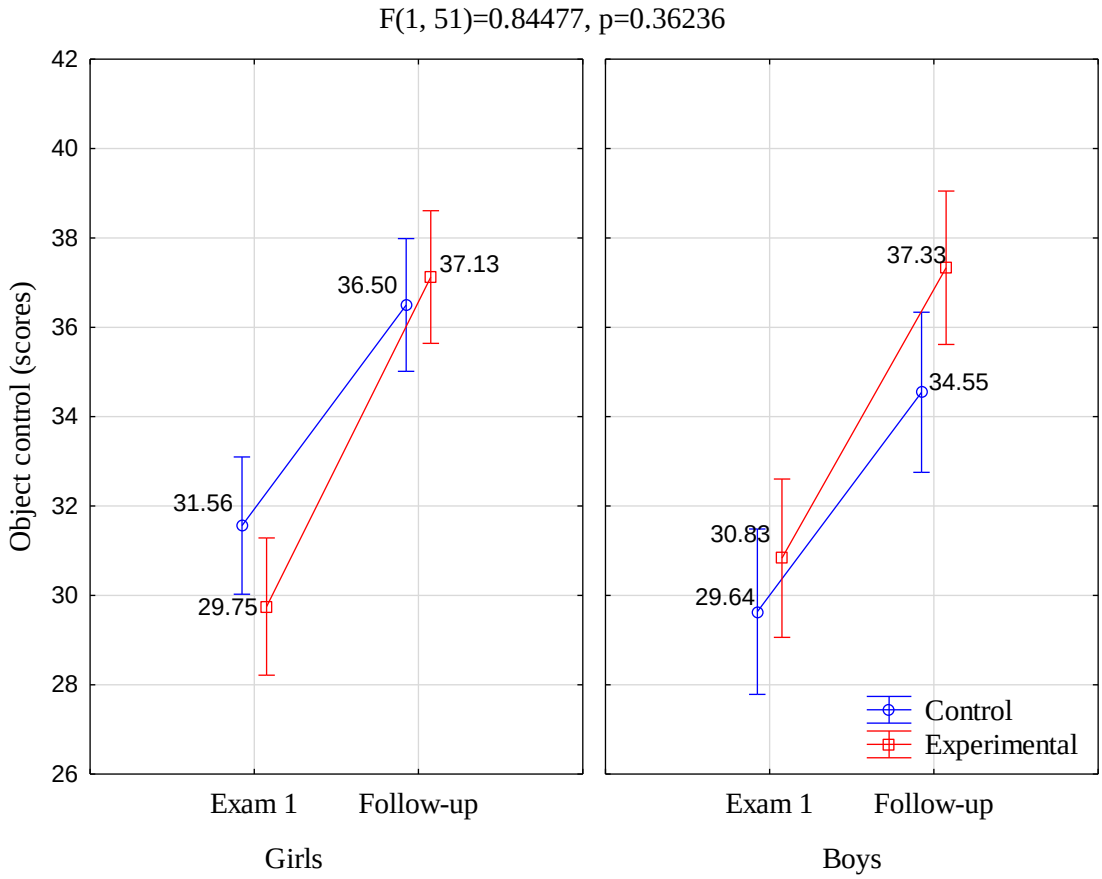


Figure 50. The results of the Object control skills in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

5.3. Math level of pupils from experimental and control groups in first, second, and follow-up examinations

The results of the analysis of variance for the repeated measurements in the Math skills test showed that the level of the Math skills of pupils from the experimental group after one school year improved significantly compared to students from the control group ($F(2, 102)=6.0870$, $p=0.0031$) (Figure 51). However, the results of the Post-hoc test showed that there were no significant differences in the Math skills between pupils from the experimental group and the control group at the first, second, and follow-up examinations ($p>0.05$) (Tables 67, 68, Appendix).

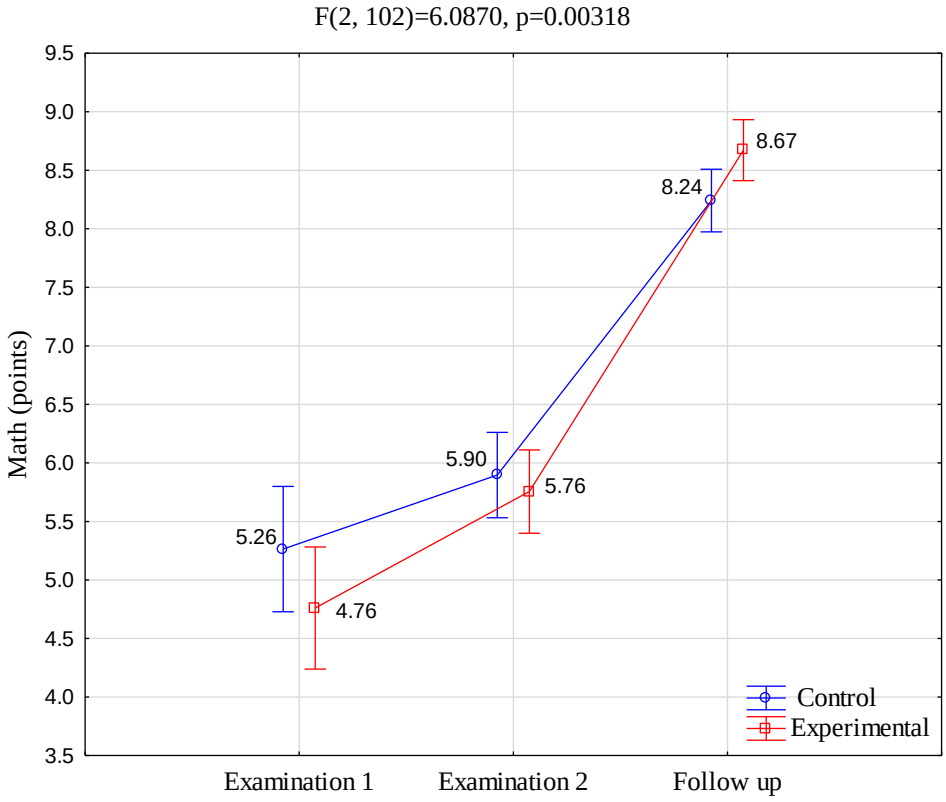


Figure 51. The results of the Math skills in pupils from the experimental and control groups in the first, second, and follow-up examinations

Comparing the results obtained on the level of the Math skills in pupils from experimental and control groups at the first, second, and follow-up examinations, the results showed that the level of the Math skills improved significantly after 20 weeks of intervention separately in the experimental group ($p<0.0001$), and in the control group

(p=0.012), and also after eight months at the follow-up examination, separately in the experimental group (p<0.0001) and the control group (p<0.0001) (Table 68, Appendix)

The analysis of variance for the repeated measurements in the Math skills test showed no significant differences in the level of development of Math skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of Math skills between girls from the experimental group and girls from control groups (F(2, 102)=0.2431, p=0.7846) (Figure 52). The results of the Post hoc test showed that there were no significant differences in the Math skills of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations (p>0.05) (Tables 69, Appendix).

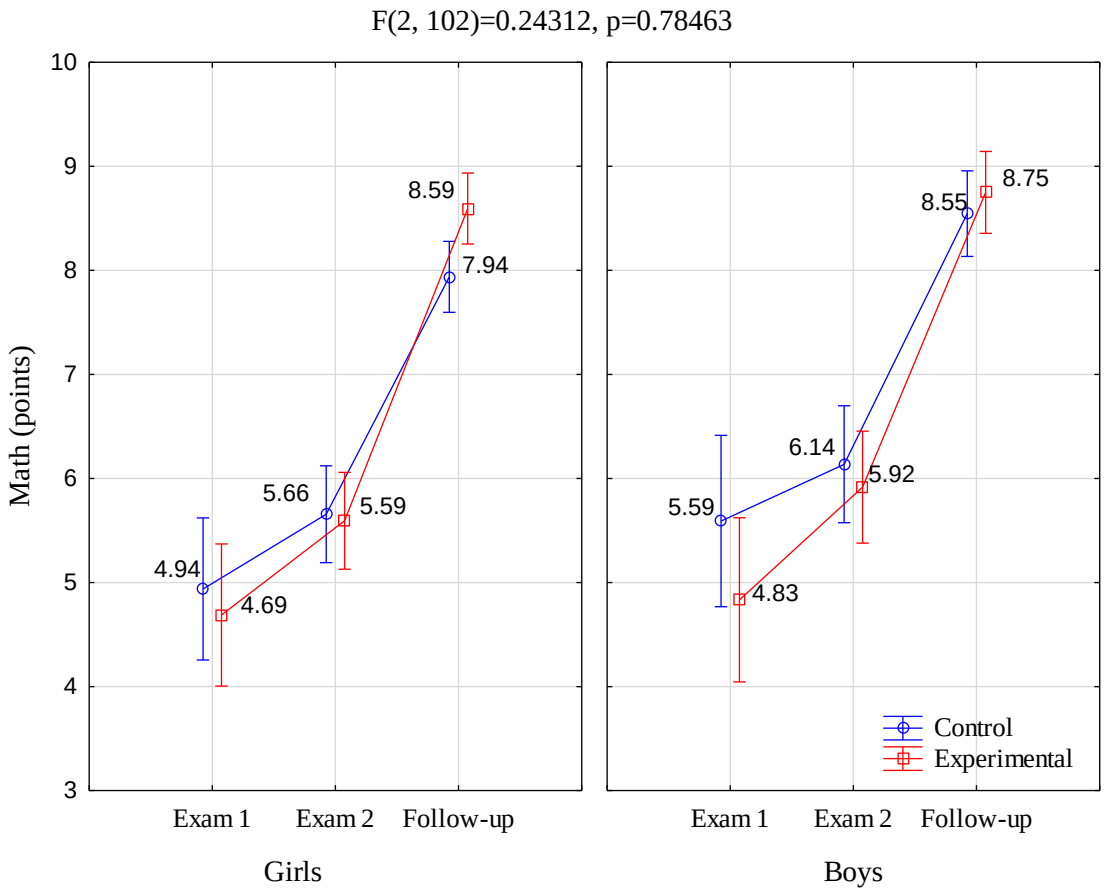


Figure 52. The results of the Math skills in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

5.4. English level of pupils from experimental and control groups in the first, second, and follow-up examinations

The results of the analysis of variance for the repeated measurements in the English skills test showed that the level of the English skills of pupils from the experimental group after one school year improved significantly compared to students from the control group ($F(2, 102)=5.4336$, $p=0.0057$) (Figure 53). However, the results of the Post-hoc test showed that there were no significant differences in the English skills between students from the experimental group and the control group at the first, second, and follow-up examinations ($p>0.05$) (Tables 70, 71, Appendix).

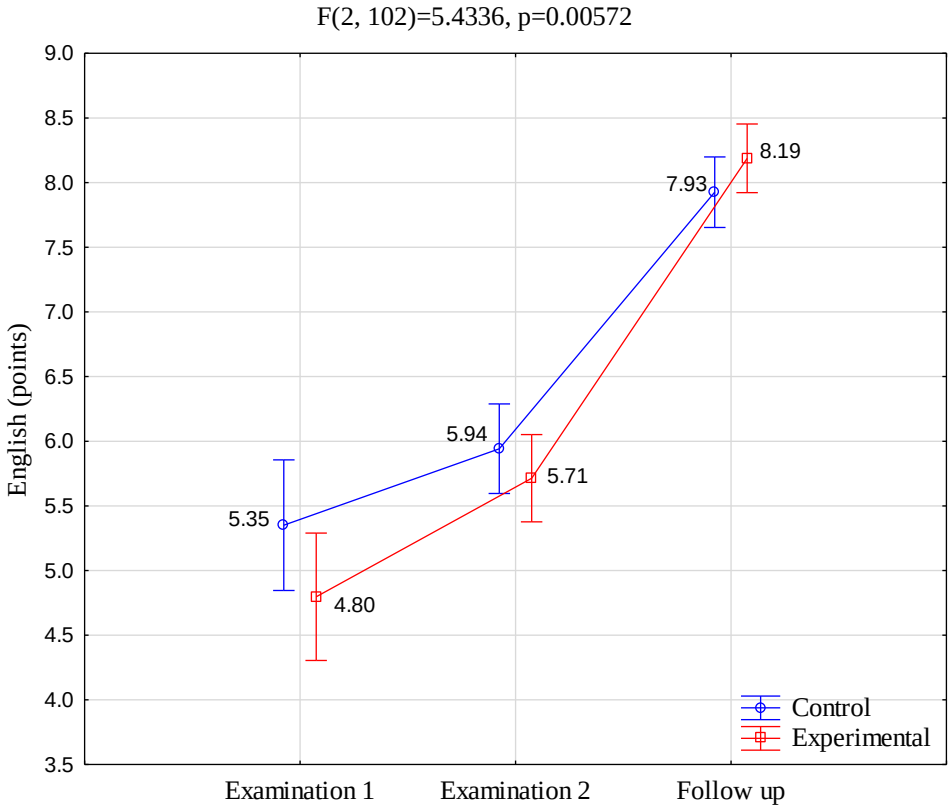


Figure 53. The results of the English skills in pupils from the experimental and control groups in the first, second, and follow-up examinations

Comparing the results obtained on the level of the English skills in pupils from experimental and control groups at the first, second, and follow-up examinations, the results showed that the level of the English skills improved significantly after 20 weeks of intervention separately in the experimental group ($p<0.0001$) and the control group

(p=0.018), and also after eight months at the follow-up examination, separately in the experimental group (p<0.0001) and the control group (p<0.0001) (Table 68, Appendix)

The analysis of variance for the repeated measurements in the English skills test showed no significant differences in the level of development of English skills performance between boys from the experimental group and boys from the control group. There were also no significant differences in the level of development of English skills between girls from the experimental group and girls from control groups (F(2, 102)=0.5431, p=0.5825) (Figure 54). The results of the Post-hoc test showed that there were no significant differences in the English skills of 7-year-old boys and girls between the experimental group and the control group at the first, second, and follow-up examinations (p>0.05) (Tables 72, Appendix).

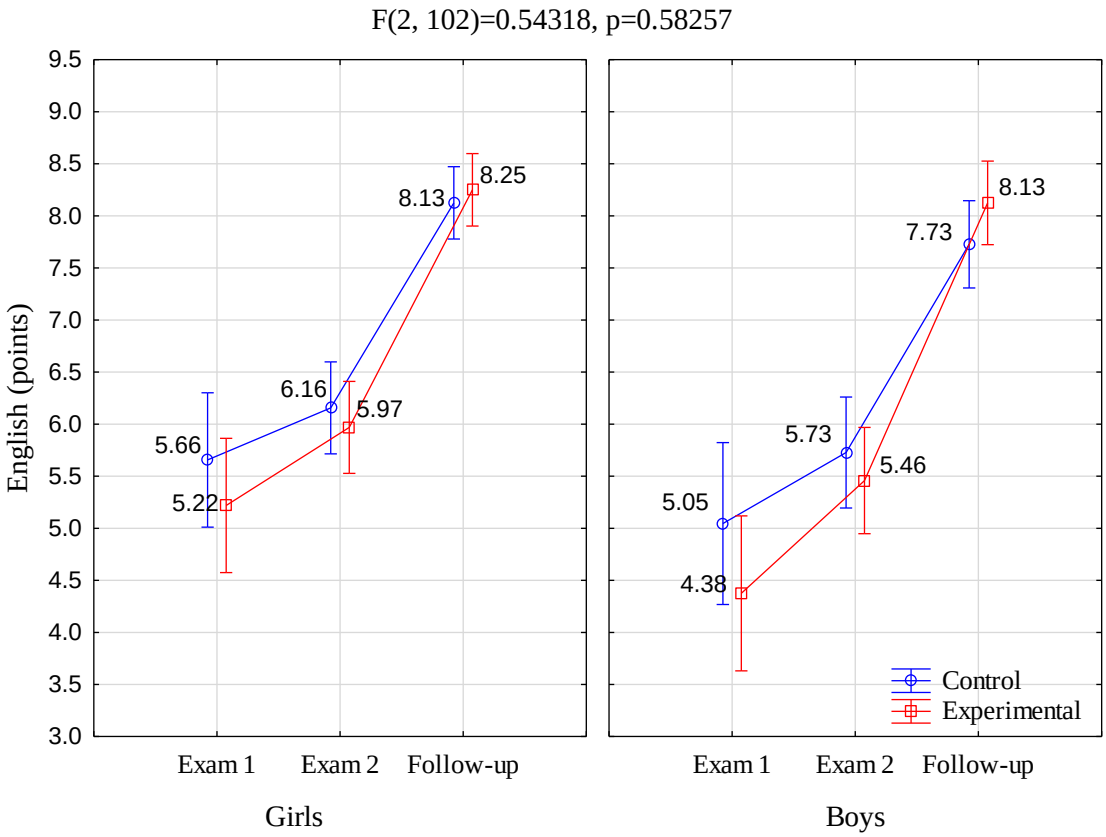


Figure 54. The results of the English skills in 7-year-old boys and girls from the experimental and control groups in the first, second, and follow-up examinations

VI DISCUSSION

The study's primary purpose is to evaluate the impact of the Brainball program applied in physical education classes on math skills, English, basic motor skills, and physical fitness for 7-year-olds at a primary school in Vietnam. The Brainball program is an innovative integrated education program that promotes and provides opportunities for intense activities aimed at improving health-related fitness and motor skills and enhances performance learning to improve academic achievement in the integrated content. After one year of study, experimental effects were found for math skills, English, basic motor skills, and physical fitness. The findings in this study are particularly encouraging.

Physical fitness findings showed that pupils in both groups (experimental and controlled) significantly improved their physical fitness levels after one year of school. The Brainball program and the current physical education curriculum have a positive impact on the development of students' physical fitness. The study results demonstrated no difference in the level of physical fitness development between students from the experimental group and the control group after 20 weeks of experimentation. However, a follow-up study found a difference in the level of physical fitness development between the two study groups, with students from the experimental group significantly improving compared to students from the control group after a school year. These findings have shown that using Brainballs in physical education classes for 7-year-olds in Vietnam regularly impacted physical fitness development during the experiment and had long-term positive effects in terms of speed, strength, flexibility.

Similar results on physical fitness development have also been found in previous studies when the educational balls were used in PE classes for preschool and elementary school students in Poland (Cichy, 2010; Rokita, 2008; Cichy & Rokita, 2012; Cichy & Rzepa, 2005). A 3-year study (2004-2007) was led by Rokita (2008) to evaluate the usefulness of the educational balls for performing physical activities integrated with the subject content (reading and writing). The study samples were pupils in grades 1-3 at two elementary schools. In each school, there was one experimental group and one control one. It was a longitudinal study, and the student's physical fitness has been assessed a total of 6 times (always at the beginning and the end of each consecutive school year). The study results showed that the change in students' fitness was not affected by their participation in

physical activities using the educational ball. Cichy and Rzepa (2005) made similar findings of the relationship between the use of educational balls in physical education classes and the student's physical development. Students taking classes with the educational balls did not adversely affect the child's physical changes. The authors concluded that a curriculum that uses educational balls could influence students' motor development just as much as a traditional curriculum (Cichy & Rokita, 2012). Cichy conducted a study (2010), a year-long investigation that tried to understand the physical development, body coordination, and learning ability of first graders in the program traditional physical education compared to the non-traditional curriculum. Research results have shown that the non-traditional curriculum, using educational balls in physical activity did not cause adverse changes to physical skills and general body coordination, but can contribute to the more effective achievement of the learning objectives at this stage of education.

Results of the physical fitness tests at the beginning of the school year showed that pupils from the experimental group performed worse or equal to pupils from the control group; however, after one year of study, pupils from the experimental group performed better than pupils from the control group on most fitness tests. The significant differences in improvement between the two groups were shown in the results of the following tests: 50-meter running, Toe touch, Standing long jump, 4 x 10 m sprint, and Hand strength. These findings demonstrated that there was a relationship between the effects of the Brainball program on the physical fitness levels of pupils from the experimental group. The relationship to students' physical development can be explained by the attractiveness of physical activities along with Brainballs. Exercises, games, and playing with balls (including educational balls) are the most engaging and favorite forms of physical activity for children. These exciting activities help students actively participate in physical activities, have the opportunity to develop their motor skills, improve their ability to cooperate and interact, and exercise their creative thinking ability (Cichy & Rzepa, 2007). Increasing physical activity is one of the important factors to develop and improve physical fitness (Åstrand, 1992).

Rink (2010) states that fitness is only developed when certain standards are met in terms of workload, duration of action and intensity. Eather et al. (2013) in a study aimed at

assessing the impact of a novel, multi-component school-based intervention on health-related fitness and objectively measured physical activity in primary school children. The authors have demonstrated that a student's physical fitness level can improve relatively quickly by using short and frequent periods of enjoyable and engaging physical activities. Many other researchers have also demonstrated that improving the quality of the curriculum, increasing the amount of physical activity and intensity in exercise have many benefits for students' physical development (Faigenbaum et al., 2009; Kriemler et al., 2010; Greco et al., 2019; Valantine et al., 2017).

In terms of fundamental motor skills, the present study results showed that pupils in both groups (experimental and controlled) significantly improved their fundamental motor skills after one year of study. This means that the current physical education program and the Brainballs program have positively impacted students' development of fundamental motor skills. However, when comparing the effect levels between the two programs after one school year, the results showed that pupils who participated in the Brainballs program significantly improved their skills compared to pupils in the control group who participated in the traditional physical education program. These findings have shown that the use of Brainballs in physical education classes positively affects the development of fundamental motor skills of 7-year-olds in Vietnam. The positive differences could occur because children in the experimental groups regularly used new attractive sports equipment, namely Brainballs, which probably kept motivational and volitional aspects of the activities equally high to the fun factor. But this should be further investigated via some in-depth study on another occasion.

Similar findings were found in a study by Korbecki (2019) to find relationships between fundamental movement skills, graphomotor skills, and school achievements of first-grade primary school students and the implementation of physical activities integrated with the subject-related contents with Eduballs. The author demonstrated that students participating in physical activity with educational balls significantly improved their fundamental motor skills compared with students in the control group who participated in the traditional PE program after one school year. Therefore, based on the abovementioned findings of Korbecki (2019), we may state that implementing physical activity with

Eduballs seems sensible when it comes to developing and improving motor skills at the first stage of education.

In these terms, our findings are consistent and similar to the results of previous studies, demonstrating that the physical activity programs focusing on games and exercises with the aim to increase the level of fundamental motor skills in children can be effective (Vernadakis et al., 2015; Akbari et al., 2009; Fotrousi et al., 2012; Mostafavi et al., 2013; Piek et al., 2013; Ruiz-Esteban et al., 2020), however, the possible long-term effect was less recognized.

Follow-up procedures are an important component of all research. They are most often conducted during the actual research but can also be conducted afterward. Follow-up is generally done to increase the overall effectiveness of the research effort. It can be conducted for a number of reasons, namely, to further an end in a particular study, review new developments, fulfill a research promise, comply with institutional review board protocol for research exceeding a year, ensure that targeted project milestones are being met, etc. (Salkind, 2010). In recent years, many follow-up studies have been performed in studies aimed at assessing the impact of physical activity intervention on student development. The results of these studies provide additional understanding of the positive effects of the intervention program not only during the experimental period but also long after the end of the program (Lahti et al., 2018; Barros et al., 2019; Jurak et al., 2013; Pate et al., 2007). Lahti et al. (2018) conducted a study to examine whether daily physical activity during compulsory school encourages children to be more physically active during the intervention and four years after termination of the program. The study concluded that intervention with daily school PE throughout compulsory school is associated with a higher duration of physical activity not only during the intervention but also four years after termination of the program. Another study (Pate et al., 2007) aimed to evaluate the long-term impact of a physical activity intervention in female high school students. The research results have shown that girls in the intervention schools that most fully implemented and maintained the intervention were more likely than girls in the other schools to participate in an average of one or more blocks of vigorous physical activity per day. In the longitudinal follow-up study of physical activity from preschool to school-age (Barros et al., 2019), the authors have pointed out that the level of physical activity in the

school-age was significantly predicted by the behavior in relation to activities presented by children still in the preschool age.

Our research observed that introducing the BRAINballs for 20 weeks had a positive effect on locomotor and object control skills techniques even after another 20 weeks after ceasing the influencing factor, which might indicate a sustainable impact. But this certainly requires further analyzes with well-designed longitudinal research.

Motor skills are acquired in many ways. Some skills, such as walking, are developmental skills that all children acquire as the result of a maturational readiness and environmental conditions that encourage their development. By the time children go to school, they can perform a large number of fundamental motor skills (FMS), all without the assistance of a physical education teacher. More specialized skills, such as sport skills, and the skillful use of fundamental patterns (e.g., running a race, catching a ball) develop largely as a result of learning (Rink, 2010) either in a natural environment of free, spontaneous play or as a part of sporting experience. Scientists believe that environmental conditions are effective in motor skill development. Environmental conditions that include opportunities for practice, encouragement, and instruction are crucial to the development of mature patterns of fundamental movement (Gallahue & Donnelly, 2003; Morgan et al., 2013). Numerous studies also highlight that school-based intervention focusing on motor competence enhance children's basic motor skills. In addition, interventions concentrating on object control skills are more effective (Morgan et al., 2013; Jaksic et al., 2020). Our results show that the experimental group significantly improved both the locomotor and object control skills ($p<0,001$ for both) after one school year.

Promoting fundamental motor skills is integral to a holistic view and sound development of a child. Researchers suggest optimizing physical, psychological, and mental health by promoting the development of more physically literate children (Barnett et al., 2016). O'Brien et al. (2016) found that adolescents may have a difficult time in making the successful transition towards more advanced motor skills within the sport-specific stage. The alarming findings indicate that adolescents aged between 12 and 13 years entering their first year of post-primary PE and also dealing with their pubertal transformation do not display appropriate motor proficiency (O'Brien et al., 2016). It is known that early identification of motor skill problems is beneficial and the systematic

evaluation may help in the identification of learning difficulties and disorders that can affect the proper development of the child (Piek et al., 2008; Skinner & Piek, 2001). Understanding the importance of FMS and awareness of irregularities in motor skills may help to prevent later school problems as well as aid in preparation and implementation of well-tailored intervention programs (Piek et al., 2008; Skinner & Piek, 2001; Korbecki et al., 2017).

The results of the present study on the level of maths and English skills showed that pupils from the two groups (experimental and control) significantly improved their skills after one school year (follow-up testing) as compared to the baseline, but analysis a growth between the two groups showed that there was no significant difference in growth between the two groups after the first 20 weeks of the study (post-intervention testing) which marked the intervention period. Also, it was observed that pupils from the experimental group improved significantly after one school year compared with pupils from the control group in both math and English skills. These findings have shown that although the use of educational balls in physical classes did not affect students' development of maths and English skills after 20 weeks of intervention program but indicated some positive effects in the long term for students' development of maths and English skills in the experimental group. However, it cannot be said for sure that the use of Brainballs in physical classes has a long-term positive effect on the development of math and English skills for 7-year-olds in Vietnam. Because the development of math and English skills of students not only depends on learning factors at school but also is influenced by many other factors such as family, environment, and society (Leondari & Gialamas, 2002). To be sure, one would have to take under investigation many factors that could potentially have influenced pupils’ development of maths and English skills.

Math and English are two compulsory subjects in the primary school curriculum in Vietnam. Student achievement in math and English is of great concern to schools, teachers, communities, and families. In order to help students' learning process achieve high results, the school is always fully equipped with facilities for the teaching and learning process. Teachers always explore and discover new and creative teaching methods to make lessons lively, interesting and stimulate students' self-discipline. The community often organizes themed contests, fun activities to reinforce and improve knowledge for students. Families

always care, support, and create all conditions for students to enhance academic achievement. Outside of school hours, parents often give their children extra lessons to improve their knowledge and skills, hire tutors to tutor and equip students with modern electronic devices to support their learning process.

Many previous studies have demonstrated that student achievement is affected by many factors. In a study aimed at exploring the predictors of math attainment trajectories in primary and secondary education by focusing specifically on the school climate and children's effect towards school, student-teacher relationships, teacher characteristics, attitudes towards math, and perceptions of the math teacher (Evans & Field, 2020). The authors have concluded that the most important school-related predictor of math attainment trajectories in primary and secondary education was children's math attitudes. There were differences between primary and secondary variables where aspects of the school climate (student-teacher relationships and school belonging) had a significant association with attainment in secondary education but not in primary education. In addition to factors related to school and student learning attitudes, other researchers have also shown other factors that can affect student achievement. Dukmak and Ishtaiwa (2015) conducted research to investigate the students' scholastic accomplishment with regard to their age and gender and in relation to their parent's level of education, family size, and family income. The study results showed that there were significant differences between high and low achievement students in their age and in the educational attainment of their parents. High-achieving students were younger than low achievers, parents' education level for high-achieving students was more significant than their counterparts (Dukmak & Ishtaiwa, 2015). More parent support at school and more positive parent-child relationships are also associated with increased math achievement (Selvam, 2013; Wang et al., 1996; Udida et al., 2012). Wang et al. (1996) pointed out that parental education and encouragement are closely related to improving student achievement. A study aimed to examine the influence of parental socioeconomic background on students' academic performance in selected public secondary schools in Calabar Municipal Local Government Area of Cross River State (Udida et al., 2012). The results showed that parental socioeconomic background significantly influenced students' academic performance as students whose parents had better jobs and higher levels of educational attainment and who were exposed to more

educational and cultural resources at home tended to perform better than their counterparts without such opportunities.

Physical activity was also identified as one of the factors that positively impacted student achievement. Many studies have proven that regular physical activity has not only many physical health benefits but also has positive effects that improve students' cognitive abilities and academic performance (Chaddock et al., 2011; Chomitz et al., 2009; Castelli et al., 2007). Children who exercised and were physically active regularly had more significant differences than sedentary children in abilities such as concentration, quick reaction and creative thinking; have better memory; improve fitness; improve and maintain better learning outcomes (Chaddock et al., 2010; Tomporowski et al., 2008). According to Chaddock-Heyman et al. (2015), growing evidence suggests that these aerobic fitness differences in cognition and academics have a biological basis in the brain. In particular, higher fit children have larger structural brain volumes in the hippocampus and dorsal striatum, two subcortical regions critical for memory and learning, as well as more efficient brain activation patterns (via functional magnetic resonance imaging (fMRI) and event-related potential (fMRI) and event-related potential (ERP) measures) during attentional and interference control tasks, relative to lower fit peers (Chaddock-Heyman et al., 2015).

To determine how and why physical activity may affect student performance, researchers often use measures of different outcomes such as the ability of cognitive function, executive function, behavior, brain activation (Sneck et al., 2019). For example, a study investigated whether fine or gross motor activity integrated into math lessons (i.e., motor-enrichment) could improve children's mathematical performance. Beck et al. (2016) proved that motor enriched learning activities could improve mathematical achievement. The authors argued that the favorable effect of motor activities on learning outcomes could be accounted for by changes in visual-spatial short-term memory and improved attentional resources. In the present study, the positive effects of physical activity on students' mathematical performance from the experimental group could be attributed to the effect of physical activity with Brainballs. Games and exercises played with balls containing numbers and math symbols allow students to practice the content they learn in the classroom, increasing math learning time compared to students from the control group. At

the same time, the attractiveness of games helps the classroom become lively. Students actively and confidently solve tasks, improving their ability to think, remember and form mathematical concepts (Rokita et al., 2017). Many previous studies have also shown that the use of games in teaching mathematics has benefits for improving the understanding of mathematics (Orim & Ekwueme, 2011; Afari, 2012; Cichy et al., 2020). Bertozzi (2014) has suggested that playing mathematics games promotes strategic thinking, problem-solving and develops fluency. They give a chance for students to apply their learning in a different context and the opportunity to explain and discuss the mathematics involved with their peers - often without fear of failure.

Similarly, the positive effects of physical activity with Brainballs on English skills improvement can be attributed to learning and playing with balls containing letters on their surface. The lesson contents are integrated into physical activities with Brainballs to help increase learning time and create conditions for students to have more opportunities to expose themselves to English. Thereby helping students easily memorize new words, practice listening, speaking skills, and form English concepts. The exciting nature of the games also encourages students to be confident in communication and actively acquire knowledge (Rokita et al., 2017). Integrating a cognitive learning task with physical activity was also found to be beneficial for learning outcomes. Many previous studies have demonstrated that physical activity increases brain function and activity, leading to improved achievement in foreign language learning in children (Pruitt & Morini, 2021; Schmidt-Kassow et al., 2013; Gold et al., 2003; Uysal et al., 2005; Derri et al., 2010). Mavilidi et al. (2015) in an attempt to investigate the effects of enacting words through full-body movements in the form of physical exercise and part-body movements in the form of gesturing on learning a foreign language vocabulary. The authors randomly assigned 111 preschool children to one of four conditions. Participants had to learn 14 Italian words in a 4-week teaching program. They were tested on their memory for the words during, directly after, and six weeks after the program. In the integrated physical exercise condition, children enact the actions indicated by the words to be learned in physical exercises. In the non-integrated physical exercise condition, children perform physical exercises at the same intensity but unrelated to the learning task. In the gesturing condition, children enact the actions indicated by the words to be learned by gesturing

while remaining seated. In the conventional condition, children verbally repeated the words while remaining seated. Results confirmed the main hypothesis, indicating that children in the integrated physical exercise condition achieve the highest learning outcomes.

However, we must admit that our study was just a preliminary study to recognize the general patterns of influence but, with some caution that the use of educational balls in physical classes contributed to this positive outcome as well and in future research studies, these aspects should be taken into consideration as study variables. It is still worth noticing that the study results showed no significant differences in student's math and English skills from the experimental and control groups after 20 weeks of study. But when looking at the students' scores in the two groups, it can be seen that the students from the experimental group improved their scores compared to the students from the control group, although there was no statistical significance. On the first test, students from the experimental group achieved a lower average result than students from the control group in math skills (4.76 vs. 5.26) and English (4.80 vs. 5.35). However, after 20 weeks of the intervention program, the average scores of students in the two groups were nearly similar, particularly in math skills (5.71 vs. 5.94), English (5.76 vs. 5.90). These findings have shown that there may be a relationship between the positive effects of using Brainballs in physical classes on math and English skills development for 7-year-olds in Vietnam. But due to the short period of experimentation and learning with the educational ball, it is not enough for pupils to acquire and develop comprehensive skills. This effect can result from playing and learning characteristics along with the educational ball in physical education classes. The contents of the lessons are integrated into games and exercises with educational balls to help pupils actively participate and absorb knowledge in a proactive way. In an integrated form, pupils have learned the content twice in two different classrooms, and those learned in the classroom are practiced in physical education classes with Brainballs.

Many studies have been done to investigate the relationship between the use of educational balls in physical education classes and the development of children. Researchers have demonstrated that the use of educational balls in physical activities for students in preschool and primary schools not only positively affects students' motor development but also stimulates the intellectual development of students (Rokita & Cichy,

2013; Rokita & Cichy, 2014). Rokita et al. (2017), in a study that summarizes 15 years of research, use EDUballs educational balls in preschool and early childhood education. The authors have shown that the use of Brainballs in physical education classes not only positively affects the development of physical fitness and motor skills but also has positive effects on increasing knowledge and skills in Polish language, mathematics, foreign languages, and other subjects (Rokita et al., 2017).

Rzepa performed a year-long pedagogical experiment, which proved that using Eduball education balls in physical education classes significantly improved students' Polish learning skills (Rzepa, 2003). Research results of Rokita (2008), and Rzepa and Wojcik (2007a, b) have confirmed the significant impact of performing educational ball-based physical activities on reading and writing skills in primary school students. Rokita and Kaczmarczyk (2011) performed a pedagogical experiment aimed at verifying the effectiveness of using educational balls in physical activities on first graders' math competencies. The authors observed that faster acquisition of math skills could happen thanks to student participation in physical activities with the educational ball. At the end of the school year, students from experimental classes have significantly improved math knowledge and skills (Rokita & Kaczmarczyk, 2011). Subsequent studies have similarly concluded about the positive effects of using the educational ball on the faster and more efficient acquisition of mathematical competencies (Kaczmarczyk, 2013; Korbecki, 2019).

Cichy et al. (2020), in a study aimed at investigating the relationships between the use of educational balls and the acquisition of mathematical knowledge and skills by children, also indicated that participation in classes with the use of Eduballs has helped students acquire math skills as well as knowledge faster. Although there was general progress in both studied groups, only participants from the experimental class improved their results significantly in all analyzed mathematical categories. Students from the control class improved their results only in four of eight categories (strongly related to operations on numbers such as addition, subtraction, counting money, and measuring time). What distinguishes the experimental group is the fact that, in its case, there was also an improvement in the mathematical imagination (multiplication and division) and spatial imagination (sets and their elements, geometric shapes and measuring length, and measuring volume and mass), which are not so closely related to numbers. These are

definitely more abstract activities that require different mathematical thinking. Such an observation shows that learning with Eduball creates optimal conditions for holistic mathematical development (Cichy et al., 2020).

Many studies have provided evidence of the positive benefits of integrating physical activities and learning. The integration of different school subjects' contents into physical education does not affect the development of physical fitness and motor skills but has an added positive effect on pupils academic and overall achievements (Connor-Kuntz & Dummer, 1996; Thompson & Robertson, 2015; Hall, 2007). Connor-Kuntz and Dummer (1996) researched to evaluate the impact of a language-enhanced physical education program on preschool language skills. Results illustrated that language instruction can be added to physical education lessons without requiring additional instructional time and, more importantly, without compromising improvement in motor skill performance. Further, preschool children exposed to language-enriched physical education context improved their language skills.

Interestingly, children with learning difficulties did not experience that enhancement effect. Thus, physical activity appears to be an effective environment in which to enhance the cognitive development of all abilities of preschool children (Connor-Kuntz & Dummer, 1996). Derri et al. (2010), in the study of a similar design, tried to examine the impact of integrating physical and language education on preschool speech and writing. The authors concluded that an integrated physical education program could support early childhood language skills development (Derri et al., 2010). Thompson and Robertson (2015) have shown that integrating mathematics into the physical education setting increased the amount of learning time for mathematics during the school day, which may have helped students improve conceptual/deep understanding of currency concepts. The improvement of student's learning suggests that physical education is a suitable environment for integrating the two concepts – motor and language learning - to enhance core concept learning (Thompson & Robertson, 2015).

In a study by Lisowski et al. (2020), it was found that there are some differences between the genders in terms of motor achievements in children in the transition period from kindergarten to primary school education. But these differences were observed only in few motor aspects like endurance, speed, and coordination. This can be taken into

account while designing intervention programs aiming at physical fitness, while in the case of the programs targeting more general, sound development, the teaching-learning contents, and methods could be more gender-unified. In our study, analyzing gender differences in math and English skills, fundamental motor skills, and physical fitness after one year of study showed that there were no significant differences in developmental levels between boys and girls from the experimental group and boys and girls from the control group. In addition, the study also showed that there was no significant difference in the development of math and English skills, fundamental motor skills, and physical fitness between boys and girls in both experimental and control groups. These findings indicate that there were no gender differences in the development of the tested content when the education balls were used in physical education classes for 7-year-olds in Vietnam.

Korbecki (2019) has similarly concluded in a year-long pedagogical experiment to find the relationships between fundamental movement skills, graphomotor skills, and school achievements of first-grade primary school students and the implementation of physical activities integrated with the subject-related contents with Eduball educational balls. Gender did not show significant differences between first graders' fundamental motor skills, graphomotor skills, and academic achievement when participating in experimental programs (Korbecki, 2019). Previous studies have also demonstrated that there were no developmental differences between boys and girls in different areas. Perić and Masnjak (2017) conducted research to determine whether there were significant differences in the development of boys and girls in the five developmental areas (cognitive development, communication development, social-emotional development, self-care, and motor development). The results obtained did not show a statistically significant difference between girls and boys in the developmental domains, although girls generally performed better (Perić & Masnjak, 2017). Another study aimed to analyze developmental differences between boys and girls in Mecklenburg-Western Pomerania in fine and gross motor skills, language and cognition, and social development (Lewicki et al., 2018). The authors demonstrated that sex differences were generally negligible, apart from a few statistically significant, yet quantitatively small. Consequently, competency-based, intersectional, individual-centered rather than sex-based strategies seem promising for preschool programs in northeastern Germany. Thomas and French (1985) also concluded that gender

differences were unrelated to age, and effect sizes were small. Results are discussed in relation to the development of gender differences to biological and environmental sources (Thomas & French, 1985).

The findings of our study have been considered with caution due to several limitations. Firstly, this is the first study to be done in Vietnam on the use of Brainballs in physical education classes. In Vietnam, teachers and students are very interested in new teaching and learning methods. Still, they also feel confused and have difficulty approaching the process, especially with advanced methods like the Eduball/Brainball concept. Second, the study was conducted with a small sample size group, so the research results could not be generalized to other country regions. Third, due to the impact of the COVID-19 epidemic, the experimental study could not be done for the entire school year but could only be done in the first semester (20 weeks), and also second (post-intervention) testing could be organized for general gross motor skills test due to the same reasons – pandemic restrictions in schools. However, it was carried out in the follow-up testing after the whole school year. Experimental time is short, so it does not allow to study fully the cause-effect relationship caused by the manipulation of independent variables.

Despite its limitations, the research has many strengths. The study was carried out by experimental pedagogical method with two parallel groups in a natural environment. Students voluntarily participated and received special attention from school leaders, teachers, and parents. In the implementation process, the study had rhythmic coordination between classroom teachers and teachers of physical education in teaching content, which is a novelty in the Vietnam educational system. Although this was limited a little bit by the restrictions of the educational authorities on the research tools that were allowed to be used – all tools had to be accepted -like motor tests, or developed - like math and language tests, by the local panel of school teaching experts accordingly to guidelines of the national subject curricula. The study's findings provide further insight into the effectiveness of using educational balls in physical education classes for 7-year-olds in Vietnam on math and English skills, fundamental motor skills, and physical fitness. Students had the opportunity to experience new learning methods, participate in exciting physical activities with educational balls, increase interest and actively absorb knowledge in learning.

Promoting health, improving physical fitness, and improving student achievement have become important goals in education. Research has shown that an educational program that integrates subjects into physical activities to enhance motor skills, physical fitness, and academic achievement is most effective. The positive results from this study will supplement the growing evidence base to support the value of using education balls in physical education classes in Vietnam. Pupils participating in classes with educational balls not only improve physically but also make positive intellectual improvements. Brainball program has been scientifically designed as a teaching method using games and exercises along with educational balls with the purpose of the enhancement of the sound development of a child initiating early education process. In the form of games, exercises should help teachers easily guide and organize the implementation in the teaching process; help students enjoy participating in practice and actively absorb knowledge. From there, it shows that the Brainball program has the potential to spread teaching on a large scale in the future.

VII CONCLUSIONS

1) An analysis of the results showed no major differences in physical fitness development between 7-year-old Vietnamese pupils from the experimental and control groups after 20 weeks of experimentation. However, there were significant differences in the level of physical fitness development between pupils from the experimental and control groups after one school year. Pupils from the experimental group significantly improved their physical fitness levels compared to pupils from the control group after one year of study, specifically in 50-meter running ($p=0.004$), Toe touch ($p=0.013$), Standing long jump ($p=0.007$), 4 x 10m sprint ($p=0.033$), Hand strength ($p=0.023$). From the above results, it can be concluded that the use of educational balls in physical classes had a long-term positive effect on the physical fitness development of 7-year-olds in Vietnam.

The level of fundamental motor skills of 7-year-old pupils from Vietnam at the second test (after 20 weeks of testing) could not be measured because of the COVID-19 epidemic. However, the results of a follow-up study (after one school year) showed that pupils from the experimental group experienced significant improvements compared with pupils from the control group on both sub-tests, locomotor skills ($p=0.001$), object control skills ($p=0.001$). Therefore, it can be concluded that the use of Brainballs in PE classes had a significant impact on the development of fundamental motor skills for 7-year-olds in Vietnam.

2) The analysis of math and English skills results showed that there were no significant differences in math and English skills development between students from the experimental group and the control group after 20 weeks of the intervention program. However, there has been noticed a difference in the level of development of maths and English skills after one year of study. Students from the experimental group improved significantly compared with students from the control group in both skills, math ($p=0.003$), English ($p=0.005$). These findings indicate that the use of Brainballs in physical education classes did not significantly affect the development of math and English skills of 7-year-olds in Vietnam after 20 weeks of experimentation but can have a long-term positive effect on student development. However, this claim needs to be verified and analyzed further in the next studies.

3) Research also demonstrated that there were no gender differences in the development of English and maths skills, fundamental motor skills, and physical fitness when the education balls were used in physical education for 7-year-olds in Vietnam.

The results of this study provide promising early findings that the adoption of Brainballs in preschool and primary curriculum in Vietnam could be a useful method for improving students' mobility and academic performance.

VIII REFERENCES

Adler, A. (2015). *The education of children*. Routledge - Taylor & Francis Group. London and New York. ISBN: 978-1-138-912007 (hbk); ISBN: 978-1-315-68793-3 (ebk).

Afari, E. (2012). Teaching mathematics in game learning environment. *International Review of Contemporary Learning Research*, *1*(1), 33–45.

Akbari, H., Abdoli, B., Shafizadeh, M., Khalaji, H., HAJI, H. S., & Ziaei, V. (2009). The effect of traditional games in fundamental motor skill development in 7-9 year-old boys. *Iranian Journal of Pediatrics*, *19*(2), 123–129.

Andres, M., Olivier, E., & Badets, A. (2008). Actions, words, and numbers: a motor contribution to semantic processing? *Current Directions in Psychological Science*, *17*(5), 313–317.

Arbib, M. A. (2005). From monkey-like action recognition to human language: An evolutionary framework for neurolinguistics. *Behavioral and Brain Sciences*, *28*(2), 105–124.

Åstrand, P.-O. (1992). Physical activity and fitness. *The American Journal of Clinical Nutrition*, *55*(6), 1231S-1236S.

Bailey, R., Hillman, C., Arent, S., & Petitpas, A. (2013). Physical activity: an underestimated investment in human capital? *Journal of Physical Activity and Health*, *10*(3), 289–308.

Barnett, L. M., Stodden, D., Cohen, K. E., Smith, J. J., Lubans, D. R., Lenoir, M., Iivonen, S., Miller, A. D., Laukkanen, A., & Dudley, D. (2016). Fundamental movement skills: An important focus. *Journal of Teaching in Physical Education*, *35*(3), 219–225.

Barros, S. S. H., Nahas, M. V., Hardman, C. M., Bezerra, J., & Barros, M. V. G. de. (2019). Longitudinal follow-up of physical activity from preschool to school age: the ELOS-Pré study. *Revista Brasileira de Cineantropometria & Desempenho Humano*, *21*, e59242.

Beck, M. M., Lind, R. R., Geertsen, S. S., Ritz, C., Lundbye-Jensen, J., & Wienecke, J. (2016). Motor-enriched learning activities can improve mathematical performance in preadolescent children. *Frontiers in Human Neuroscience*, *10*, 645.

Bertozzi, E. (2014). Using games to teach, practice, and encourage interest in STEM subjects. *Learning, Education and Games*, 23.

Bộ Giáo dục và Đào tạo. (2006a). *Quyết định số 16/2006/QĐ-BGDĐT phê duyệt Chương trình giáo dục phổ thông (Decision No. 16/2006/QD-BGDĐT approving the General Education Program)*. https://vanbanphapluat.co/quyet-dinh-16-2006-qd-bgddt-chuong-trinh-giao-duc-pho-thong

Bộ Giáo dục và Đào tạo. (2006b). *Quyết định số 40/2006/QĐ-BGDĐT. Quy chế đánh giá, xếp loại học sinh trung học cơ sở và học sinh trung học phổ thông (Decision No. 40/2006/QD-BGDĐT. Regulation on assessment and grading of junior high school students and high school students)*. https://vanbanphapluat.co/quyet-dinh-40-2006-qd-bgddt-quy-che-danh-gia-xep-loai-hoc-sinh-trung-hoc-co-so-pho-thong#van-ban-goc

Bộ Giáo dục và Đào tạo. (2007). *Quyết định số 43/2007/QĐ-BGDĐT, Ban hành Quy chế đào tạo đại học và cao đẳng hệ chính quy theo hệ thống tín chỉ (Decision No. 43/2007/QD-BGDĐT, Promulgating the Regulation on formal university and college training according to the credit system)*. https://chinhphu.vn/default.aspx?pageid=27160&docid=38739#:~:text=Quyết định số 43%2F2007%2FQĐ-BGDĐT của Bộ Giáo dục,hệ chính quy theo hệ thống tín chỉ.

Bộ Giáo dục và Đào tạo. (2018a). *Thông tư số 32/2018/TT-BGDĐT phê duyệt Chương trình giáo dục phổ thông làm quen Tiếng Anh lớp 1 và lớp 2 (Circular No. 32/2018/TT-BGDĐT approving the general education program to become familiar with English for grade 1 and grade 2)*. https://moet.gov.vn/content/vanban/Lists/VBPQ/Attachments/1301/TT 32.2018 CTGDPT.pdf

Bộ Giáo dục và Đào tạo. (2018b). *Thông tư số 32/2018/TT-BGDĐT phê duyệt Chương trình giáo dục phổ thông môn Thể dục (Circular No. 32/2018/TT-BGDĐT approving the General Education Program in Physical Education)*. https://moet.gov.vn/content/vanban/Lists/VBPQ/Attachments/1301/TT 32.2018 CTGDPT.pdf

Bộ Giáo dục và Đào tạo. (2018c). *Thông tư số 32/2018/TT-BGDĐT phê duyệt Chương trình giáo dục phổ thông môn Tiếng Anh (Circular No. 32/2018/TT-BGDĐT approving the general education program in English)*. https://moet.gov.vn/content/vanban/Lists/VBPQ/Attachments/1301/TT 32.2018 CTGDPT.pdf

Bộ Giáo dục và Đào tạo. (2018d). *Thông tư số 32/2018/TT-BGDĐT phê duyệt Chương trình giáo dục phổ thông môn Toán (Circular No. 32/2018/TT-BGDĐT approving the general education program in Mathematics)*. https://moet.gov.vn/content/vanban/Lists/VBPQ/Attachments/1301/TT 32.2018 CTGDPT.pdf

Boreham, C., & Riddoch, C. (2001). The physical activity, fitness and health of children. *Journal of Sports Sciences*, *19*(12), 915–929.

Bronikowski, M. (2014). Where is physical and health education heading in Poland? *Physical Education and Health: Global Perspectives and Best Practice. Urbana, Il: Sagemore Publishing*, 238–327.

Budde, H., Voelcker-Rehage, C., Pietraßyk-Kendziorra, S., Ribeiro, P., & Tidow, G. (2008). Acute coordinative exercise improves attentional performance in adolescents. *Neuroscience Letters*, *441*(2), 219–223.

Bùi, T. Á. (2006). *Giáo Trình Giải Phẫu Sinh Lý-Vệ Sinh Phòng Bệnh Trẻ Em (Textbook of Anatomy - Hygiene and Prevention of Children)*. Nxb Hà Nội.

Castelli, D. M., Hillman, C. H., Buck, S. M., & Erwin, H. E. (2007). Physical fitness and academic achievement in third-and fifth-grade students. *Journal of Sport and Exercise Psychology*, *29*(2), 239–252.

Chaddock-Heyman, L., Erickson, K. I., Kienzler, C., King, M., Pontifex, M. B., Raine, L. B., Hillman, C. H., & Kramer, A. F. (2015). The role of aerobic fitness in cortical thickness and mathematics achievement in preadolescent children. *PloS One*, *10*(8), e0134115.

Chaddock, L., Erickson, K. I., Prakash, R. S., Kim, J. S., Voss, M. W., VanPatter, M., Pontifex, M. B., Raine, L. B., Konkel, A., & Hillman, C. H. (2010). A neuroimaging investigation of the association between aerobic fitness, hippocampal volume, and memory performance in preadolescent children. *Brain Research*, *1358*, 172–183.

Chaddock, L., Pontifex, M. B., Hillman, C. H., & Kramer, A. F. (2011). A review of the relation of aerobic fitness and physical activity to brain structure and function in children. *Journal of the International Neuropsychological Society*, *17*(6), 975–985.

Chính phủ. (2016). *Quyết định số 1981/QĐ-TTg phê duyệt khung cơ cấu hệ thống giáo dục quốc dân (Decision No. 1981/QD-TTg approving the structural framework of the*

national education system). https://vanbanphapluat.co/quyet-dinh-1981-qd-ttg-phe-duyet-khung-co-cau-he-thong-giao-duc-quoc-dan#van-ban-goc

Chomitz, V. R., Slining, M. M., McGowan, R. J., Mitchell, S. E., Dawson, G. F., & Hacker, K. A. (2009). Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the northeastern United States. *Journal of School Health*, *79*(1), 30–37.

Cichy, I. (2010). *Sprawność fizyczna, ogólna koordynacja ciała i kompetencje edukacyjne uczniów I klasy szkoły podstawowej prowadzonych programem tradycyjnym i nietradycyjnym*. Rozprawa doktorska. AWF, Wrocław.

Cichy, I., Kaczmarczyk, M., Wawrzyniak, S., Kruszwicka, A., Przybyla, T., Klichowski, M., & Rokita, A. (2020). Participating in physical classes using Eduball stimulates acquisition of mathematical knowledge and skills by primary school students. *Frontiers in Psychology*, *11*, 2194.

Cichy, I., Kruszwicka, A., Krysman, A., Przybyla, T., Rochatka, W., Szala, E., Wawrzyniak, S., Bronikowski, M., Klichowski, M., & Rokita, A. (2022). Eduball as a method of brain training for lower performing students with dyslexia: A one-year experiment in natural settings. *Int. J. Disabil. Hum. Dev., in press*.

Cichy, I., & Rokita, A. (2012). The use of the "Eduball" educational ball in rural and urban primary schools and the physical fitness levels of children. *Human Movement*, *13*(3), 247–257.

Cichy, I., Rokita, A., Wolny, M., & Popowczak, M. (2015). Effect of physical exercise games and playing with Edubal educational balls on eye-hand coordination in first-year primary school children. *Med. Dello Sport*, *68*, 461–472.

Cichy, I., & Rzepa, T. (2005). Próba określenia kompetencji oraz poziomu sprawności ruchowej w kształceniu zintegrowanym z wykorzystaniem piłek edukacyjnych.[w:] Bartoszewicz R. *Koszczyc T., Nowak A.(Red.) Dydaktyka Wychowania Fizycznego w Świetle Współczesnych Potrzeb Edukacyjnych. WTN, Wrocław*, 193–201.

Cichy, I., & Rzepa, T. (2007). The usage of educational balls "EDUBAL" during physical classes in integrated education. *Education in a Reformed School 6*, 131–136.

Cliff, D. P., Okely, A. D., Smith, L. M., & McKeen, K. (2009). Relationships between fundamental movement skills and objectively measured physical activity in preschool

children. *Pediatric Exercise Science*, *21*(4), 436–449.

Cone, T. P., Werner, P. H., & Cone, S. L. (2009). *Interdisciplinary elementary physical education*. Human kinetics.

Connor-Kuntz, F. J., & Dummer, G. M. (1996). Teaching across the curriculum: Language-enriched physical education for preschool children. *Adapted Physical Activity Quarterly*, *13*(3), 302–315.

Conyers, M., & Wilson, D. (2015). Smart moves: Powering up the brain with physical activity. *Phi Delta Kappan*, *96*(8), 38–42.

Council, N. R., & Population, C. on. (2013). *US health in international perspective: Shorter lives, poorer health*.

DeFrancesco, C., & Casas, B. (2002). The effect of incorporating math skills into physical education classes on math achievement of second grade elementary students. *1st Annual College of Education Research Conference. Miami: Florida International University*, 31–35.

Dehaene, S., Bossini, S., & Giraux, P. (1993). The mental representation of parity and number magnitude. *Journal of Experimental Psychology: General*, *122*(3), 371.

Derri, V., Kourtessis, T., Goti-Douma, E., & Kyrgiridis, P. (2010). Physical education and language integration: Effects on oral and written speech of pre-school children. *Physical Educator*, *67*(4), 178.

Desai, I. K., Kurpad, A. V, Chomitz, V. R., & Thomas, T. (2015). Aerobic fitness, micronutrient status, and academic achievement in Indian school-aged children. *PLoS One*, *10*(3), e0122487.

Domahs, F., Moeller, K., Huber, S., Willmes, K., & Nuerk, H.-C. (2010). Embodied numerosity: implicit hand-based representations influence symbolic number processing across cultures. *Cognition*, *116*(2), 251–266.

Đồng, H. L. (2016). *Nghiên cứu phát triển thể chất của học sinh trung học phổ thông chuyên các tỉnh Bắc Miền Trung (Research on the physical development of gifted high school students in the North Central provinces)*. Luận án tiến sĩ khoa học giáo dục, Trường ĐH TDTT Bắc Ninh, Hà Nội.

Dukmak, S., & Ishtaiwa, F. F. (2015). Factors influencing the academic achievement of students in the preparatory and secondary schools of the United Arab Emirates.

European Journal of Social Sciences, *46*(2), 132–148.

Dwyer, T., Coonan, W. E., Leitch, D. R., Hetzel, B. S., & Baghurst, R. A. (1983). An investigation of the effects of daily physical activity on the health of primary school students in South Australia. *International Journal of Epidemiology*, *12*(3), 308–313.

Eather, N., Morgan, P. J., & Lubans, D. R. (2013). Improving the fitness and physical activity levels of primary school children: Results of the Fit-4-Fun group randomized controlled trial. *Preventive Medicine*, *56*(1), 12–19.

Education, I. P. (2010). *The association between school-based physical activity, including physical education, and academic performance*. US Department of Health and Human Services Atlanta, GA, USA.

Ericsson, I. (2008). Motor skills, attention and academic achievements. An intervention study in school years 1–3. *British Educational Research Journal*, *34*(3), 301–313.

Etnier, J. L., Salazar, W., Landers, D. M., Petruzzello, S. J., Han, M., & Nowell, P. (1997). The influence of physical fitness and exercise upon cognitive functioning: A meta-analysis. *Journal of Sport and Exercise Psychology*, *19*(3), 249–277.

Evans, D., & Field, A. P. (2020). Maths attitudes, school affect and teacher characteristics as predictors of maths attainment trajectories in primary and secondary education. *Royal Society Open Science*, *7*(10), 200975.

Faigenbaum, A. D., Farrell, A. C., Radler, T., Zbojovsky, D., Chu, D. A., Ratamess, N. A., Kang, J., & Hoffman, J. R. (2009). " Plyo Play": a novel program of short bouts of moderate and high intensity exercise Improves physical fitness in elementary school children. *Physical Educator*, *66*(1), 37.

Fisher, A. (2009). *Relationships between physical activity and motor and cognitive function in young children*. Doctoral dissertation, University of Glasgow.

Fotrousi, F., Bagherly, J., & Ghasemi, A. (2012). The compensatory impact of mini-basketball skills on the progress of fundamental movements in children. *Procedia-Social and Behavioral Sciences*, *46*, 5206–5210.

Frey, S. H. (2008). Tool use, communicative gesture and cerebral asymmetries in the modern human brain. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1499), 1951–1957.

Gallahue, D. L., & Donnelly, F. C. (2003). *Developmental Physical Education for All*

Children (4th ed). Champaign, IL: Human Kinetics.

Gallahue, D., & Ozmun, J. (2006). *Understanding Motor Development: Infants, Children, Adolescents, Adults* (6th ed.). McGraw-Hill.

Glapa, A., Grzesiak, J., Laudanska-Krzeminska, I., Chin, M.-K., Edginton, C. R., Mok, M. M. C., & Bronikowski, M. (2018). The impact of brain breaks classroom-based physical activities on attitudes toward physical activity in polish school children in third to fifth grade. *International Journal of Environmental Research and Public Health*, *15*(2), 368.

Gold, S. M., Schulz, K.-H., Hartmann, S., Mladek, M., Lang, U. E., Hellweg, R., Reer, R., Braumann, K.-M., & Heesen, C. (2003). Basal serum levels and reactivity of nerve growth factor and brain-derived neurotrophic factor to standardized acute exercise in multiple sclerosis and controls. *Journal of Neuroimmunology*, *138*(1–2), 99–105.

Greco, G., Cataldi, S., & Fischetti, F. (2019). Effectiveness of a Short After-School Intervention on Physical Fitness in School-Aged Children. *Ricerche Di Pedagogia e Didattica. Journal of Theories and Research in Education*, *14*(1), 143–164.

Hà, T. L. H. (2015). *Dạy học tích hợp vì mục tiêu phát triển năng lực vận dụng kiến thức của học sinh (Integrated teaching for the purpose of developing students' ability to apply knowledge)*. Viện NCSP, Trường Đại Học Sư Phạm Hà Nội.

Haddad, C., & Tan, L. C. (2008). *Innovative practices in physical education and sports in Asia*. Bangkok, Thailand: UNESCO Asia and Pacific Regional Bureau for Education.

Hall, E. M. (2007). Integration: Helping to get our kids moving and learning. *Physical Educator*, *64*(3), 123.

Hardman, K. (2008). Physical education in schools: a global perspective. *Kinesiology*, *40*(1).

Haskell, W. L., Montoye, H. J., & Orenstein, D. (1985). Physical activity and exercise to achieve health-related physical fitness components. *Public Health Reports*, *100*(2), 202.

Haywood, K., & Getchell, N. (2005). *Lifespan motor development* (4th ed.). Champaign, IL, Human Kinetics.

Jaksic, D., Mandic, S., Maksimovic, N., Milosevic, Z., Roklicer, R., Vukovic, J., Pocek, S., Lakicevic, N., Bianco, A., & Cassar, S. (2020). Effects of a nine-month physical

activity intervention on morphological characteristics and motor and cognitive skills of preschool children. *International Journal of Environmental Research and Public Health*, *17*(18), 6609.

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 1–16.

Jurak, G., Cooper, A., Leskosek, B., & Kovac, M. (2013). Long-term effects of 4-year longitudinal school-based physical activity intervention on the physical fitness of children and youth during 7-year follow-up assessment. *Central European Journal of Public Health*, *21*(4), 190.

Kaczmarczyk, M. (2013). *Zajęcia ruchowe z piłkami edukacyjnymi „Edubal" a wiadomości i umiejętności matematyczne uczniów klasy I szkoły podstawowej*. Rozprawa doktorska, AWF, Wrocław.

Klebanov, P. K., Brooks-Gunn, J., McCarton, C., & McCormick, M. C. (1998). The contribution of neighborhood and family income to developmental test scores over the first three years of life. *Child Development*, *69*(5), 1420–1436.

Klichowski, M., & Króliczak, G. (2017). Numbers and functional lateralization: a visual half-field and dichotic listening study in proficient bilinguals. *Neuropsychologia*, *100*, 93–109.

Kolanowska, E., & Edukacji, F. R. S. (2018). *The system of education in Poland*. Foundation for the Development of the Education System.

Korbecki, M. (2019). *Zajęcia ruchowe z piłkami EDUball a wybrane umiejętności ruchowe i sprawność grafomotorycz*. Rozprawa doktorska, AWF, Wrocław.

Korbecki, M., Wawrzyniak, S., & Rokita, A. (2017). Fundamental movement skills of six- to seven-year-old children in the first grade of elementary school: A pilot study. *Baltic Journal of Health and Physical Activity. The Journal of Gdansk University of Physical Education and Sport*, *9*(4).

Krajewski, J. (2007). *Gotowość szkolna dzieci kończących edukację przedszkolną prowadzonych programami tradycyjnym i niekonwencjonalnym*. Rozprawa doktorska, AWF, Wrocław.

Kriemler, S., Zahner, L., Schindler, C., Meyer, U., Hartmann, T., Hebestreit, H., Brunner-

La Rocca, H. P., Van Mechelen, W., & Puder, J. J. (2010). Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: cluster randomised controlled trial. *Bmj*, *340*.

Króliczak, G., Piper, B. J., & Frey, S. H. (2016). Specialization of the left supramarginal gyrus for hand-independent praxis representation is not related to hand dominance. *Neuropsychologia*, *93*, 501–512.

Krysmann, A. (2012). *Wykorzystanie piłek edukacyjnych „edubal" w kształceniu zintegrowanym a umiejętności czytania i pisania uczniów z dysleksją*. Rozprawa doktorska, AWF, Wrocław.

Kubiak, A., & Króliczak, G. (2016). *Left extrastriate body area is sensitive to the meaning of symbolic gesture: evidence from fMRI repetition suppression. Sci Rep 6: 31064.*

Kulinna, P. H. (2008). Models for curriculum and pedagogy in elementary school physical education. *The Elementary School Journal*, *108*(3), 219–227.

Lahti, A., Rosengren, B. E., Nilsson, J.-Å., Karlsson, C., & Karlsson, M. K. (2018). Long-term effects of daily physical education throughout compulsory school on duration of physical activity in young adulthood: An 11-year prospective controlled study. *BMJ Open Sport & Exercise Medicine*, *4*(1), e000360.

Lai, N. K., Ang, T. F., Por, L. Y., & Liew, C. S. (2018). The impact of play on child development-a literature review. *European Early Childhood Education Research Journal*, *26*(5), 625–643.

Larson, L. (2012). *Międzynarodowy test sprawności fizycznej ICSPFT dla osób w wieku od 6 do 32 lat*. http://testy-sprawnosci-fizycznej.blogspot.com/2012/03/miedzynarodowy-test-sprawnosci.html

Lê, T. T. M. (2015). *Đánh giá sự phát triển về hình thái và thể lực của trẻ em mẫu giáo 4 tuổi ở trường mầm non Rạng Đông 9, Quận 6, Thành phố Hồ Chí Minh (Evaluation of the development of morphology and physical fitness of 4-year-old kindergarten children at Rang Dong 9, Dis)*. Luận văn Thạc sĩ giáo dục học. Trường Đại học sư phạm TDTT TP. HCM.

Lê, V. H., Lê, N. L., & Nguyễn, V. T. (2008). *Tâm lý học lứa tuổi và tâm lý học sư phạm (Age psychology and pedagogical psychology)*. Nxb Thế giới, Hà Nội.

Leondari, A., & Gialamas, V. (2002). Implicit theories, goal orientations, and perceived

competence: Impact on students' achievement behavior. *Psychology in the Schools*, *39*(3), 279–291.

Lewicki, K., Franze, M., Gottschling-Lang, A., & Hoffmann, W. (2018). Developmental differences between preschool boys and girls in Northeastern Germany. *European Early Childhood Education Research Journal*, *26*(3), 316–333.

Lisowski, P., Kantanista, A., & Bronikowski, M. (2020). Are there any differences between first grade boys and girls in physical fitness, physical activity, BMI, and sedentary behavior? Results of HCSC study. *International Journal of Environmental Research and Public Health*, *17*(3), 1109.

Lưu, Q. H. (1994). *Tập bài giảng sinh lý học TDTT (Lectures on Sports Physiology)*. Tài liệu dùng cho các học viên cao học TDTT, Hà Nội.

Lưu, Q. H., & Phạm, T. U. (2003). *Sinh lý học TDTT (Physiology of sport)*. Nxb TDTT, Hà Nội.

Lý, Đ. T., Vũ, V. A., & Đoàn, A. T. (2013). *Các chương trình, chính sách phát triển Giáo dục thể chất ở một số quốc gia trên thế giới (Physical education development programs and policies in some countries around the world)*. Trung tâm Thông tin TDTT – Điểm tin tổng hợp phục vụ Quản lý nhà nước – Số 30, Tổng cục Thể dục thể thao.

Maghan, B. (2016). *The Effect of Physical Activity and Exercise on the Academic Achievement of Elementary School Students*. Graduate Programs in Education, Goucher College.

Marttinen, R. H. J., McLoughlin, G., Fredrick III, R., & Novak, D. (2017). Integration and physical education: A review of research. *Quest*, *69*(1), 37–49.

Mavilidi, M.-F., Okely, A. D., Chandler, P., Cliff, D. P., & Paas, F. (2015). Effects of integrated physical exercises and gestures on preschool children's foreign language vocabulary learning. *Educational Psychology Review*, *27*(3), 413–426.

Mavilidi, M. F., Lubans, D. R., Eather, N., Morgan, P. J., & Riley, N. (2018). Preliminary efficacy and feasibility of "thinking while moving in English": a program with physical activity integrated into primary school English lessons. *Children*, *5*(8), 109.

Mavilidi, M. F., & Vazou, S. (2021). Classroom-based physical activity and math performance: Integrated physical activity or not? *Acta Paediatrica*, *110*(7), 2149–

2156.

Mok, M. M. C., Chin, M.-K., Korcz, A., Popeska, B., Edginton, C. R., Uzunoz, F. S., Podnar, H., Coetzee, D., Georgescu, L., & Emeljanovas, A. (2020). Brain breaks® physical activity solutions in the classroom and on attitudes toward physical activity: A randomized controlled trial among primary students from eight countries. *International Journal of Environmental Research and Public Health*, *17*(5), 1666.

Morgan, P. J., Barnett, L. M., Cliff, D. P., Okely, A. D., Scott, H. A., Cohen, K. E., & Lubans, D. R. (2013). Fundamental movement skill interventions in youth: A systematic review and meta-analysis. *Pediatrics*, *132*(5), e1361–e1383.

Mostafavi, R., Ziaee, V., Akbari, H., & Haji-Hosseini, S. (2013). The effects of spark physical education program on fundamental motor skills in 4-6 year-old children. *Iranian Journal of Pediatrics*, *23*(2), 216.

Naskręt, M., Borowiec, J., Grzesiak, J., & Bronikowski, M. (2018). umiejętności grafomotoryczne uczniów klas pierwszych szkół podstawowych uczestniczących w zajęciach realizowanych różnymi metodami aktywizacji fizycznej. *Rozprawy Naukowe Akademii Wychowania Fizycznego We Wrocławiu*, *60*, 46–61.

Nguyễn, N. B. (1998). *Tâm lý học nhân cách – Một số vấn đề lý luận (Personality psychology – Some theoretical issues)*. Nxb Giáo dục, Hà Nội.

Nguyễn, N. C. (1996). *"Y học thể thao", Tài liệu bồi dưỡng nghiệp vụ bác sĩ thể thao, tập 1 + 2 ("Sports Medicine", Training manual for sports doctors, volume 1 + 2)*. Hà Nội.

Nguyễn, Q. U. (1995). *Tâm lý học đại cương (General Psychology)*. Nxb Giáo dục, Hà Hội.

Nguyễn, T. T. (1990). *Độ tuổi và những năng lực thể thao (Age and athletic abilities)*. Thông tin khoa học kỹ thuật TDTT (4), Hà Nội.

O'Brien, W., Belton, S., & Issartel, J. (2016). Fundamental movement skill proficiency amongst adolescent youth. *Physical Education and Sport Pedagogy*, *21*(6), 557–571.

Orim, R. E., & Ekwueme, C. O. (2011). The roles of games in teaching and learning of mathematics in junior secondary schools. *Global Journal of Educational Research*, *10*(2), 121–124.

Osher, D., Kendziora, K., Spier, E., & Garibaldi, M. L. (2014). School influences on child

and youth development. In *Defining prevention science* (pp. 151–169). Springer.

Pate, R. R., Saunders, R., Dishman, R. K., Addy, C., Dowda, M., & Ward, D. S. (2007). Long-term effects of a physical activity intervention in high school girls. *American Journal of Preventive Medicine*, *33*(4), 276–280.

Pem, D. (2015). Factors affecting early childhood growth and development: Golden 1000 days. *Adv Practice Nurs*, *1*(101), 347–2573.

Perić, M., & Masnjak, R. F. (2017). Differences between Boys and Girls in Developmental Areas. *Eurlyaid Conference 2017*, *159*, 351.

Phan, T. H. (2009). *Giáo trình sinh lý học trẻ mầm non (Textbook of Physiology of preschool children)*. Nxb Giáo dục, Hà Hội.

Piek, Jan P, Dawson, L., Smith, L. M., & Gasson, N. (2008). The role of early fine and gross motor development on later motor and cognitive ability. *Human Movement Science*, *27*(5), 668–681.

Piek, Jan Patricia, McLaren, S., Kane, R., Jensen, L., Dender, A., Roberts, C., Rooney, R., Packer, T., & Straker, L. (2013). Does the Animal Fun program improve motor performance in children aged 4–6 years? *Human Movement Science*, *32*(5), 1086–1096.

Pilicz, S., Przewęda, R., Nowacka-Dobosz, S., & Piłsudskiego, A. W. F. J. (2004). *Punktacja sprawności fizycznej młodzieży polskiej wg Międzynarodowego Testu Sprawności Fizycznej: Kryteria pomiaru wydolności organizmu testem Coopera*. Wydawnictwo AWF.

Pippi, R., Buratta, L., Germani, A., Fanelli, C. G., & Mazzeschi, C. (2020). Physical Activity Habits and Well-Being among 6-Year-Old Children: The "Improving Umbrian Kids' Healthy Lifestyle", an Uncontrolled Pilot Study Project. *International Journal of Environmental Research and Public Health*, *17*(17), 6067.

Pruitt, M., & Morini, G. (2021). Examining the Role of Physical Activity on Word Learning in School-Aged Children. *Journal of Speech, Language, and Hearing Research*, *64*(5), 1712–1725.

Przybylski, Ł., & Króliczak, G. (2017). Planning functional grasps of simple tools invokes the hand-independent praxis representation network: an fMRI study. *Journal of the International Neuropsychological Society*, *23*(2), 108–120.

Quốc Hội. (2019). *Luật Giáo dục số 43/2019/QH14 (Education Law No. 43/2019/QH14)*. https://www.bqllang.gov.vn/van-ban/vbpq-do-nha-nuoc-ban-hanh/9191-luat-giao-duc-so-43-2019-qh14-ngay-14-6-2019.html

Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: a systematic review of the literature. *Preventive Medicine*, *52*, S10–S20.

Rink, J. (2010). *Teaching physical education for learning – 6th ed*. Mc Graw Hill Higher Education.

Rokita, A. (2008). *Zajęcia ruchowe z piłkami edukacyjnymi" edubal" w kształceniu zintegrowanym a sprawność fizyczna oraz umiejętności czytania i pisania uczniów*. Wydawnictwo Akademii Wychowania Fizycznego.

Rokita, A., & Cichy, I. (2013). Edubal" educational balls: I learn while playing. *Glob. J. Health Phys. Educ. Pedagogy*, *2*, 289–297.

Rokita, A., & Cichy, I. (2014). "Edubal" as a new method in the pedagogy of games and ball games - a review of research. *Scientific Dissertations*, *45*, 70–78.

Rokita, A., Cichy, I., Wawrzyniak, S., & Korbecki, M. (2017). Eduball–Games and sports. *A Guide for Primary School Teachers and Cooperating Physical Education Teachers Carrying out the "Little Champion" Program. Wroclaw, Poland: Ministry of Sport and Tourism, Marshal Office of the Lower Silesia Region, and School Sports Association "Dolny Sl*.

Rokita, A., & Kaczmarczyk, M. (2011). Związki wykorzystania piłek edukacyjnych "edubal" z orientacją w przestrzeni u uczniów klasy I szkoły podstawowej. *Rozprawy Naukowe AWF We Wrocławiu*, *35*, 108–111.

Rokita, A., & Krysmann, A. (2011). Związki wykorzystania piłek edukacyjnych "edubal" z wybranymi zdolnościami motorycznymi uczniów klasy I szkoły podstawowej. *Rozprawy Naukowe AWF We Wrocławiu*, *35*, 112–121.

Rokita, A., & Rzepa, T. (2002). *Bawiąc-uczę się: piłki edukacyjne w kształceniu zintegrowanym*. Wydaw. AWF.

Rokita, A., & Rzepa, T. (2005). *Piłki edukacyjne w kształceniu wczesnoszkolnym*. Wydawnictwo Akademii Wychowania Fizycznego.

Rokita, A., Wawrzyniak, S., & Cichy, I. (2018a). EDUballs – An Innovative Interdisciplinary Approach to Teaching Preschool and Elementary School Physical Education: A review of studies in Poland. *EECERA*.

Rokita, A., Wawrzyniak, S., & Cichy, I. (2018b). *Learning by Playing!: 100 Games and Exercises of Brainballs*. University School of Physical Education in Wrocław, Poland.

Ruiz-Esteban, C., Terry Andrés, J., Méndez, I., & Morales, Á. (2020). Analysis of motor intervention program on the development of gross motor skills in preschoolers. *International Journal of Environmental Research and Public Health*, *17*(13), 4891.

Rzepa, T. (2003). Aktywność ruchowa z piłką w osiąganiu wybranych celów kształcenia w zakresie języka polskiego w drugiej klasie szkoły podstawowej. W: T. Koszczyc, J. Dembiński (red.), Instrumentalne wykorzystanie gier z piłką. *Wrocław: WTN*, s. 57–61.

Rzepa, T., & Wojcik, A. (2007). "Sprawnosc fizyczna dzieci klas I–III mieszkajacych w miescie (Physical fitness in urban primary schools)" in Pilki edukacyjne "Edubal" w ksztalceniu zintegrowanym. *Raport z Badan. Ed. T. Koszczyc (Wrocław: AWF)*, 26–32.

Salkind, N. J. (2010). *Encyclopedia of research design* (Vol. 1). Thousand Oaks, CA: SAGE Publications, Inc. https://doi.org/10.4135/9781412961288

Schell, L. M., Gallo, M. V, & Ravenscroft, J. (2009). Environmental influences on human growth and development: historical review and case study of contemporary influences. *Annals of Human Biology*, *36*(5), 459–477.

Schmidt-Kassow, M., Deusser, M., Thiel, C., Otterbein, S., Montag, C., Reuter, M., Banzer, W., & Kaiser, J. (2013). Physical exercise during encoding improves vocabulary learning in young female adults: a neuroendocrinological study. *PloS One*, *8*(5), e64172.

Selvam, P. (2013). A study on relationship between parental education and student achievement. *Education Research Journal*, *3*(3), 75–82.

Sgrò, F., Quinto, A., Messana, L., Pignato, S., & Lipoma, M. (2017). Assessment of gross motor developmental level in Italian primary school children. *Journal of Physical Education and Sport*, *17*(3), 1954–1959.

Sibley, B. A., & Etnier, J. L. (2003). The relationship between physical activity and

cognition in children: a meta-analysis. *Pediatric Exercise Science*, *15*(3), 243–256.

Skinner, R. A., & Piek, J. P. (2001). Psychosocial implications of poor motor coordination in children and adolescents. *Human Movement Science*, *20*(1–2), 73–94.

Sneck, S., Viholainen, H., Syväoja, H., Kankaapää, A., Hakonen, H., Poikkeus, A.-M., & Tammelin, T. (2019). Effects of school-based physical activity on mathematics performance in children: a systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *16*(1), 1–15.

So, W.-Y. (2012). Association between physical activity and academic performance in Korean adolescent students. *BMC Public Health*, *12*(1), 1–7.

Strong, W. B., Malina, R. M., Blimkie, C. J. R., Daniels, S. R., Dishman, R. K., Gutin, B., Hergenroeder, A. C., Must, A., Nixon, P. A., & Pivarnik, J. M. (2005). Evidence based physical activity for school-age youth. *The Journal of Pediatrics*, *146*(6), 732–737.

Thomas, J. R., & French, K. E. (1985). Gender differences across age in motor performance: A meta-analysis. *Psychological Bulletin*, *98*(2), 260.

Thompson, S. D., & Robertson, J. L. (2015). The Effects of integrating mathematics into the physical education setting. *SOPHIA*, 1–50. http://sophia.stkate.edu/cgi/viewcontent.cgi?article=1102&context=maed

Tô, T. Á., & Nguyễn, T. B. H. (1991). *Tâm lý học lứa tuổi (Psychology of age)*. Nxb Giáo dục, Hà Nội.

To, T., Cadarette, S. M., & Liu, Y. (2001). Biological, social, and environmental correlates of preschool development. *Child: Care, Health and Development*, *27*(2), 187–200.

Tomporowski, P. D., Davis, C. L., Miller, P. H., & Naglieri, J. A. (2008). Exercise and children's intelligence, cognition, and academic achievement. *Educational Psychology Review*, *20*(2), 111–131.

Trịnh, N. B., & Trần, H. T. (1998). *Giải phẩu và sinh lý học trẻ em (Anatomy and physiology of children)*. Nxd Giáo dục, Hà Nôi.

Udida, L. A., Ukwayi, J. K., & Ogodo, F. A. (2012). Parental socioeconomic background as a determinant of student's academic performance in selected public secondary schools in Calabar Municipal Local Government Area, Cross River State, Nigeria. *Journal of Education and Practice*, *3*(16), 129–135.

Ulrich, D. . (2000). *Test of Gross Motor Development, 2nd Edition*. Austin, TX: PRO-ED.

Uysal, N., Tugyan, K., Kayatekin, B. M., Acikgoz, O., Bagriyanik, H. A., Gonenc, S., Ozdemir, D., Aksu, I., Topcu, A., & Semin, I. (2005). The effects of regular aerobic exercise in adolescent period on hippocampal neuron density, apoptosis and spatial memory. *Neuroscience Letters*, *383*(3), 241–245.

Valantine, I., Madic, D., & Sporis, G. (2017). Effects of invasion games on physical fitness in primary school children. *Exercise and Quality of Life*, *9*(1), 15–22.

Vazou, S., Long, K., Lakes, K. D., & Whalen, N. L. (2021). "Walkabouts" integrated physical activities from preschool to second grade: Feasibility and effect on classroom engagement. *Child & Youth Care Forum*, *50*(1), 39–55.

Vernadakis, N., Papastergiou, M., Zetou, E., & Antoniou, P. (2015). The impact of an exergame-based intervention on children's fundamental motor skills. *Computers & Education*, *83*, 90–102.

Walkley, J., Holland, B. V, Treloar, R., & O'Connor, J. (1996). *Fundamental motor skills: A manual for classroom teachers*. Victoria. Department of Education.

Wang, J., Wildman, L., & Calhoun, G. (1996). The relationships between parental influence and student achievement in seventh grade mathematics. *School Science and Mathematics*, *96*(8), 395–399.

Wawrzyniak, S. (2016). *Sprawność grafomotoryczna, koordynacyjna oko-ręka i orientacja czasowo-przestrzenna uczniów klasy pierwszej szkoły podstawowej uczestniczących w zajęciach ruchowych z piłkami edukacyjnycmi "Edubal."* Praca doktorska. Akademia Wychowania Fizycznego we Wrocławiu.

Wawrzyniak, Sara, Cichy, I., Matias, A. R., Pawlik, D., Kruszwicka, A., Klichowski, M., & Rokita, A. (2021). Physical Activity With Eduball Stimulates Graphomotor Skills in Primary School Students. *Frontiers in Psychology*, *12*, 606.

Wawrzyniak, Sara, Korbecki, M., Cichy, I., Kruszwicka, A., Przybyla, T., Klichowski, M., & Rokita, A. (2022). Everyone Can Implement Eduball in Physical Education to Develop Cognitive and Motor Skills in Primary School Students. *International Journal of Environmental Research and Public Health*, *19*(3), 1275.

Wawrzyniak, Sara, Rokita, A., & Pawlik, D. (2015). Temporal-spatial orientation in first-grade pupils from elementary school participating in physical education classes using

Edubal educational balls. *Baltic Journal of Health and Physical Activity. The Journal of Gdansk University of Physical Education and Sport*, *2*(07).

Yen, I. H., & Syme, S. L. (1999). The social environment and health: a discussion of the epidemiologic literature. *Annual Review of Public Health*, *20*(1), 287–308.

Žumarova, M. (2014). The Influence of Social Environment on Child Development in Preschool Age. *International Journal of Early Childhood Learning*, *20*(3), 11–19.

Żurek, G. (2012). *Zdolności motoryczne i cechy somatyczne a osiągnięcia szkolne uczniów wiejskich szkół podstawowych z Dolnego Śląska*. Wydawnictwo Akademii Wychowania Fizycznego.

ABSTRACT

The purpose of the study was to evaluate the impact of the Brainball program in physical education classes on English skills, math skills, fundamental motor skills, and physical fitness of 7-year-old pupils in Vietnam.

The study was conducted in the school year 2019-2020 at an elementary school in An Giang. A total of 55 students (23 boys and 32 girls) aged seven years participated in the study. The study design was a pedagogical experiment with the use of the technique of parallel groups. The pedagogical experiment involved two groups: 28 students (12 boys, 16 girls) in the control group and 27 students (11 boys and 16 girls) in the experimental group – the groups (control and experimental) were assigned to the research program by a random selection. The teaching process was conducted in both groups (experimental and control) based on the same curriculum specified by Vietnam's Ministry of Education and Training. All physical education classes in the experimental group were taken twice a week for 35 minutes, including the educational balls tasks. In the control group, physical education classes were also taken twice a week for 35 minutes and conducted with a traditional curriculum (without BRAINballs).

The study conducted tests on fundamental motor skills, physical fitness, math skills, and English skills of students in two groups (experimental and control) at two periods: the beginning of the school year (September 2019) and the end of the first semester (January 2020) and for estimating long-terms effects third time in September 2020. Fundamental motor skills and physical fitness tests were conducted at the training ground during physical education classes. Math and English tests were taken in the classroom during regular school hours. In addition, prior to taking the tests, information about the tests and how to perform it has been approved by the principal, teachers, and parents of students.

The analysis results showed no significant differences in math skills, English skills, and physical fitness development between 7-year-old pupils from the experimental group and the control group after 20 weeks of experimentation. However, there were significant differences in the level of physical fitness development, math skills, and English skills between pupils from the experimental and control groups after one school year. Pupils from the experimental group improved significantly compared with pupils from the control group in math skills ($p=0.003$), English skills ($p=0.005$) and in physical fitness level,

specifically in 50-meter running (p=0.004), Toe touch (p=0.013), Standing long jump (p=0.007), 4 x 10m sprint (p=0.033), Hand strength (p=0.023).

The level of fundamental motor skills of 7-year-old pupils at the second test (after 20 weeks of testing) could not be measured because of the COVID-19 epidemic. However, the results of a follow-up study (after one school year) showed that pupils from the experimental group had significant improvements compared with pupils from the control group on both sub-tests, locomotor skills p=0.001, object control skills p=0.001.

Research also demonstrated that there were no gender differences in the development of English and maths skills, funadamental motor skills, and physical fitness when the education balls were used in physical education classes for 7-year-olds pupils in Vietnam.

The results of this study provide promising early findings that the adoption of BRAINballs in preschool and primary curriculum in Vietnam could be a useful solution for improving students' mobility and academic performance.

List of pictures

List of tables

Appendix

Appendix 1. Sample scenario of physical activities integrated with course content implemented using Brainballs

The games were conducted at the experimental class during week 9 on October 24, 2019.

LESSON 18

GAMES "PAIR UP", "WATCH OUT"

- - - - - -

I. Objective:

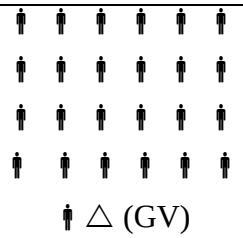
- Game "Pair up" to practice the distinction between even and odd digits and improve certain motor skills.

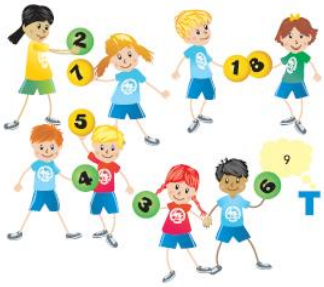
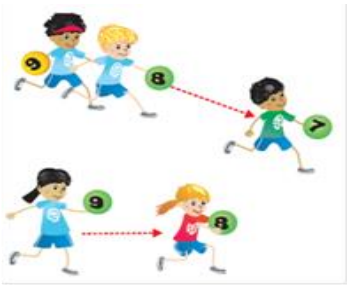
- Game "Watch out" to improve the students' knowledge of the digit order in an increasing number sequence, practice their perceptiveness and orientation in space and time, and improve certain motor abilities and physical skills.

II. Place - Equipment:

- Place: open air.
- Equipment: educational balls, rings.
- Time: 35 minutes.
- Class: II
- Number of students: 27

III. Content and methods:

Main contents	*Time*	*Organization method*
I. Introduction: 1. Gathering, introducing the students to the subject of the classes. 2. Warm-up: are different interactive games, role-playing, moving around and so on. **II. Content Development** 1. Pair up: Each student has a green or yellow ball. They are galloping across the gymnasium when, at	5' 25'	 △ (GV)

the teacher's signal, they have to pair up in indicated combinations of numbers and colors, e.g. even and odd numbers in the same colors or even and odd number in separate colors. 2. Watch out: Each student has a green or yellow ball with a number from 0 to 9. The teacher appoints catchers. The catchers are the students with balls with the digit "9" on them. The catchers' task is to tag students with the digit "8". After a student has been tagged, they pair up with the catcher and try to tag the student with the digit "7" together, etc. The game is over when all the digits have been tagged. **III. Closure:** 1. Relax. 2. Remind the purpose of the lesson for the day. 3. Comments: to review important cues to skill development, to praise the behavior, and so forth. 4. Introduce the content of the new lesson.	5'	   △ (GV)

LESSON 18

GAMES "PAIR UP", "WATCH OUT"

- - - - - -

I. Mục tiêu:

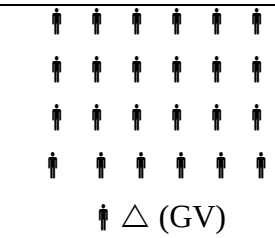
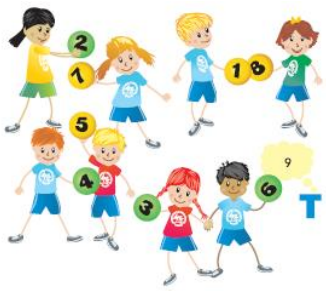
- Trò chơi "Pair up" để thực hành sự phân biệt giữa các chữ số chẵn và lẻ và cải thiện một số kỹ năng vận động.

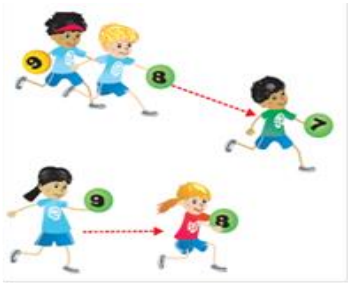
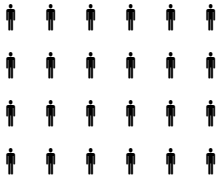
- Trò chơi "Watch out" nhằm nâng cao kiến thức cho học sinh về thứ tự các chữ số trong dãy số tăng dần, rèn luyện khả năng nhận thức và định hướng trong không gian và thời gian, đồng thời nâng cao một số năng lực vận động và kỹ năng thể chất.

II. Địa điểm - Thiết bị:

- Địa điểm: ngoài trời.
- Thiết bị: bóng giáo dục, vòng.
- Thời gian: 35 phút.
- Lớp: II
- Số học sinh: 27

III. Nội dung và phương pháp:

Nội dung bài học	*TG*	*Phương pháp tổ chức*
I. Giới thiệu: 1. Tập hợp, giới thiệu học sinh về chủ đề của bài học. 2. Khởi động: là các trò chơi tương tác khác nhau, nhập vai, di chuyển, vân vân. **II. Phát triển nội dung** 1. Pair up: Mỗi học sinh có một quả bóng màu xanh lá cây hoặc màu vàng. Họ đang phi nước đại trên sân thể dục khi nghe tín hiệu của giáo viên, họ phải ghép đôi theo các tổ hợp số và màu được chỉ định, ví dụ: số chẵn và số lẻ cùng màu hoặc số chẵn và số lẻ khác màu.	5' 25'	 △ (GV) 

2. Watch out: Mỗi học sinh có một quả bóng màu xanh lá cây hoặc màu vàng với các số từ 0 đến 9. Giáo viên chỉ định người bắt. Những người bắt được là những học sinh có quả bóng có chữ số "9" trên chúng. Nhiệm vụ của người bắt là chạm học sinh với chữ số "8". Sau khi một học sinh đã được chạm, họ bắt cặp với người bắt và cố gắng chạm học sinh có chữ số "7" với nhau, v.v. Trò chơi kết thúc khi tất cả các chữ số đã được chạm. **III. Phần kết thúc:** 1. Thả lỏng. 2. Nhắc lại mục đích học trong ngày. 3. Nhận xét: để xem xét các tín hiệu quan trọng để phát triển kỹ năng, khen ngợi hành vi, v.v. 4. Giới thiệu nội dung bài học mới.	5’	  △ (GV)

Appendix 2. Math and English test sample

TRƯỜNG PHỔ THÔNG QUỐC TẾ GIS Họ tên: Lớp: Năm học: 2019 - 2020	MÔN TOÁN CHỦ ĐỀ: HỌC TRONG KHI CHƠI

1. Tìm số (1 điểm)

a) Số lớn nhất có hai chữ số khác nhau là:.....

b) Những số tròn chục có hai chữ số bé hơn 50 là:.....

2. Khoanh vào chữ có các số xếp theo thứ tự từ bé đến lớn (1 điểm)

a) 36, 28, 39, 72, 94, 82

b) 94, 82, 72, 39, 36, 28

c) 28, 36, 39, 72, 82, 94

d) 39, 94, 36, 72, 28, 82

3. Tính: (2 điểm)

a) 23 + 4 – 19 = ...
=.....

b. 24 + 18 – 28 =.....
=.....

4. Khoanh vào chữ đặt trước kết quả đúng (1 điểm)

☐ + 8 = 8

A. ☐ = 8 B. ☐ = 10 C. ☐ = 0

5. Điền dấu (> < =) vào chỗ trống (2 điểm)

a) 15 + 34 50

b) 78 ..... 38 + 42

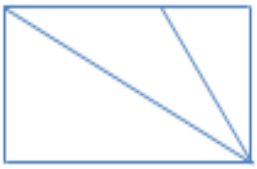
c) 79 – 12 60

d) 95 - 18.....28 + 49

6. Trong hình bên có bao nhiêu hình: (1 điểm)

A. .....tứ giác

B. .....tam giác



7. Bài toán (2 điểm)

Đội A trồng được 86 cây bạch đàn, đội B trồng nhiều hơn đội A 8 cây bạch đàn. Hỏi đội B trồng được bao nhiêu cây bạch đàn.

Bài giải

.....

.....

.....

.....

Name:.....

Class:.....

GLOBAL INTERNATIONAL SCHOOL

FINAL EXAM – GRADE 2

☆ ☆

I. MATCHING:

1. Horse
2. Candy
3. Bird
4. Swim
5. Chicken

A.

B.

C.

D.

E.

II. UNSCRAMBLE WORDS:

1. wrelfo →.....	
2. cie - recam →.....	
3. lnoi →.....	
4. sihf →.....	
5. rteku →.....	

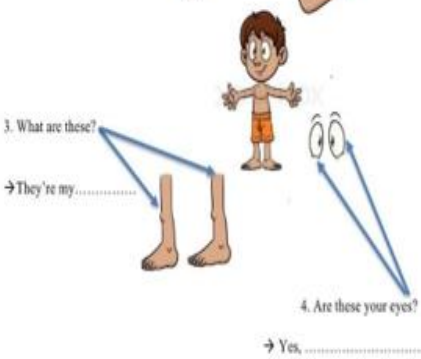
III. COMPLETE THE SENTENCES:

1. What's this?

→This is my.....

2. Is this your leg?

→No,.....



3. What are these?

→They're my.....

4. Are these your eyes?

→ Yes, ...

IV. REARRANGE THESE STATEMENTS:

1. like / I / bread. I / like / rice / don't.

→.....

2. I / bike / can't / ride / a.

→.....

3. can / I / my / brush / teeth.

→.....

4. are / those / trains / short.

→.....

Appendix 3. Supplementary Table

Table 4. Mean and standard deviation (SD) of the experimental and control groups in the 50-meter running test at the first, second, and follow-up examination

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=5.7196, p=.00442 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	13.224	0.3068	12.608	13.840	27
2	Control	II	13.079	0.3167	12.444	13.715	27
3	Control	III	12.423	0.2458	11.929	12.916	27
4	Experimental	I	13.404	0.2992	12.804	14.005	28
5	Experimental	II	13.196	0.3087	12.576	13.815	28
6	Experimental	III	11.905	0.2397	11.424	12.386	28

Table 5. Results of Tukey's post hoc test of 50-meter running in pupils from the experimental and control groups at the first, second, and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 2.2149, df Group	R1	{1} 13.318	{2} 13.193	{3} 12.499	{4} 13.485	{5} 13.238	{6} 11.927
1	Control	I		0.971	0.000	0.998	1.000	0.012
2	Control	II	0.971		0.001	0.978	1.000	0.028
3	Control	III	0.000	0.001		0.153	0.447	0.712
4	Experimental	I	0.998	0.978	0.153		0.624	0.000
5	Experimental	II	1.000	1.000	0.447	0.624		0.000
6	Experimental	III	0.012	0.028	0.712	0.000	0.000	

Table 6. Results of Tukey's post hoc test of 50-meter running in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

Nr	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 2.2149, df Group	Gender	R1	{1} 13.731	{2} 13.692	{3} 12.832	{4} 12.716	{5} 12.466	{6} 12.014	{7} 13.966	{8} 13.494	{9} 12.056	{10} 12.843	{11} 12.897	{12} 11.754
1	C	Girl	I		1.000	0.002	0.842	0.577	0.150	1.000	1.000	0.086	0.915	0.944	0.040
2	C	Girl	II	1.000		0.004	0.873	0.622	0.173	1.000	1.000	0.103	0.936	0.959	0.048
3	C	Girl	III	0.002	0.004		1.000	1.000	0.959	0.586	0.981	0.942	1.000	1.000	0.757
4	C	Boy	I	0.842	0.873	1.000		0.998	0.198	0.594	0.971	0.992	1.000	1.000	0.920
5	C	Boy	II	0.577	0.622	1.000	0.998		0.814	0.317	0.831	1.000	1.000	1.000	0.991
6	C	Boy	III	0.150	0.173	0.959	0.198	0.814		0.056	0.335	1.000	0.971	0.955	1.000
7	E	Girl	I	1.000	1.000	0.586	0.594	0.317	0.056		0.509	0.000	0.706	0.766	0.012
8	E	Girl	II	1.000	1.000	0.981	0.971	0.831	0.335	0.509		0.000	0.991	0.996	0.115
9	E	Girl	III	0.086	0.103	0.942	0.992	1.000	1.000	0.000	0.000		0.963	0.941	1.000
10	E	Boy	I	0.915	0.936	1.000	1.000	1.000	0.971	0.706	0.991	0.963		1.000	0.001
11	E	Boy	II	0.944	0.959	1.000	1.000	1.000	0.955	0.766	0.996	0.941	1.000		0.001
12	E	Boy	III	0.040	0.048	0.757	0.920	0.991	1.000	0.012	0.115	1.000	0.001	0.001	

Table 7. Mean and standard deviation (SD) of the experimental and control groups in the Toe touch test at the first, second, and follow-up examinations

	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=4.4744, p=.01372 Dekompozycja efektywnych hipotez						
Nr podkl.	Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	5.327	0.634	4.055	6.599	27
2	Control	II	6.082	0.493	5.092	7.073	27
3	Control	III	8.216	0.485	7.242	9.189	27
4	Experimental	I	3.542	0.618	2.302	4.782	28
5	Experimental	II	5.385	0.481	4.420	6.351	28
6	Experimental	III	8.313	0.473	7.363	9.262	28

Table 8. Results of Tukey's post hoc test of the Toe touch in pupils from the experimental and control groups at the first, second, and follow-up examinations

	Test Newmana-Keulsa; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 7.6462, df							
Nr podkl.	Group	R1	{1} 5.5556	{2} 6.1481	{3} 8.2222	{4} 3.6786	{5} 5.5000	{6} 8.3929
1	Control	I		0.182	0.000	0.036	0.941	0.002
2	Control	II	0.182		0.000	0.007	0.661	0.010
3	Control	III	0.000	0.000		0.000	0.003	0.820
4	Experimental	I	0.036	0.007	0.000		0.000	0.000
5	Experimental	II	0.941	0.661	0.003	0.000		0.000
6	Experimental	III	0.002	0.010	0.820	0.000	0.000	

Table 9. Results of Tukey's post hoc test of the Toe touch in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 7.6462, df														
Nr	Group	Gender	R1	{1} 6.562	{2} 6.437	{3} 8.250	{4} 4.090	{5} 5.727	{6} 8.181	{7} 4.500	{8} 6.187	{9} 8.875	{10} 2.583	{11} 4.583	{12} 7.750
1	C	Girl	I		1.000	0.149	0.497	1.000	0.938	0.618	1.000	0.441	0.015	0.771	0.993
2	C	Girl	II	1.000		0.087	0.578	1.000	0.900	0.704	1.000	0.359	0.022	0.836	0.984
3	C	Girl	III	0.149	0.087		0.012	0.465	1.000	0.012	0.618	1.000	0.000	0.037	1.000
4	C	Boy	I	0.497	0.578	0.012		0.449	0.000	1.000	0.734	0.002	0.976	1.000	0.084
5	C	Boy	II	1.000	1.000	0.465	0.449		0.030	0.992	1.000	0.158	0.234	0.998	0.838
6	C	Boy	III	0.938	0.900	1.000	0.000	0.030		0.045	0.790	1.000	0.000	0.096	1.000
7	E	Girl	I	0.618	0.704	0.012	1.000	0.992	0.045		0.149	0.000	0.805	1.000	0.106
8	E	Girl	II	1.000	1.000	0.618	0.734	1.000	0.790	0.149		0.001	0.044	0.931	0.942
9	E	Girl	III	0.441	0.359	1.000	0.002	0.158	1.000	0.000	0.001		0.000	0.006	0.995
10	E	Boy	I	0.015	0.022	0.000	0.976	0.234	0.000	0.805	0.044	0.000		0.124	0.000
11	E	Boy	II	0.771	0.836	0.037	1.000	0.998	0.096	1.000	0.931	0.006	0.124		0.001
12	E	Boy	III	0.993	0.984	1.000	0.084	0.838	1.000	0.106	0.942	0.995	0.000	0.001	

Table 10. Mean and standard deviation (SD) of the experimental and control groups in the standing long jump test at the first, second, and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=5.1121, p=.00766 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	100.119	2.35180	95.398	104.841	27
2	Control	II	100.355	2.60769	95.120	105.590	27
3	Control	III	113.705	1.66708	110.358	117.051	27
4	Experimental	I	101.292	2.29300	96.688	105.895	28
5	Experimental	II	105.479	2.54249	100.375	110.583	28
6	Experimental	III	123.688	1.62540	120.424	126.951	28

Table 11. Results of Tukey's post hoc test of the standing long jump in pupils from the experimental and control groups at the first, second, and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 131.33, df Group	R1	{1} 98.963	{2} 100.19	{3} 113.30	{4} 100.64	{5} 105.07	{6} 123.43
1	Control	I		0.989	0.000	0.994	0.364	0.000
2	Control	II	0.989		0.000	1.000	0.613	0.000
3	Control	III	0.000	0.000		0.001	0.094	0.018
4	Experimental	I	0.994	1.000	0.001		0.195	0.000
5	Experimental	II	0.364	0.613	0.094	0.195		0.000
6	Experimental	III	0.000	0.000	0.018	0.000	0.000	

Table 12. Results of Tukey's post hoc test of the standing long jump in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

Nr	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 131.33, df Group	Gender	R1	{1} 93.875	{2} 99.437	{3} 111.50	{4} 106.36	{5} 101.27	{6} 115.91	{7} 96.750	{8} 102.63	{9} 121.87	{10} 105.83	{11} 108.33	{12} 125.50
1	C	Girl	I		0.550	0.000	0.206	0.886	0.000	1.000	0.583	0.000	0.229	0.058	0.000
2	C	Girl	II	0.550		0.000	0.924	1.000	0.020	1.000	1.000	0.000	0.947	0.670	0.000
3	C	Girl	III	0.000	0.000		0.992	0.499	0.998	0.022	0.561	0.318	0.978	1.000	0.077
4	C	Boy	I	0.206	0.924	0.992		0.876	0.088	0.595	1.000	0.038	1.000	1.000	0.007
5	C	Boy	II	0.886	1.000	0.499	0.876		0.000	0.997	1.000	0.001	0.998	0.943	0.000
6	C	Boy	III	0.000	0.020	0.998	0.088	0.000		0.003	0.139	0.973	0.620	0.910	0.689
7	E	Girl	I	1.000	1.000	0.022	0.595	0.997	0.003		0.464	0.000	0.641	0.271	0.000
8	E	Girl	II	0.583	1.000	0.561	1.000	1.000	0.139	0.464		0.000	1.000	0.977	0.000
9	E	Girl	III	0.000	0.000	0.318	0.038	0.001	0.973	0.000	0.000		0.020	0.100	1.000
10	E	Boy	I	0.229	0.947	0.978	1.000	0.998	0.620	0.641	1.000	0.020		0.999	0.000
11	E	Boy	II	0.058	0.670	1.000	1.000	0.943	0.910	0.271	0.977	0.100	0.999		0.000
12	E	Boy	III	0.000	0.000	0.077	0.007	0.000	0.689	0.000	0.000	1.000	0.000	0.000	

Table 13. Mean and standard deviation (SD) of the experimental and control groups in the 4 x 10 m sprint test at the first, second, and follow-up examinations

	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=3.5158, p=.03338 Dekompozycja efektywnych hipotez						
Nr podkl.	Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	16.309	0.3369	15.633	16.985	27
2	Control	II	15.768	0.2348	15.297	16.240	27
3	Control	III	14.892	0.2301	14.430	15.354	27
4	Experimental	I	16.409	0.3285	15.750	17.069	28
5	Experimental	II	15.477	0.2290	15.017	15.937	28
6	Experimental	III	14.218	0.2243	13.768	14.669	28

Table 14. Results of Tukey's post hoc test of the 4 x 10 m sprint in pupils from the experimental and control groups at the first, second, and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.9258, df							
Nr podkl.	Group	R1	{1} 16.347	{2} 15.783	{3} 14.883	{4} 16.445	{5} 15.485	{6} 14.246
1	Control	I		0.076	0.000	1.000	0.206	0.000
2	Control	II	0.076		0.001	0.492	0.967	0.001
3	Control	III	0.000	0.001		0.001	0.596	0.536
4	Experimental	I	1.000	0.492	0.001		0.000	0.000
5	Experimental	II	0.206	0.967	0.596	0.000		0.000
6	Experimental	III	0.000	0.001	0.536	0.000	0.000	

Table 15. Results of Tukey's post hoc test of the 4 x 10 m sprint in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.9258, df												
Nr	Group	Gender	R1	{1} 16.513	{2} 15.850	{3} 14.841	{4} 16.105	{5} 15.686	{6} 14.943	{7} 16.663	{8} 15.530	{9} 14.416	{10} 16.156	{11} 15.424	{12} 14.021
1	C	Girl	I		0.362	0.000	1.000	0.930	0.166	1.000	0.690	0.003	1.000	0.656	0.001
2	C	Girl	II	0.362		0.013	1.000	1.000	0.876	0.882	1.000	0.154	1.000	1.000	0.040
3	C	Girl	III	0.000	0.013		0.468	0.920	1.000	0.019	0.959	0.999	0.368	0.994	0.922
4	C	Boy	I	1.000	1.000	0.468		0.977	0.023	0.997	0.996	0.099	1.000	0.989	0.026
5	C	Boy	II	0.930	1.000	0.920	0.977		0.476	0.815	1.000	0.460	1.000	1.000	0.171
6	C	Boy	III	0.166	0.876	1.000	0.023	0.476		0.086	0.995	0.998	0.628	1.000	0.907
7	E	Girl	I	1.000	0.882	0.019	0.997	0.815	0.086		0.003	0.000	0.998	0.461	0.000
8	E	Girl	II	0.690	1.000	0.959	0.996	1.000	0.995	0.003		0.004	0.989	1.000	0.182
9	E	Girl	III	0.003	0.154	0.999	0.099	0.460	0.998	0.000	0.004		0.063	0.754	1.000
10	E	Boy	I	1.000	1.000	0.368	1.000	1.000	0.628	0.998	0.989	0.063		0.432	0.000
11	E	Boy	II	0.656	1.000	0.994	0.989	1.000	1.000	0.461	1.000	0.754	0.432		0.001
12	E	Boy	III	0.001	0.040	0.922	0.026	0.171	0.907	0.000	0.182	1.000	0.000	0.001	

Table 16. Mean and standard deviation (SD) of the experimental and control groups in the Hand strength test at the first, second, and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=3.8974, p=.02338 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	10.413	0.5395	9.330	11.496	27
2	Control	II	10.483	0.4539	9.572	11.395	27
3	Control	III	11.696	0.3346	11.024	12.367	27
4	Experimental	I	9.306	0.5260	8.250	10.362	28
5	Experimental	II	9.863	0.4426	8.974	10.751	28
6	Experimental	III	11.672	0.3262	11.017	12.327	28

Table 17. Results of Tukey's post hoc test of the Hand strength in students from the experimental and control groups at the first, second, and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 5.2938, df Group	R1	{1} 10.219	{2} 10.411	{3} 11.560	{4} 9.2893	{5} 9.7857	{6} 11.621
1	Control	I		0.981	0.000	0.667	0.982	0.225
2	Control	II	0.981		0.001	0.468	0.914	0.382
3	Control	III	0.000	0.001		0.007	0.061	1.000
4	Experimental	I	0.667	0.468	0.007		0.440	0.000
5	Experimental	II	0.982	0.914	0.061	0.440		0.000
6	Experimental	III	0.225	0.382	1.000	0.000	0.000	

Table 18. Results of Tukey's post hoc test of the Hand strength in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

Nr	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 5.2938, df Group	Gender	R1	{1} 9.3625	{2} 10.094	{3} 10.966	{4} 11.464	{5} 10.873	{6} 12.425	{7} 9.1875	{8} 9.3250	{9} 11.316	{10} 9.4250	{11} 10.400	{12} 12.028
1	C	Girl	I		0.653	0.001	0.466	0.873	0.049	1.000	1.000	0.420	1.000	0.989	0.122
2	C	Girl	II	0.653		0.381	0.930	0.999	0.308	0.993	0.998	0.935	1.000	1.000	0.555
3	C	Girl	III	0.001	0.381		1.000	1.000	0.896	0.565	0.681	1.000	0.836	1.000	0.987
4	C	Boy	I	0.466	0.930	1.000		0.965	0.522	0.343	0.438	1.000	0.609	0.993	1.000
5	C	Boy	II	0.873	0.999	1.000	0.965		0.022	0.773	0.854	1.000	0.933	1.000	0.987
6	C	Boy	III	0.049	0.308	0.896	0.522	0.022		0.028	0.043	0.984	0.098	0.618	1.000
7	E	Girl	I	1.000	0.993	0.565	0.343	0.773	0.028		1.000	0.000	1.000	0.963	0.075
8	E	Girl	II	1.000	0.998	0.681	0.438	0.854	0.043	1.000		0.000	1.000	0.985	0.110
9	E	Girl	III	0.420	0.935	1.000	1.000	1.000	0.984	0.000	0.000		0.588	0.996	1.000
10	E	Boy	I	1.000	1.000	0.836	0.609	0.933	0.098	1.000	1.000	0.588		0.431	0.000
11	E	Boy	II	0.989	1.000	1.000	0.993	1.000	0.618	0.963	0.985	0.996	0.431		0.007
12	E	Boy	III	0.122	0.555	0.987	1.000	0.987	1.000	0.075	0.110	1.000	0.000	0.007	

Table 19. Mean and standard deviation (SD) of the experimental and control groups in the Bent arm hang test at the first, second, and follow-up examinations

	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=.37550, p=.68789 Dekompozycja efektywnych hipotez						
Nr podkl.	Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	2.173	0.172	1.827	2.518	27
2	Control	II	2.556	0.145	2.265	2.847	27
3	Control	III	3.833	0.120	3.592	4.073	27
4	Experimental	I	2.372	0.168	2.035	2.709	28
5	Experimental	II	2.842	0.141	2.559	3.125	28
6	Experimental	III	3.970	0.117	3.735	4.204	28

Table 20. Results of Tukey's post hoc test of the Bent arm hang in students from the experimental and control groups at the first, second, and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .56447, df							
Nr podkl.	Group	R1	{1} 2.1707	{2} 2.5189	{3} 3.8000	{4} 2.3782	{5} 2.8532	{6} 3.9857
1	Control	I		0.055	0.000	0.909	0.014	0.000
2	Control	II	0.055		0.000	0.982	0.568	0.000
3	Control	III	0.000	0.000		0.000	0.000	0.941
4	Experimental	I	0.909	0.982	0.000		0.002	0.000
5	Experimental	II	0.014	0.568	0.000	0.002		0.000
6	Experimental	III	0.000	0.000	0.941	0.000	0.000	

Table 21. Results of Tukey's post hoc test of the Bent arm hang in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .56447, df													
Nr	Group	Gender	R1	{1} 2.1619	{2} 2.3550	{3} 3.6563	{4} 2.1836	{5} 2.7573	{6} 4.0091	{7} 2.4138	{8} 2.9206	{9} 4.0812	{10} 2.3308	{11} 2.7633	{12} 3.8583
1	C	Girl	I		0.986	0.000	1.000	0.677	0.000	0.998	0.177	0.000	1.000	0.627	0.000
2	C	Girl	II	0.986		0.000	1.000	0.967	0.000	1.000	0.604	0.000	1.000	0.956	0.000
3	C	Girl	III	0.000	0.000		0.000	0.112	0.988	0.001	0.213	0.904	0.001	0.097	1.000
4	C	Boy	I	1.000	1.000	0.000		0.118	0.000	1.000	0.352	0.000	1.000	0.786	0.000
5	C	Boy	II	0.677	0.967	0.112	0.118		0.000	0.990	1.000	0.001	0.968	1.000	0.033
6	C	Boy	III	0.000	0.000	0.988	0.000	0.000		0.000	0.019	1.000	0.000	0.008	1.000
7	E	Girl	I	0.998	1.000	0.001	1.000	0.990	0.000		0.071	0.000	1.000	0.986	0.000
8	E	Girl	II	0.177	0.604	0.213	0.352	1.000	0.019	0.071		0.000	0.655	1.000	0.065
9	E	Girl	III	0.000	0.000	0.904	0.000	0.001	1.000	0.000	0.000		0.000	0.001	1.000
10	E	Boy	I	1.000	1.000	0.001	1.000	0.968	0.000	1.000	0.655	0.000		0.431	0.000
11	E	Boy	II	0.627	0.956	0.097	0.786	1.000	0.008	0.986	1.000	0.001	0.431		0.000
12	E	Boy	III	0.000	0.000	1.000	0.000	0.033	1.000	0.000	0.065	1.000	0.000	0.000	

Table 22. Mean and standard deviation (SD) of the experimental and control groups in the Sit-ups test at the first, second, and follow-up examinations

	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=.58502, p=.55895 Dekompozycja efektywnych hipotez						
Nr podkl.	Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	8.310	0.6901	6.924	9.695	27
2	Control	II	10.173	0.5257	9.118	11.229	27
3	Control	III	17.338	0.7186	15.895	18.781	27
4	Experimental	I	9.042	0.6728	7.691	10.392	28
5	Experimental	II	11.354	0.5126	10.325	12.383	28
6	Experimental	III	17.396	0.7006	15.989	18.802	28

Table 23. Results of Tukey's post hoc test of the Sit-ups in students from the experimental and control groups at the first, second, and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 11.029, df							
Nr podkl.	Group	R1	{1} 8.3333	{2} 10.222	{3} 17.148	{4} 9.1429	{5} 11.464	{6} 17.607
1	Control	I		0.115	0.000	0.946	0.006	0.000
2	Control	II	0.115		0.000	0.835	0.735	0.000
3	Control	III	0.000	0.000		0.000	0.000	0.996
4	Experimental	I	0.946	0.835	0.000		0.021	0.000
5	Experimental	II	0.006	0.735	0.000	0.021		0.000
6	Experimental	III	0.000	0.000	0.996	0.000	0.000	

Table 24. Results of Tukey's post hoc test of the Sit-ups in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 11.029, df												
Nr	Group	Gender	R1	{1} 8.4375	{2} 10.438	{3} 16.313	{4} 8.1818	{5} 9.9091	{6} 18.364	{7} 9.7500	{8} 12.125	{9} 18.875	{10} 8.3333	{11} 10.583	{12} 15.917
1	C	Girl	I		0.629	0.000	1.000	0.993	0.000	0.994	0.073	0.000	1.000	0.872	0.000
2	C	Girl	II	0.629		0.000	0.853	1.000	0.000	1.000	0.956	0.000	0.887	1.000	0.001
3	C	Girl	III	0.000	0.000		0.000	0.000	0.918	0.000	0.019	0.562	0.000	0.000	1.000
4	C	Boy	I	1.000	0.853	0.000		0.938	0.000	0.989	0.100	0.000	1.000	0.853	0.000
5	C	Boy	II	0.993	1.000	0.000	0.938		0.000	1.000	0.867	0.000	0.993	1.000	0.001
6	C	Boy	III	0.000	0.000	0.918	0.000	0.000		0.000	0.000	1.000	0.000	0.000	0.837
7	E	Girl	I	0.994	1.000	0.000	0.989	1.000	0.000		0.361	0.000	0.994	1.000	0.000
8	E	Girl	II	0.073	0.956	0.019	0.100	0.867	0.000	0.361		0.000	0.111	0.988	0.111
9	E	Girl	III	0.000	0.000	0.562	0.000	0.000	1.000	0.000	0.000		0.000	0.000	0.453
10	E	Boy	I	1.000	0.887	0.000	1.000	0.993	0.000	0.994	0.111	0.000		0.666	0.000
11	E	Boy	II	0.872	1.000	0.000	0.853	1.000	0.000	1.000	0.988	0.000	0.666		0.000
12	E	Boy	III	0.000	0.001	1.000	0.000	0.001	0.837	0.000	0.111	0.453	0.000	0.000	

Table 25. Mean and standard deviation (SD) of the experimental and control groups in the test of Run skills at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=12.066, p=.00106 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	4.912	0.221	4.468	5.356	27
2	Control	III	5.295	0.159	4.976	5.614	27
3	Experimental	I	4.688	0.216	4.255	5.120	28
4	Experimental	III	5.833	0.155	5.522	6.144	28

Table 26. Results of Tukey's post hoc test of Run skills in students from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .96626, df Group	R1	{1} 4.9630	{2} 5.3333	{3} 4.6786	{4} 5.8571
1	Control	I		0.090	0.707	0.007
2	Control	III	0.090		0.074	0.207
3	Experimental	I	0.707	0.074		0.000
4	Experimental	III	0.007	0.207	0.000	

Table 27. Results of Tukey's post hoc test of the Run skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .96626, df Group	Gender	R1	{1} 5.1875	{2} 5.5000	{3} 4.6364	{4} 5.0909	{5} 4.6250	{6} 6.0000	{7} 4.7500	{8} 5.6667
1	C	Girl	I		0.772	0.840	1.000	0.738	0.288	0.939	0.905
2	C	Girl	III	0.772		0.340	0.962	0.205	0.836	0.491	1.000
3	C	Boy	I	0.840	0.340		0.571	1.000	0.016	1.000	0.208
4	C	Boy	III	1.000	0.962	0.571		0.926	0.277	0.991	0.853
5	E	Girl	I	0.738	0.205	1.000	0.926		0.000	1.000	0.118
6	E	Girl	III	0.288	0.836	0.016	0.277	0.000		0.029	0.986
7	E	Boy	I	0.939	0.491	1.000	0.991	1.000	0.029		0.005
8	E	Boy	III	0.905	1.000	0.208	0.853	0.118	0.986	0.005	

Table 28. Mean and standard deviation (SD) of the experimental and control groups in the test of Gallop skills at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=8.6404, p=.00493 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	5.540	0.172	5.195	5.884	27
2	Control	III	5.986	0.131	5.723	6.248	27
3	Experimental	I	5.396	0.167	5.060	5.732	28
4	Experimental	III	6.490	0.127	6.234	6.745	28

Table 29. Results of Tukey's post hoc test of Gallop skills in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .60632, df Group	R1	{1} 5.5556	{2} 6.0000	{3} 5.3929	{4} 6.5000
1	Control	I		0.030	0.866	0.000
2	Control	III	0.030		0.025	0.089
3	Experimental	I	0.866	0.025		0.000
4	Experimental	III	0.000	0.089	0.000	

Table 30. Results of Tukey's post hoc test of the Gallop skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .60632, df Group	Gender	R1	{1} 5.6250	{2} 6.0625	{3} 5.4545	{4} 5.9091	{5} 5.3750	{6} 6.5625	{7} 5.4167	{8} 6.4167
1	C	Girl	I		0.385	0.999	0.982	0.985	0.022	0.997	0.149
2	C	Girl	III	0.385		0.493	1.000	0.211	0.611	0.379	0.932
3	C	Boy	I	0.999	0.493		0.576	1.000	0.011	1.000	0.074
4	C	Boy	III	0.982	1.000	0.576		0.654	0.397	0.797	0.771
5	E	Girl	I	0.985	0.211	1.000	0.654		0.000	1.000	0.016
6	E	Girl	III	0.022	0.611	0.011	0.397	0.000		0.005	1.000
7	E	Boy	I	0.997	0.379	1.000	0.797	1.000	0.005		0.002
8	E	Boy	III	0.149	0.932	0.074	0.771	0.016	1.000	0.002	

Table 31. Mean and standard deviation (SD) of the experimental and control groups in the test of Hop skills at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=.29374, p=.59020 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	6.514	0.215	6.082	6.946	27
2	Control	III	7.415	0.173	7.067	7.763	27
3	Experimental	I	6.583	0.210	6.162	7.004	28
4	Experimental	III	7.344	0.169	7.005	7.683	28

Table 32. Results of Tukey's post hoc test of Hop in students from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .99439, df Group	R1	{1} 6.5926	{2} 7.4074	{3} 6.6429	{4} 7.3929
1	Control	I		0.000	0.998	0.020
2	Control	III	0.000		0.029	1.000
3	Experimental	I	0.998	0.029		0.001
4	Experimental	III	0.020	1.000	0.001	

Table 33. Results of Tukey's post hoc test of the Hop skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .99439, df Group	Gender	R1	{1} 6.9375	{2} 7.3750	{3} 6.0909	{4} 7.4545	{5} 7.0000	{6} 7.6875	{7} 6.1667	{8} 7.0000
1	C	Girl	I		0.590	0.383	0.887	1.000	0.407	0.473	1.000
2	C	Girl	III	0.590		0.031	1.000	0.962	0.987	0.043	0.975
3	C	Boy	I	0.383	0.031		0.000	0.292	0.003	1.000	0.373
4	C	Boy	III	0.887	1.000	0.000		0.940	0.999	0.053	0.957
5	E	Girl	I	1.000	0.962	0.292	0.940		0.092	0.370	1.000
6	E	Girl	III	0.407	0.987	0.003	0.999	0.092		0.004	0.618
7	E	Boy	I	0.473	0.043	1.000	0.053	0.370	0.004		0.065
8	E	Boy	III	1.000	0.975	0.373	0.957	1.000	0.618	0.065	

Table 34. Mean and standard deviation (SD) of the experimental and control groups in the test of Leap skills at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=1.9056, p=.17348 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	3.750	0.139	3.471	4.029	27
2	Control	III	4.847	0.150	4.545	5.149	27
3	Experimental	I	4.063	0.136	3.790	4.335	28
4	Experimental	III	4.781	0.147	4.487	5.076	28

Table 35. Results of Tukey's post hoc test of Leap in students from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .54729, df Group	R1	{1} 3.7037	{2} 4.8519	{3} 4.0714	{4} 4.7857
1	Control	I		0.000	0.260	0.000
2	Control	III	0.000		0.001	0.987
3	Experimental	I	0.260	0.001		0.002
4	Experimental	III	0.000	0.987	0.002	

Table 36. Results of Tukey's post hoc test of the Leap skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .54729, df Group	Gender	R1	{1} 3.5000	{2} 4.8750	{3} 4.0000	{4} 4.8182	{5} 4.1250	{6} 4.8125	{7} 4.0000	{8} 4.7500
1	C	Girl	I		0.000	0.671	0.000	0.258	0.000	0.642	0.001
2	C	Girl	III	0.000		0.061	1.000	0.090	1.000	0.050	1.000
3	C	Boy	I	0.671	0.061		0.143	1.000	0.106	1.000	0.239
4	C	Boy	III	0.000	1.000	0.143		0.257	1.000	0.151	1.000
5	E	Girl	I	0.258	0.090	1.000	0.257		0.132	1.000	0.353
6	E	Girl	III	0.000	1.000	0.106	1.000	0.132		0.089	1.000
7	E	Boy	I	0.642	0.050	1.000	0.151	1.000	0.089		0.181
8	E	Boy	III	0.001	1.000	0.239	1.000	0.353	1.000	0.181	

Table 37. Mean and standard deviation (SD) of the experimental and control groups in the test of Jump skills at the first and follow-up examinations

	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=.43241, p=.51377 Dekompozycja efektywnych hipotez						
Nr podkl.	Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	4.926	0.213	4.498	5.354	27
2	Control	III	6.097	0.167	5.761	6.432	27
3	Experimental	I	4.948	0.208	4.530	5.366	28
4	Experimental	III	6.281	0.163	5.954	6.608	28

Table 38. Results of Tukey's post hoc test of Jump skill in pupils from the experimental and control groups at the first and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .95696, df					
Nr podkl.	Group	R1	{1} 4.9630	{2} 6.1481	{3} 4.9643	{4} 6.2857
1	Control	I		0.000	1.000	0.000
2	Control	III	0.000		0.000	0.954
3	Experimental	I	1.000	0.000		0.000
4	Experimental	III	0.000	0.954	0.000	

Table 39. Results of Tukey's post hoc test of the Jump skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .95696, df									
Nr podkl.	Group	Gender	R1	{1} 5.1250	{2} 6.3750	{3} 4.7273	{4} 5.8182	{5} 5.0625	{6} 6.3125	{7} 4.8333	{8} 6.2500
1	C	Girl	I		0.000	0.967	0.616	1.000	0.021	0.994	0.066
2	C	Girl	III	0.000		0.001	0.829	0.007	1.000	0.002	1.000
3	C	Boy	I	0.967	0.001		0.005	0.988	0.002	1.000	0.008
4	C	Boy	III	0.616	0.829	0.005		0.507	0.900	0.251	0.964
5	E	Girl	I	1.000	0.007	0.988	0.507		0.000	0.999	0.042
6	E	Girl	III	0.021	1.000	0.002	0.900	0.000		0.004	1.000
7	E	Boy	I	0.994	0.002	1.000	0.251	0.999	0.004		0.000
8	E	Boy	III	0.066	1.000	0.008	0.964	0.042	1.000	0.000	

Table 40. Mean and standard deviation (SD) of the experimental and control groups in the test of Slide skill at the first and follow-up examinations

	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=7.2742, p=.00946 Dekompozycja efektywnych hipotez						
Nr podkl.	Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	6.213	0.163	5.886	6.540	27
2	Control	III	6.938	0.136	6.665	7.210	27
3	Experimental	I	5.760	0.159	5.441	6.079	28
4	Experimental	III	7.229	0.132	6.964	7.494	28

Table 41. Results of Tukey's post hoc test of Slide skill in pupils from the experimental and control groups at the first and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .58582, df					
Nr podkl.	Group	R1	{1} 6.1852	{2} 6.9259	{3} 5.7857	{4} 7.2500
1	Control	I		0.0021	0.2202	0.0001
2	Control	III	0.0021		0.0001	0.4005
3	Experimental	I	0.2202	0.0001		0.0002
4	Experimental	III	0.0001	0.4005	0.0002	

Table 42. Results of Tukey's post hoc test of the Slide skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .58582, df									
Nr podkl.	Group	Gender	R1	{1} 6.0625	{2} 6.8750	{3} 6.3636	{4} 7.0000	{5} 5.9375	{6} 7.3750	{7} 5.5833	{8} 7.0833
1	C	Girl	I		0.043	0.973	0.046	1.000	0.000	0.725	0.016
2	C	Girl	III	0.043		0.684	1.000	0.017	0.590	0.001	0.996
3	C	Boy	I	0.973	0.684		0.434	0.845	0.023	0.233	0.330
4	C	Boy	III	0.046	1.000	0.434		0.014	0.914	0.001	1.000
5	E	Girl	I	1.000	0.017	0.845	0.014		0.000	0.927	0.004
6	E	Girl	III	0.000	0.590	0.023	0.914	0.000		0.000	0.974
7	E	Boy	I	0.725	0.001	0.233	0.001	0.927	0.000		0.000
8	E	Boy	III	0.016	0.996	0.330	1.000	0.004	0.974	0.000	

Table 43. Mean and standard deviation (SD) of the experimental and control groups in the test of Locomotor skills at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=14.142, p=.00044 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	31.855	0.5674	30.716	32.994	27
2	Control	III	36.577	0.4642	35.645	37.509	27
3	Experimental	I	31.438	0.5532	30.327	32.548	28
4	Experimental	III	37.958	0.4526	37.050	38.867	28

Table 44. Results of Tukey's post hoc test of Locomotor skills in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 7.0062, df Group	R1	{1} 31.963	{2} 36.667	{3} 31.536	{4} 38.071
1	Control	I		0.000	0.932	0.000
2	Control	III	0.000		0.000	0.211
3	Experimental	I	0.932	0.000		0.000
4	Experimental	III	0.000	0.211	0.000	

Table 45. Results of Tukey's post hoc test of the Locomotor skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 7.0062, df Group	Gender	R1	{1} 32.438	{2} 37.063	{3} 31.273	{4} 36.091	{5} 32.125	{6} 38.750	{7} 30.750	{8} 37.167
1	C	Girl	I		0.000	0.949	0.017	1.000	0.000	0.706	0.001
2	C	Girl	III	0.000		0.000	0.981	0.000	0.620	0.000	1.000
3	C	Boy	I	0.949	0.000		0.000	0.991	0.000	1.000	0.000
4	C	Boy	III	0.017	0.981	0.000		0.007	0.188	0.000	0.977
5	E	Girl	I	1.000	0.000	0.991	0.007		0.000	0.871	0.000
6	E	Girl	III	0.000	0.620	0.000	0.188	0.000		0.000	0.768
7	E	Boy	I	0.706	0.000	1.000	0.000	0.871	0.000		0.000
8	E	Boy	III	0.001	1.000	0.000	0.977	0.000	0.768	0.000	

Table 46. Mean and standard deviation (SD) of the experimental and control groups in the test of Strike skills at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=10.086, p=.00254 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	5.665	0.214	5.236	6.094	27
2	Control	III	6.526	0.199	6.126	6.925	27
3	Experimental	I	5.594	0.208	5.176	6.012	28
4	Experimental	III	7.333	0.194	6.944	7.723	28

Table 47. Results of Tukey's post hoc test of Strike skill in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.1109, df Group	R1	{1} 5.7037	{2} 6.5556	{3} 5.5714	{4} 7.2857
1	Control	I		0.000	0.966	0.000
2	Control	III	0.000		0.005	0.057
3	Experimental	I	0.966	0.005		0.000
4	Experimental	III	0.000	0.057	0.000	

Table 48. Results of Tukey's post hoc test of the Strike skill in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.1109, df Group	Gender	R1	{1} 5.8750	{2} 6.6875	{3} 5.4545	{4} 6.3636	{5} 5.4375	{6} 7.0000	{7} 5.7500	{8} 7.6667
1	C	Girl	I		0.044	0.970	0.934	0.937	0.064	1.000	0.001
2	C	Girl	III	0.044		0.070	0.994	0.026	0.990	0.291	0.241
3	C	Boy	I	0.970	0.070		0.078	1.000	0.008	0.998	0.000
4	C	Boy	III	0.934	0.994	0.078		0.338	0.783	0.857	0.074
5	E	Girl	I	0.937	0.026	1.000	0.338		0.000	0.994	0.000
6	E	Girl	III	0.064	0.990	0.008	0.783	0.000		0.051	0.715
7	E	Boy	I	1.000	0.291	0.998	0.857	0.994	0.051		0.000
8	E	Boy	III	0.001	0.241	0.000	0.074	0.000	0.715	0.000	

Table 49. Mean and standard deviation (SD) of the experimental and control groups in the test of Dribble skill at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=.02329, p=.87930 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	4.909	0.278	4.352	5.466	27
2	Control	III	5.724	0.222	5.278	6.170	27
3	Experimental	I	4.823	0.271	4.280	5.366	28
4	Experimental	III	5.604	0.217	5.169	6.039	28

Table 50. Results of Tukey's post hoc test of Dribble skill in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.6484, df Group	R1	{1} 4.9259	{2} 5.7407	{3} 4.9286	{4} 5.6786
1	Control	I		0.000	1.000	0.142
2	Control	III	0.000		0.099	0.998
3	Experimental	I	1.000	0.099		0.000
4	Experimental	III	0.142	0.998	0.000	

Table 51. Results of Tukey's post hoc test of the Dribble skill in 7-year-old boys and girls from the experimental and control groups in the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.6484, df Group	Gender	R1	{1} 5.0000	{2} 5.8125	{3} 4.8182	{4} 5.6364	{5} 5.5625	{6} 6.1250	{7} 4.0833	{8} 5.0833
1	C	Girl	I		0.005	1.000	0.908	0.917	0.224	0.576	1.000
2	C	Girl	III	0.005		0.505	1.000	0.999	0.997	0.017	0.811
3	C	Boy	I	1.000	0.505		0.033	0.815	0.176	0.867	1.000
4	C	Boy	III	0.908	1.000	0.033		1.000	0.977	0.091	0.968
5	E	Girl	I	0.917	0.999	0.815	1.000		0.130	0.068	0.976
6	E	Girl	III	0.224	0.997	0.176	0.977	0.130		0.002	0.411
7	E	Boy	I	0.576	0.017	0.867	0.091	0.068	0.002		0.002
8	E	Boy	III	1.000	0.811	1.000	0.968	0.976	0.411	0.002	

Table 52. Mean and standard deviation (SD) of the experimental and control groups in the test of Catch skill at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=.47793, p=.49250 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	4.449	0.223	4.002	4.896	27
2	Control	III	4.989	0.174	4.639	5.338	27
3	Experimental	I	4.781	0.217	4.346	5.217	28
4	Experimental	III	5.156	0.170	4.815	5.497	28

Table 53. Results of Tukey's post hoc test of Catch skill in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.0416, df Group	R1	{1} 4.4815	{2} 5.0370	{3} 4.7500	{4} 5.1429
1	Control	I		0.009	0.764	0.086
2	Control	III	0.009		0.725	0.981
3	Experimental	I	0.764	0.725		0.093
4	Experimental	III	0.086	0.981	0.093	

Table 54. Results of Tukey's post hoc test of the Catch skill in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.0416, df Group	Gender	R1	{1} 4.6250	{2} 5.2500	{3} 4.2727	{4} 4.7273	{5} 4.5625	{6} 5.0625	{7} 5.0000	{8} 5.2500
1	C	Girl	I		0.101	0.987	1.000	1.000	0.926	0.978	0.747
2	C	Girl	III	0.101		0.236	0.893	0.552	1.000	0.998	1.000
3	C	Boy	I	0.987	0.236		0.668	0.996	0.505	0.683	0.311
4	C	Boy	III	1.000	0.893	0.668		1.000	0.990	0.998	0.921
5	E	Girl	I	1.000	0.552	0.996	1.000		0.316	0.950	0.646
6	E	Girl	III	0.926	1.000	0.505	0.990	0.316		1.000	1.000
7	E	Boy	I	0.978	0.998	0.683	0.998	0.950	1.000		0.973
8	E	Boy	III	0.747	1.000	0.311	0.921	0.646	1.000	0.973	

Table 55. Mean and standard deviation (SD) of the experimental and control groups in the test of Kick skill at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=5.0719, p=.02865 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	4.969	0.259	4.449	5.488	27
2	Control	III	5.875	0.127	5.619	6.131	27
3	Experimental	I	4.490	0.252	3.983	4.996	28
4	Experimental	III	6.115	0.124	5.865	6.364	28

Table 56. Results of Tukey's post hoc test of Kick skill in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.0848, df Group	R1	{1} 4.9630	{2} 5.8519	{3} 4.3929	{4} 6.1071
1	Control	I		0.001	0.185	0.001
2	Control	III	0.001		0.000	0.800
3	Experimental	I	0.185	0.000		0.000
4	Experimental	III	0.001	0.800	0.000	

Table 57. Results of Tukey's post hoc test of the Kick skill in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.0848, df Group	Gender	R1	{1} 4.9375	{2} 5.7500	{3} 5.0000	{4} 6.0000	{5} 3.8125	{6} 6.0625	{7} 5.1667	{8} 6.1667
1	C	Girl	I		0.122	1.000	0.168	0.057	0.057	0.999	0.052
2	C	Girl	III	0.122		0.596	0.999	0.000	0.990	0.823	0.966
3	C	Boy	I	1.000	0.596		0.107	0.083	0.168	1.000	0.141
4	C	Boy	III	0.168	0.999	0.107		0.000	1.000	0.543	1.000
5	E	Girl	I	0.057	0.000	0.083	0.000		0.000	0.021	0.000
6	E	Girl	III	0.057	0.990	0.168	1.000	0.000		0.332	1.000
7	E	Boy	I	0.999	0.823	1.000	0.543	0.021	0.332		0.080
8	E	Boy	III	0.052	0.966	0.141	1.000	0.000	1.000	0.080	

Table 58. Mean and standard deviation (SD) of the experimental and control groups in the test of Throw skill at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=.08409, p=.77301 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	5.037	0.180	4.675	5.399	27
2	Control	III	5.943	0.184	5.574	6.312	27
3	Experimental	I	5.063	0.176	4.710	5.415	28
4	Experimental	III	5.896	0.179	5.536	6.256	28

Table 59. Results of Tukey's post hoc test of Throw skill in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .86466, df Group	R1	{1} 5.1111	{2} 6.0000	{3} 5.0000	{4} 5.8571
1	Control	I		0.000	0.971	0.020
2	Control	III	0.000		0.001	0.941
3	Experimental	I	0.971	0.001		0.000
4	Experimental	III	0.020	0.941	0.000	

Table 60. Results of Tukey's post hoc test of the Throw skill in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .86466, df Group	Gender	R1	{1} 5.4375	{2} 6.2500	{3} 4.6364	{4} 5.6364	{5} 4.6250	{6} 5.6250	{7} 5.5000	{8} 6.1667
1	C	Girl	I		0.018	0.363	0.999	0.223	0.999	1.000	0.454
2	C	Girl	III	0.018		0.001	0.697	0.000	0.554	0.416	1.000
3	C	Boy	I	0.363	0.001		0.015	1.000	0.133	0.348	0.004
4	C	Boy	III	0.999	0.697	0.015		0.116	1.000	1.000	0.870
5	E	Girl	I	0.223	0.000	1.000	0.116		0.002	0.226	0.001
6	E	Girl	III	0.999	0.554	0.133	1.000	0.002		1.000	0.792
7	E	Boy	I	1.000	0.416	0.348	1.000	0.226	1.000		0.214
8	E	Boy	III	0.454	1.000	0.004	0.870	0.001	0.792	0.214	

Table 61. Mean and standard deviation (SD) of the experimental and control groups in the test of Roll skill at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=5.7919, p=.01976 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	5.571	0.209	5.152	5.990	27
2	Control	III	6.466	0.168	6.128	6.804	27
3	Experimental	I	5.542	0.203	5.133	5.950	28
4	Experimental	III	7.125	0.164	6.796	7.454	28

Table 62. Results of Tukey's post hoc test of Roll skill in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .93596, df Group	R1	{1} 5.5926	{2} 6.5185	{3} 5.5714	{4} 7.1429
1	Control	I		0.000	1.000	0.000
2	Control	III	0.000		0.003	0.086
3	Experimental	I	1.000	0.003		0.000
4	Experimental	III	0.000	0.086	0.000	

Table 63. Results of Tukey's post hoc test of the Roll skill in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .93596, df Group	Gender	R1	{1} 5.6875	{2} 6.7500	{3} 5.4545	{4} 6.1818	{5} 5.7500	{6} 7.2500	{7} 5.3333	{8} 7.0000
1	C	Girl	I		0.004	0.999	0.895	1.000	0.001	0.979	0.014
2	C	Girl	III	0.004		0.021	0.806	0.080	0.825	0.006	0.997
3	C	Boy	I	0.999	0.021		0.310	0.994	0.000	1.000	0.006
4	C	Boy	III	0.895	0.806	0.310		0.946	0.104	0.423	0.471
5	E	Girl	I	1.000	0.080	0.994	0.946		0.000	0.949	0.023
6	E	Girl	III	0.001	0.825	0.000	0.104	0.000		0.000	0.997
7	E	Boy	I	0.979	0.006	1.000	0.423	0.949	0.000		0.000
8	E	Boy	III	0.014	0.997	0.006	0.471	0.023	0.997	0.000	

Table 64. Mean and standard deviation (SD) of the experimental and control groups in the test of Object control skills at the first and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(1, 51)=19.127, p=.00006 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	30.599	0.5990	29.397	31.802	27
2	Control	III	35.523	0.5799	34.359	36.687	27
3	Experimental	I	30.292	0.5840	29.119	31.464	28
4	Experimental	III	37.229	0.5654	36.094	38.364	28

Table 65. Results of Tukey's post hoc test of Object control skills in pupils from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 9.0617, df Group	R1	{1} 30.778	{2} 35.704	{3} 30.214	{4} 37.214
1	Control	I		0.000	0.899	0.000
2	Control	III	0.000		0.000	0.256
3	Experimental	I	0.899	0.000		0.000
4	Experimental	III	0.000	0.256	0.000	

Table 66. Results of Tukey's post hoc test of the Object control skills in 7-year-old boys and girls from the experimental and control groups at the first and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 9.0617, df Group	Gender	R1	{1} 31.563	{2} 36.500	{3} 29.636	{4} 34.545	{5} 29.750	{6} 37.125	{7} 30.833	{8} 37.333
1	C	Girl	I		0.000	0.728	0.203	0.685	0.000	0.998	0.000
2	C	Girl	III	0.000		0.000	0.714	0.000	0.999	0.000	0.996
3	C	Boy	I	0.728	0.000		0.000	1.000	0.000	0.979	0.000
4	C	Boy	III	0.203	0.714	0.000		0.003	0.374	0.080	0.356
5	E	Girl	I	0.685	0.000	1.000	0.003		0.000	0.980	0.000
6	E	Girl	III	0.000	0.999	0.000	0.374	0.000		0.000	1.000
7	E	Boy	I	0.998	0.000	0.979	0.080	0.980	0.000		0.000
8	E	Boy	III	0.000	0.996	0.000	0.356	0.000	1.000	0.000	

Table 67. Mean and standard deviation (SD) of the experimental and control groups in the test of Math skills at the first, second, and follow-up examinations

Nr podkl.	Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=6.0870, p=.00318 Dekompozycja efektywnych hipotez						
1	Control	I	5.264	0.267	4.729	5.799	27
2	Control	II	5.896	0.182	5.531	6.261	27
3	Control	III	8.241	0.133	7.974	8.508	27
4	Experimental	I	4.760	0.260	4.239	5.282	28
5	Experimental	II	5.755	0.177	5.399	6.111	28
6	Experimental	III	8.672	0.130	8.412	8.932	28

Table 68. Results of Tukey's post hoc test of Math skills in pupils from the experimental and control groups at the first, second, and follow-up examinations

Nr podkl.	Group	R1	{1} 5.2037	{2} 5.8519	{3} 8.1852	{4} 4.7500	{5} 5.7321	{6} 8.6607
	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.0582, df							
1	Control	I		0.012	0.000	0.578	0.406	0.000
2	Control	II	0.012		0.000	0.002	0.998	0.000
3	Control	III	0.000	0.000		0.000	0.000	0.526
4	Experimental	I	0.578	0.002	0.000		0.000	0.000
5	Experimental	II	0.406	0.998	0.000	0.000		0.000
6	Experimental	III	0.000	0.000	0.526	0.000	0.000	

Table 69. Results of Tukey's post hoc test of the math skills in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

Nr	Group	Gender	R1	{1} 4.9375	{2} 5.6563	{3} 7.9375	{4} 5.5909	{5} 6.1364	{6} 8.5455	{7} 4.6875	{8} 5.5938	{9} 8.5938	{10} 4.8333	{11} 5.9167	{12} 8.7500
	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = 1.0582, df														
1	C	Girl	I		0.152	0.000	0.897	0.132	0.000	1.000	0.812	0.000	1.000	0.357	0.000
2	C	Girl	II	0.152		0.000	1.000	0.988	0.000	0.261	1.000	0.000	0.628	1.000	0.000
3	C	Girl	III	0.000	0.000		0.000	0.001	0.935	0.000	0.000	0.812	0.000	0.000	0.646
4	C	Boy	I	0.897	1.000	0.000		0.796	0.000	0.524	1.000	0.000	0.833	1.000	0.000
5	C	Boy	II	0.132	0.988	0.001	0.796		0.000	0.024	0.970	0.000	0.115	1.000	0.000
6	C	Boy	III	0.000	0.000	0.935	0.000	0.000		0.000	0.000	1.000	0.000	0.000	1.000
7	E	Girl	I	1.000	0.261	0.000	0.524	0.024	0.000		0.019	0.000	1.000	0.090	0.000
8	E	Girl	II	0.812	1.000	0.000	1.000	0.970	0.000	0.019		0.000	0.734	1.000	0.000
9	E	Girl	III	0.000	0.000	0.812	0.000	0.000	1.000	0.000	0.000		0.000	0.000	1.000
10	E	Boy	I	1.000	0.628	0.000	0.833	0.115	0.000	1.000	0.734	0.000		0.013	0.000
11	E	Boy	II	0.357	1.000	0.000	1.000	1.000	0.000	0.090	1.000	0.000	0.013		0.000
12	E	Boy	III	0.000	0.000	0.646	0.000	0.000	1.000	0.000	0.000	1.000	0.000	0.000	

Table 70. Mean and standard deviation (SD) of the experimental and control groups in the test of English skills at the first, second, and follow-up examinations

Nr podkl.	R1*Group; Srednie niewazone (Research data 29-11) Biezacy efekt: F(2, 102)=5.4336, p=.00572 Dekompozycja efektywnych hipotez Group	R1	DV_1 Srednie	DV_1 Bl. Std.	DV_1 -95.00%	DV_1 +95.00%	N
1	Control	I	5.351	0.252	4.846	5.856	27
2	Control	II	5.942	0.172	5.596	6.288	27
3	Control	III	7.926	0.136	7.654	8.199	27
4	Experimental	I	4.797	0.245	4.305	5.289	28
5	Experimental	II	5.714	0.168	5.376	6.051	28
6	Experimental	III	8.188	0.132	7.922	8.453	28

Table 71. Results of Tukey's post hoc test of English skills in students from the experimental and control groups at the first, second, and follow-up examinations

Nr podkl.	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .96819, df Group	R1	{1} 5.4074	{2} 5.9815	{3} 7.9630	{4} 4.8571	{5} 5.7500	{6} 8.1964
1	Control	I		0.018	0.000	0.310	0.789	0.000
2	Control	II	0.018		0.000	0.001	0.952	0.000
3	Control	III	0.000	0.000		0.000	0.000	0.951
4	Experimental	I	0.310	0.001	0.000		0.000	0.000
5	Experimental	II	0.789	0.952	0.000	0.000		0.000
6	Experimental	III	0.000	0.000	0.951	0.000	0.000	

Table 72. Results of Tukey's post hoc test of the English skills in 7-year-old boys and girls from the experimental and control groups at the first, second, and follow-up examinations

Nr	Test HSD Tukeya; zmienna DV_1 (Research data 29-11) Przyblizone prawdopodobienstwa dla testów post hoc Blad: MS miedzygrupowe, powt. pomiarów, polaczone = .96819, df Group	Gender	R1	{1} 5.6563	{2} 6.1563	{3} 8.1250	{4} 5.0455	{5} 5.7273	{6} 7.7273	{7} 5.2187	{8} 5.9687	{9} 8.2500	{10} 4.3750	{11} 5.4583	{12} 8.1250
1	C	Girl	I		0.556	0.000	0.910	1.000	0.000	0.982	0.999	0.000	0.043	1.000	0.000
2	C	Girl	II	0.556		0.000	0.165	0.993	0.005	0.246	1.000	0.000	0.001	0.782	0.000
3	C	Girl	III	0.000	0.000		0.000	0.000	0.997	0.000	0.000	1.000	0.000	0.000	1.000
4	C	Boy	I	0.910	0.165	0.000		0.362	0.000	1.000	0.420	0.000	0.892	0.997	0.000
5	C	Boy	II	1.000	0.993	0.000	0.362		0.000	0.975	1.000	0.000	0.059	1.000	0.000
6	C	Boy	III	0.000	0.005	0.997	0.000	0.000		0.000	0.001	0.969	0.000	0.000	0.998
7	E	Girl	I	0.982	0.246	0.000	1.000	0.975	0.000		0.058	0.000	0.522	1.000	0.000
8	E	Girl	II	0.999	1.000	0.000	0.420	1.000	0.001	0.058		0.000	0.003	0.968	0.000
9	E	Girl	III	0.000	0.000	1.000	0.000	0.000	0.969	0.000	0.000		0.000	0.000	1.000
10	E	Boy	I	0.043	0.001	0.000	0.892	0.059	0.000	0.522	0.003	0.000		0.004	0.000
11	E	Boy	II	1.000	0.782	0.000	0.997	1.000	0.000	1.000	0.968	0.000	0.004		0.000
12	E	Boy	III	0.000	0.000	1.000	0.000	0.000	0.998	0.000	0.000	1.000	0.000	0.000	