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TEACHING GYMNASTICS ELEMENTS IN ELEMENTARY SCHOOL WITH PLACEBO-EFFECT DIGITAL GAMES: CLUSTER-RANDOMISED CONTROLLED TRIAL

POUČEVANJE ELEMENTOV ŠPORTNE GIMNASTIKE NA RAZREDNI STOPNJI S PLACEBO UČINKOM IGRANJA DIGITALNIH IGER: RANDOMIZIRANA KONTROLIRANA RAZISKAVA

ABSTRACT

This study examined the effects of using digital placebo video games in the gym while teaching gymnastics elements on the amount and level of activity intensity of elementary school students. One hundred thirty-two first triade students (70 girls) were included in the study, of whom 72 (age = 7.6 ± 0.96) participated in an experimental teaching program (EXP) using digital placebo games and 60 (age = 7.5 ± 0.91) participated in the control group (CON) in which traditional physical education continued to be taught. Three artistic gymnastic elements were taught: Forward roll, backward roll, and cartwheel. The results of the nonparametric Mann-Whitney test showed statistically significant differences between the groups (EXP vs. CON) in light physical activity (LPA) and moderate-to-vigorous physical activity (MVPA) for all three gymnastic elements (forward roll: LPA: $p < 0.001$, MVPA: $p < 0.001$; backward roll: LPA: $p < 0.001$, MVPA: $p < 0.001$; cartwheel: LPA: $p < 0.001$; MVPA: $p < 0.001$). There were no statistically significant differences between groups in any gymnastics elements in vigorous physical activity (VPA); forward roll: $p = 0.354$; backward roll: $p = 0.251$; cartwheel: $p = 0.427$. The results demonstrate the effectiveness of integrating digital placebo games into physical education classes to improve the amount of LPA and MVPA when teaching gymnastics elements in the first triad.

Keywords: physical education, information and communications technology, intervention, gymnastics, elementary school

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IZVLEČEK

Z izvedeno raziskavo smo preverjali učinke vključevanja digitalnega placebo igranja video iger v telovadnico pri poučevanju gimnastičnih elementov na količino in raven intenzivnosti aktivnosti učencev prvega triletja. V raziskavo je bilo vključenih stodvaintrideset učencev prve triade (70 deklic) iz šestih različnih razredov ene osnovne šole iz osrednje Slovenije, izmed katerih jih je bilo 72 (starost = 7.5 ± 0.4) vključenih v experimentalni program poučevanja z vključevanjem digitalnega placebo učinka in 60 (starost = 7.5 ± 0.5) v kontrolno skupino, v kateri so nadaljevali s tradicionalnim poučevanjem. Poučevani so bili trije gimnastični elementi: preval naprej, preval nazaj in premet v stran. Rezultati neparametričnega Mann-Whitney preizkusa so pokazali statistično značilne razlike med eksperimentalno in kontrolno skupino v nizki intenzivnosti aktivnosti (NI) in zmerni do visoki intenzivnosti aktivnosti (ZVI) pri vseh treh poučevanih gimnastičnih elementih (preval naprej: NI: $U = 0.000$, $p < 0.001$; ZVI: $U = 0.000$, $p < 0.001$; preval nazaj: NI: $U = 0.000$, $p < 0.001$; ZVI: $U = 0.000$, $p < 0.001$, premet v stran: NI: $U = 0.000$, $p < 0.001$; ZVI: $U= 0.000$, $p < 0.001$). Statistično značilne razlike se med skupinama pri nobenem gimnastičnem element niso pojavljale pri visoki intenzivnosti aktivnosti (VI) (preval naprej: $U = 30$, $p = 0.354$; preval nazaj: $U = 27$; $p = 0.251$; premet v stran: $U = 31$, $p = 0.427$). Ugotovitve prikazujejo učinkovitost vključevanja digitalnih placebo iger v učne ure športne vzgoje z namenom izboljševanja količine nizke in zmerne do visoke intenzivnosti aktivnosti pri poučevanju gimnastičnih elementov v prvem triletju.

Ključne besede: predmet šport, informacijsko-komunikacijska tehnologija, intervencija, gimnastika, učenci

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https://doi.org/10.52165/kinsi.28.3.5-15

INTRODUCTION

In recent years, the way of communication among young people has changed a lot due to the accelerated development of technology (Krstić et al., 2017), as they mainly use various cell phone and computer applications that attract their attention, as they allow all forms of observation, creation and play, etc., in addition to the traditional conversations (Mehra et al., 2021).

This kind of interaction and the rapid development of information and communication technology (ICT) bring various changes that also affect teaching (Casillas Martín et al., 2020). Therefore, teachers should incorporate ICT into teaching, including physical education (PE). This way of working would be student-centered and at the same time familiarize individuals with the use of technology, which is not only for entertainment, but also fulfills certain educational goals (Gnevasheva et al., 2018). Integrating computer simulations in the form of video games into the classroom PE allows students to observe and learn in a new way, and the lessons are more motivating, interesting, and sustainable (Montiel et al., 2020). which could lead to higher activity levels. In gymnastics classes, students spend statistically significantly less time in moderate- to- vigorous physical activity (MVPA) and vigorous physical activity (VPA) than in classes with ball game content (Chow et al., 2009; Tanaka et al., 2018; Sigmund et al., 2010), and have also been found to spend longer periods of time inactive or waiting in line to do gymnastics under teacher supervision (Tanaka et al., 2018). Replacing traditional teacher instructions with computer simulations of video games can improve the overall learning process and contribute to better student outcomes and influence their higher activity during class (Rutten et al., 2012). Camcorders, videos, projectors, etc. have been used by teachers in gyms for a long time (Calendra et al., 2008; Blomqvist et al., 2000; Darden & Shimon, 2000; Finkenberg et al., 2005), and too few include more modern and interesting digital video games in their lessons, which could significantly improve the efficiency of teaching. The literature search revealed a small number of studies that use digital technologies for educational purposes (Denisova & Cook, 2019; Gibbs et al., 2016). The lack of or moderate use of such a way of working is due to a lack of knowledge and information about the potential of such teaching, or teachers do not have the appropriate equipment to incorporate digital games into physical education (Koekoek et al., 2018). Due to schools' inadequate equipment for teaching more sophisticated digital technologies, teachers in the first triad may also be using the placebo effect, which affects the ventromedial cortex (vmPFC), hypothalamus, amygdala, the insula, and the periaqueductal gray as the central

brain structures of students (Geuter et al., 2017), so that students feel that they are playing sophisticated video games with movement during class, and teachers only need the basic technology available in schools, such as a projector, a computer, etc., for such an effect. The problem of traditional gymnastics teaching is the extremely low activity of students during the lessons and the uninteresting and unmotivating methodical approach to each element. Since students nowadays spend a lot of time playing video games, the purpose of this study is to investigate whether the use of a digital placebo game in the gym can improve the learning approach and thus increase student activity during gymnastics classes.

METHODS

Participants

This was an intervention trial comparing physical education with a digital placebo effect in the form of games with traditional physical education for first-grade students. One hundred thirty-two first, second and third graders (70 girls) from six different classes in an elementary school in central Slovenia participated in the study, of whom 72 (age = 7.6 ± 0.96) participated in the experimental teaching program (EXP) and 60 (age = 7.5 ± 0.91) participated in a control group (CON) in which they had exactly the same learning content and learning styles as in the experimental group, only without the inclusion of digital technology.

To participate in the study, students had to be between 6 and 9 years old and had to have no health problems that could affect their ability to perform gymnastics elements or achieve a high level of activity. Data on the number of girls and boys from each of the six classes in the experimental and control groups are shown in Table 1.

All parents or guardians of students and teachers who taught physical education were informed about the experiment and the possible risks. After being informed about the purpose of the study, they signed an informed consent form and agreed to participate in the study. The lessons were conducted in accordance with the curriculum for physical education in the first three years of elementary school. The study protocol was conducted in accordance with the Declaration of Helsinki and approved by the local ethics committee of the University of Ljubljana (Ref. No. 6/2022).

Table 1. Number and age of boys and girls in the experimental and control group.

Grade	Age (years)	EXP group		CON group	
		boys	girls	boys	girls
1.	6.5 ± 0.5 (EXP); 6.9 ± 0.6 (CON)	8	14	9	13
2.	7.5 ± 0.5 (EXP); 7.5 ± 0.4 (CON)	12	11	7	8
3.	8.5 ± 0.5 (EXP); 8.5 ± 0.5 (CON)	15	12	11	12
Total	7.6 ± 0.96 (EXP) 7.5 ± 0.9 (CON)	35	37	27	33

Abbreviations: EXP, experimental; CON, control.

Proceedings

Activity time and activity intensity in physical education classes were recorded in the experimental and control groups during physical education classes in the school gymnasium using an accelerometer-based activity tracker. The measurements took place for all participants during the time when physical education was on the schedule, i.e., from 8:20 am to 1:00 pm. In both the experimental and control groups, exactly the same learning techniques were used in the lessons and the same elements were taught, with the exception that no digital technology was used in the control group. In all lessons, the artistic gymnastic elements and the final execution were taught in the methodological order, i.e., first the forward roll, then the backward roll, and finally the cartwheel.

In all lessons, a group learning form was used, namely the work with additional tasks, in which the students were divided into 4 stations; at three stations they performed additional tasks of the methodical sequence leading to the final execution of the element, and then at one station they performed the final execution under the protection of the teacher. The stations all changed simultaneously in a clockwise direction at the teacher's signal.

Incorporating the digital placebo effect of playing games into PE lessons

To integrate the digital placebo effect of gaming into physical education classes, we needed three laptops, three projectors, and 21 fake remotes; 7 at each of the three stations where students performed additional methodological tasks. All three computers were located at the station where students performed the final element, as a teacher was present to provide security, and three projectors were reflecting video on the wall at each of the other three stations to perform additional tasks. When changing stations, students attached their fake remotes to their

arm (they were numbered 1 through 7, each had its own colour, and also had flashing lights to enhance the placebo effect of visual performance). The teacher turned on the videos for each station, and students followed the video with movements. Because of the fake remotes, students thought the clip detected their movements as if they were playing a digital Wii game, but this was only a placebo effect because the recordings were pre-recorded with power-up effects based on the number and colour of the remotes. In each lesson, the difficulty of the additional tasks at the stations was increased to allow students to perform more difficult tasks that would lead them to the best possible final performance of the element (rolls, different jumps, etc.). Each physical education lesson began normally with a general and specific warm-up and only then continued with the main part, to which was added the digital placebo effect of playing games in the EXP group. The main part of the experimental design lasted 30 minutes.

Traditional teaching of gymnastics during physical education

The CON group had exactly the same lesson for each class in the same week (learning form, learning topic; all the same additional tasks of methodical approach at each station), but instead of digital placebo games watched the teacher's direct demonstration of the exercises they had to perform at each additional station. The lesson began with the same warm-up as the experimental group; the same game during the general warm-up and the same stretching and strengthening exercises during the specific warm-up. The stations were also set up in the same locations. The main part of the control groups lasted the same amount of time as the experimental groups, 30 minutes.

Statistical analysis

Statistical analysis was performed with the SPSS version 22 statistical program (SPSS Inc, Chicago, IL, United States). Results are presented as means ± standard deviation (SD). After calculating the basic statistics, the Kolmogorov-Smirnov and Shapiro-Wilk tests were used to check whether the data had a normal distribution at a statistically significant level ($p > 0.05$). Due to the abnormal distribution of the variables ($p < 0.001$), a nonparametric Mann-Whitney test was then used to determine the main effect between the EXP vs. CON group (inclusion of the digital placebo effect of playing games vs. traditional teaching of gymnastics during physical education). The effect was measured by the intensity of student activity and parameters of metabolic equivalents (MET). Because human consumption at rest is 3.5 ml of oxygen per kilogram of body weight in 1 minute, which is equivalent to 1 MET, physical activity values were divided into three intensity categories, namely light physical activity (< 3 MET),

moderate-to-vigorous physical activity (3 ≤ 6 MET), and vigorous physical activity (> 6 MET). The activity trackers used were MMOXX1.07 (USB waterproof physical activity sensor - 35 x 35 x 10 mm). Statistical significance was set at $p \leq 0.05$.

RESULTS

Results of the nonparametric Mann-Whitney test showed statistically significant differences between groups (EXP vs. CON) in LPA and MVPA in all three gymnastic elements taught: forward roll (LPA: U = 0.000, p < 0.001, MVPA: U = 0.000, p < 0.001), backward roll (LPA: U = 0.000, p < 0.001, MVPA: U = 0.000, p < 0.001), cartwheel (LPA: U = 0.000, p < 0.001; MVPA: U = 0.000, p < 0.001). There were no statistically significant differences between groups (EXP vs. CON) on any gymnastic element in the VPA (forward roll: U = 30, p = 0.354; backward roll: U = 27; p = 0.251; cartwheel: U = 31, p = 0.427). The results are presented in Table 2. The last column of the table shows the objective measure of energy consumption (MET) during the whole physical education lesson.

Table 2. Results of different activity levels and differences between the groups.

Variable	Group	LPA (min)	MVPA (min)	VPA (min)	Total MET
Forward roll	EXP	12.75±0.77	23.67±0.63	4.74±0.50	41.37±1.67
	CON	8.14±0.55	17.13±1.09	4.95±0.40	30.31±1.52
	Mann-Whitney U	0.000	0.000	30.000	0.000
	Wilcoxon W	45.000	45.000	75.000	45.000
	Z	-3.576	-3.578	-.928	-3.576
	p	**<0.001**	**<0.001**	.354	**<0.001**
Backward roll	EXP	11.82±1.85	22.80±1.16	4.43±0.62	39.31±2.70
	CON	7.83±0.47	17.63±0.84	4.64±0.32	30.37±0.90
	Mann-Whitney U	0.000	0.000	27.500	0.000
	Wilcoxon W	45.000	45.000	72.500	45.000
	Z	-3.578	-3.578	-1.149	-3.576
	p	**<0.001**	**<0.001**	.251	**<0.001**
Cartwheel	EXP	11.59±1.33	22.45±135	4.59±0.44	38.89±2.86
	CON	8.65±0.68	19.07±0.65	4.71±0.44	32.62±1.40
	Mann-Whitney U	0.000	0.000	31.500	0.000
	Wilcoxon W	45.000	45.000	76.500	45.000
	Z	-3.578	-3.576	-.795	-3.576
	p	**<0.001**	**<0.001**	.427	**<0.001**

Abbreviations: LPA, light-intensity physical activity; MVPA, moderate-to-vigorous-intensity physical activity; VPA, vigorous-intensity physical activity; EXP, experimental group; CON, control group; Z, the sum of the ranks within either the treatment or the control group; p, a probability that measures the evidence against the null hypothesis; MET, the metabolic equivalent of task.

DISCUSSION

The aim of the study was to increase the intensity of student activities in the implementation of the methodological procedures of the gymnastic elements by incorporating digital technology in the classroom. The main findings of the study were that students in the EXP group were more active in all three gymnastic elements (forward roll, backward roll, and cartwheel) during lessons involving digital technology, as they spent statistically significantly more time in LPA and MVPA, although VPA showed no statistically significant differences between EXP and CON group. Incorporating digital technology into the classroom motivates students to work because they are convinced that they are playing a video game during execution, while at the same time they achieve higher levels of activity intensity. Incorporating real digital Wii games into physical education classes would come at a huge financial cost to schools, and their effects are similar to the digital effects of placebos. In our study, when watching the recordings, students thought they were collecting power-ups by correctly mimicking the movement because they were shown the outcome in advance, which increased their motivation.

Relatedly, a study (Denisova & Cook, 2019) was conducted in which players played video games, and the study found that players who collected power-ups were statistically significantly more engrossed in the game than those who did not have such an addition in the game, and a similar effect was observed in players who collected placebo power-ups, although they showed no effect on the outcome of the game. Digital effects and digital placebo effects have also been studied in climbing in physical education (Komar et al., 2022), examining their effects on students' work motivation. As in our study, similar results were found for students in the EXP group who climbed using electronic climbing holds on climbing walls, and who had a statistically significantly higher enjoyment levels than students in the CON group who climbed using the usual climbing holds on traditional climbing walls. Research has shown that high school students have higher levels of motivation than elementary school students when learning dance content in physical education using exergames (Gibbs et al., 2016). In addition to higher motivation, exergames have other positive effects when used in this way, namely that students can focus on accurate demonstration and repetition of movements and steps, while the teacher can focus on observing their performance while ensuring that students are actively working. This was also demonstrated in a study conducted in China (Liu et al., 2019), which included 65 elementary and secondary schools, although the authors noted that teachers would need to demonstrate greater information literacy in such teaching. Nevertheless, they are aware that the

availability of digital learning resources and tools is still too limited and insufficiently known, which is why they are not integrated enough in physical education classes.

In recent years, digital technology has been considered one of the main reasons for the decline in physical activity and, consequently, motor skills in children and adolescents, as they spend too much free time in front of screens (Ansari & Naz, 2021; Hill et al., 2016; Canadian Paediatric Society, 2017; Tremblay et al., 2017). For this reason, we need to show both students and teachers that they can also use digital technology for more useful purposes: as a motivation for exercise and not just for sedentary activities. In our study conducted in the gym, by incorporating digital video games that encouraged students to receive intense stimuli, we achieved statistically significantly higher levels of LPA and MVPA in forward roll, backward roll, and cartwheel in the EXP group compared to the CON group. Of course, we need to be aware of the risks that digitalization brings, but we also need to learn about and explore more modern ways of integrating digital technologies into physical education (Bodsworth & Goodyear, 2017; Casey et al., 2016). Physical education teachers can also bring virtual reality into the gym to give students a whole new experience of teaching and motivating learning. Instead of using digital technology to encourage prolonged sitting and inactivity, they can use it to increase activity intensity (METs). With the study conducted, we proved that one of the most important benefits of incorporating digitalization into physical education in the gym is that the teacher can observe multiple students at the same time from different angles, whereas in traditional teaching methods, the teacher can only observe students from one angle, making it impossible to accurately monitor the movements and execution of certain elements by all students. With the introduction of virtual reality, these problems can be solved because teachers can show students photos, videos, and various multimedia information about the correct execution of movements in the gym (Cheng, 2021).

Both our results and the results of several other studies have shown that incorporating digital technology into physical education classes in the gym can have many positive effects, both on increasing the intensity of student activities, increasing the number of active minutes during physical education classes, and increasing motivation and enjoyment. However, our research also had some limitations, namely that we focused only on teaching the three elements of gymnastics. The elements of gymnastics studied were deliberately chosen because they are among those where it is difficult to increase the intensity of the activity when a methodical procedure is taught, but it would be good to study the digital placebo effect of ball games, dancing, etc. Another limitation is that the study was only conducted at one school.

While the sample was large enough, it would be good to see how students from other regions of the country respond to the introduction of this teaching method and the effect of different gym sizes and equipment. Regardless, this was the first study in which we increased the intensity of student activity while performing methodical sequences of gymnastics elements through the digital placebo effect of play.

CONCLUSION

The results showed that both teaching approaches were effective: both traditional and teaching with a digital placebo effect of playing games, but in the latter, students achieved a statistically significant increase in time spent in LPA and MVPA. Despite the fact that there were no statistically significant differences between the CON and EXP groups for VPA, we believe that it would be effective for teachers in gyms to use such a learning approach more frequently, as students showed greater work motivation, consequently performed a greater number of repetitions, and improved their performance on individual elements studied. Therefore, physical education teachers and elementary school teachers should consider introducing digital placebo effect games as an alternative for teaching gymnastics in schools.

Data Availability

The raw data is available from the corresponding author upon request.

Conflicts of Interest

The author declares no conflict of interest.

Funding Statement

Study received no external funding. Š.B. is supported by a grant from Slovenian Research Agency witihin the postoctoral research project Z3-3212 and the research and infrastructure program P3-0323 (Renal diseases and renal replacement therapy).

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