International Journal of Latest Research in Humanities and Social Science (IJLRHSS)
Volume 05 - Issue 01, 2022
www.ijlrhss.com || PP. 60-70

The effect of multimedia application on volleyball fundamental skills performance and athletes' technical and rules knowledge improvement in mini volleyball

Kioumourtzoglou, J., Zetou, E., Antoniou, P., Michalopoulou, M.
Democritus University of Thrace, School of Physical Education and Sport Sciences
Correspondence author: Dr Eleni Zetou,
Professor in School of Physical Education and Sport Science
Democritus University of Thrace
Komotini 69100

Abstract: The purpose of this study was to examined the effect of multimedia application on basic volleyball skill performance and learning and also the athletes' technical and rules knowledge improvement in mini volley. The participants were a total of 121 beginner female volleyball athletes, aged 10-12 years (MO = 10.94, TA = 1.1 and 1-2 years of practice experience (MO = 1.44, TA = 1.4). The participants were randomly divided in two groups, Experimental (Multimedia group EG, n= 63) and Control group (CG -typical training, n=48). The intervention program had 6 weeks duration, with 2 practices per week. For the needs of this study, a multimedia application through an internet site (www.minivolley.gr) was used which had been created for this purpose. The athletes entered the positioning in their free time. The location contained sketches, 3D animations, videos with practice exercises, and presentations for the teaching and learning of the three basic Volleyball skills and their regulations. The typical practice was the traditional practice, in which the coach was demonstrated, gave feedback, and correct the errors. Three quantitative measurements took place for both groups, in the begging, in the end and two weeks after the end of intervention for the evaluation of the retention. The instrument of AAHPERD (1984) for service and of Bartlett, Smith, Davis, and Peel, (1991) for the set and pass were used. In the end of intervention, the questionnaire of knowledge also was used, which consist of questions about the technical elements of skills and about the rules of the game of Volleyball. The results showed that both groups had an improvement but there were no differences between groups in the skills performance and learning. While in the knowledge evaluation of the technique and the rules, the experimental group had significant improvement, in both variables, compared to the control group.
Keywords: multimedia, basic volleyball skills, knowledge in technique and rules

Introduction

Technological innovations and applications seem to be very promising as a way of teaching the cognitive concepts of physical education and sports. It has been found that computers and information technology can have a positive impact on the learning environment (Coelho, 1999), if they fit the pedagogical principles and goals of physical education (Rintala, 1998). They help teachers to provide more and better information experiences and children find computer use ideal for teaching and learning theory, strategies, and rules. The teacher is, therefore, able to devote more time to the practical application and teaching of motor skills (Skinsley & Brodie 1990; Kerns 1989). Researchers (Fletcher, 1990; Najjar, 1996), who have investigated the effects of computer use on variables such as student achievement, attitudes, and learning rate, in several educational areas, found that computer use tends to be more interactive than a typical traditional lesson and results in faster learning (Capper & Copple 1985; Kulik, 1983) and more positive attitudes toward the information presented (Fletcher, 1990). At the same time, the educational material can also be better organized and the learner can set the personal learning pace. In addition, the use of computers promotes critical thinking and problem-solving ability related to the performance of skills (Bowman, 1995), as it enhances students' interest, understanding, and commitment, especially when used as a complement to teaching (Boyce, 1988). In addition, the instructor is able to teach large numbers of students in classes, and provide individualized instruction to a large number of students on an individual basis (Goggin, Finkenberg, & Morrow, 1997) and monitor their progress.

Today, many multimedia applications have developed and use different types of sources such as text, images, video, audio, animation, and high-quality graphics to provide information. Advances in technology have made them much faster than in the past. At the same time, the use of animation and 3D images has made them friendlier and more interactive. As a result, there is a significant increase in information retention (Haggerty, 1997; Kerka, 1990). People seem to prefer multimedia as a means of learning, enjoy interacting with them, and believe that it helps them learn. Multimedia technology is a technology for disseminating information to users in the form of image, sound, animation, and text. It is not only a large volume of information but also a "translation" of complexity into simplicity. From the difficult to the easy, from the static to the dynamic (Krstev & Trtovac, 2014).

Learning skills through multimedia is based on the theory of dynamic developmental systems and children's learning skills. According to this theory, movement is not only produced by the CNS but is done by a continuous interaction between skill, person, and environment (Tzetzis & Lola, 2015). More simply, the forthcoming learning is an interaction between the environment and the cooperation of the internal processes of the musculoskeletal, nervous and sensory systems. From a pedagogical point of view, Paivio's theory of dual coding (Clark, & Paivio, 1991) holds a supportive position according to which people store and decode information in two connected memory systems, language (verbal information) and images (non-verbal). The information, that is, they encode it in a double way, so the image is more effective in learning when accompanied by verbal text and vice versa.

Thus, the teacher's purpose is to create an active learning environment. Since the learning of motor skills is done with the use of three senses (hearing, sight, kinesthetic) the multimedia directly covers both as the practice/execution will cover the third. Currently, the interactive learning methods used in physical education (Ashanin, et al., 2018) and in sports (Born et al., 2018; Karaulova, et al., 2018) are increasing its effectiveness educational process. The use of multimedia motivates students to perform educational activities, improves educational, cognitive, and informational skills, and develops curiosity and thinking (Abramenko, 2018). Lessons through digital multimedia not only increase the learning ability but also create a strong interest of students for learning, especially in the field of physical activity (Chun-Hong & Huang, 2011). Today it is possible to present problems using multimedia, i.e. visual presentation. This is an element that helps a lot in the educational process. It seems that the pedagogical use of technology can offer opportunities for personalized teaching, communication, and feedback when used with an emphasis on promoting motor literacy and improving the quality of teaching. Xu, (2016) evaluated the impact of multimedia teaching using questionnaires. The results show that more than 55% of physical education students were satisfied with teaching using multimedia, however, its use had low efficiency in teaching method and interaction.

Throughout the last years increasing efforts in developing and using multimedia based courses and materials to be used for teaching sport in theory and practice can be observed (Sorrentino, 2001; Wiksten et al., 2002; Katz, 2003; Igel & Daugs, 2005). Multimedia systems have been developed for sports or disciplines of sport science such as sports biomechanics (Tavi et al., 1992; Baltzopoulos and Papadopoulos, 2001; Schleihauf, 2001; Kibele, 2005). Multimedia materials and learning environments have also been developed for technical and tactical lessons in sports (Baca et al., 2005). One specific emphasis lies in the methodical organization of the learning process of sports techniques. Leser et al. (2009a2009b); present an application for learning tactics in soccer. They presume that dynamical visualisations are advantageous when communicating tactical behaviour or the cognitive domain in the area of sport sciences (Wiemeyer, 2008). This assumption is supported by the meta analysis performed by Hoffler and Leutner, 2007, which confirms the effectiveness of such instruction materials for comprehending dynamic phenomenological and real situations.

Same time, in physical education and sports, it is not so clear that the use of computers is more effective than traditional teaching methods in promoting student motor execution and performance in motor skills. But it has been found to be just as effective in teaching golf and tennis rules (Kerns, 1989) and strategies (Adams et al., 1991). There are similar findings reported for students who learned badminton rules (Skinsley & Brodie, 1992) through computers. Only some studies on motor skill learning were published so far. Vernadakis et al. (2002, 2004, 2008) did not find significant differences in learning the setting skill in volleyball or the shooting in basketball. In a more recent study Vernadakis et al., (2006) investigated the effect of multimedia computer assisted instruction, traditional instruction and combined instruction methods on learning the long jump skill. The combined method tended to be the most effective for cognitive learning and skill development, whereas pure multimedia computer assisted instruction resulted in significantly lower skill test scores than the other groups.

It is therefore obvious that the use of multimedia in physical education and sports for the purpose of teaching (skills or knowledge) for learning is a useful tool. Teachers with the proper use of these can give very good help to their students/athletes which will help them to develop at least the thinking ability, creativity, and analytical ability and maybe the technical performance but for the time being it will remain necessary practical training (Pal, 2017).

So, the aim of this study was to examined the effect of multimedia application in performance and learning fundamental volleyball and also the athletes' technical and rules knowledge improvement in mini volley.

Material and Methods

Participants

The research involved a total of 121 beginner female athletes aged 10-12 years (MO = 10,94, TA = 1.1 and 1-2 years of practice experience (MO = 1,44, TA = 1,4), with practice experience from 0-2 years. For the purpose of the research, they were randomly divided into two groups, the experimental (n = 63) and the control group (n = 48). Prior to the intervention, the parents, after being informed about the research (parent meeting), signed written consent for the children to participate in the program after being given the assurance that their children could stop whenever they wanted.

Creation of the site

For the wants on this study, an internet site (www.minivolley.gr) was used which had been created for this purpose. At first, the standard procedure was purchased and secured a domain name (www.minivolley.gr) and a Server that provided the space for the website to be uploaded on the internet. The AMC Moodle platform is used because it's easy to navigate around and provides the most attractive and understandable learning environment. Also, it has been used by many Universities and Schools/ Departments for online courses. The material was contained sketches, 3D animations cartoons and power point lectures, which presented the technique of fundamental skills and the rules of the game. A total of 35 videos were uploaded on the platform, with practice exercises/drills, and presentations for the teaching and learning, regarding the theoretical approach of mini volley, detailed demonstrations with instructions for performing the fundamental skills required. In addition, it has related Links, Questionnaires (cognitive, motivation, satisfaction, etc.), and Forum.

The intervention

The intervention program had 6 weeks duration, with 2 practices per week. The athletes of experimental group entered the positioning in their free time. Only the athletes of experimental group were able to visit the site. In each training session the athletes selected the drills for the set, or pass or the service from the site and executed them in the training. The coach was defined the skill which the athletes should prepare for execution. The coach only oversaw and watch the training process.

The athletes of the control group participated in the training but the coach was responsible for the goal of planning, organizing and realizing the training. He presented, showed the skills to the athletes and also, he corrected the errors of them.

Measurements

For the quantitative evaluation of the skill performance, the instrument of AAHPERD (1984) for service and of Bartlett, Smith, Davis, and Peel, (1991) for the set and pass skills were used. The instruments were chosen because they qualify to resemble the game. There was marked areas in the court and a basket with balls which the coach flied to the athlete for performing the skill. There were five trials for each athlete with two trials in the begging without counting them. Each trial in the correct area took one point or zero, in case the ball was out of the markable area. The total perfect score was 5. Three measurements were accomplished for both groups, examining the evaluation of possible improvement of the quantitative execution of the three fundamental skills, in the begging, in the end of intervention and two weeks after the final measurement (retention). At the end of the intervention there was also the evaluation for both groups the theoretical knowledge of their technique plus the regulation's knowledge, through the completion of the questionnaire.

Statistical Analysis

The IBM SPSS (version 24) was used for statistical analyses. Both descriptive statistics and inductive statistics were used for data analysis. The internal consistency of the measurement scales was examined with the McDonald ohm factor (McDonald, 1985), which is considered an indicator of the generalizability of the results and an indicator of the further validity of the conceptual construction. The inductive statistical test used was the t-test of a sample to examine whether the mean value of the variable under consideration differs statistically significantly from the mean of the response scale.

Results

Initial measurements of the performance results of the two groups showed statistically significant difference in each variable. Therefore, we proceeded to a covariance analysis for each variable separately. Table 1 presents the Means and standard deviation in three measurements for the two groups.

Table 1 The descriptive statistics for the two groups in the three volleyball skills (pass, set, and service skill).

		Pass skill		Set skill		Service skill	
	Group	M	SD	M	SD	M	SD
Initial measurement	Experimental	2.38	1.361	1.48	1.41	2.48	1.81
	Control	1.05	1.099	.95	.92	.93	1.05
	Total	1.74	1.406	1.22	1.26	1.74	1.68
Final measurement	Experimental	3.19	1.378	2.60	1.49	3.40	1.53
	Control	2.74	1.433	2.19	1.43	2.64	1.58
	Total	2.98	1.417	2.40	1.47	3.03	1.59
Retention measurement	Experimental	3.14	1.342	2.52	1.49	3.75	1.63
	Control	3.41	1.044	2.74	.96	3.05	1.11
	Total	3.27	1.211	2.63	1.14	3.41	1.44

Analysis COVARIANCE of repeated measurements for the Pass skill

The t-test analysis showed statistically significant differences between groups in the initial measurements ($t_{(119)} = 5.88$, $p < .001$). For this reason, it was decided to perform a covariance analysis of repeated measures with the first measurement as a variable. The results of the analysis showed that the first measurement regulates the mean values statistically significantly (F (1, 118) = 18.45, p <.001) and there was a statistically significant interaction between the measurements and the group ($F_{(1, 118)} = 4.23$, p = .042, n2 = .035), main effect of measurement ($F_{(1, 118)} = 15.6$, p <.001, $\eta^2 = .117$), but there was not main effect of group ($F_{(1, 118)} = 6.74$, p =.102, $\eta^2 = .023$).

The Tukey criterion was used to understand the interaction. From the comparisons of the adjusted mean values, it is observed that there are statistically significant differences between the final measurement and the retention measurement for the control group (t = -3.55, p = .003). In contrast, in the experimental group, there are no statistically significant differences between final measurement and conservation measurement. Finally, there are marginally non-statistically significant differences in retention measurement between the two groups (t = -2.502, p = .065). In other words, despite the fact that the control group showed a statistically significant improvement, this did not differ from the performance of the experimental group. Therefore athletes of the two groups were improved in pass skill performance without any difference between groups.

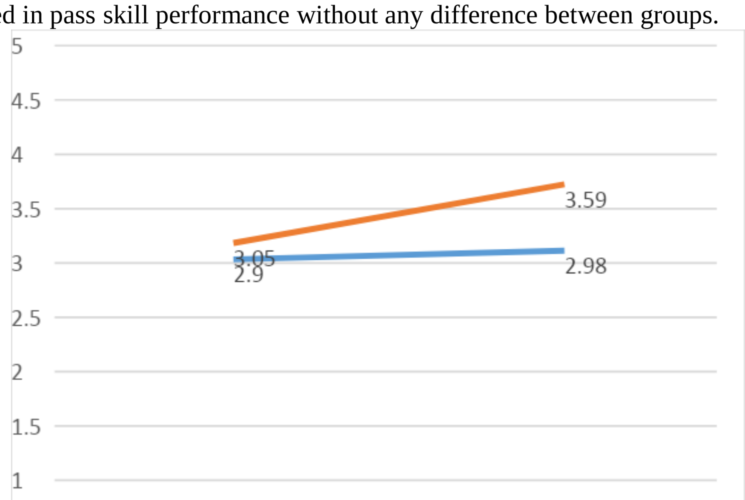

Figure 1 Performance of athletes of two groups in pass skill

Figure 1 visually shows the athletes performance for the pass skill in the final and the retention measurement.

Analysis COVARIANCE of repeated measurements for the Set skill

The t-test analysis showed statistically significant differences between groups in the initial measurements ($t_{(117)} = 2.44$, p = .016). For this reason, it was decided to perform a covariance analysis of repeated measures with the first measurement as a variable. The results of the analysis showed that the first measurement regulates the mean values statistically significantly ($F_{(1, 117)} = 22.396$, p <.001) and there was not statistically significant interaction between the measurements and the group ($F_{(1, 117)} = 2.96$, p = .088, n2 = .179), but main effect of measurement ($F_{(1, 117)}$ = 25,46, *p* <.001, η^2= .179), and there was not main effect of group ($F_{(1, 117)}$ = .329, *p* =.567, η^2= .025). Therefore, athletes of the two groups were improved in set skill performance without any difference between groups.

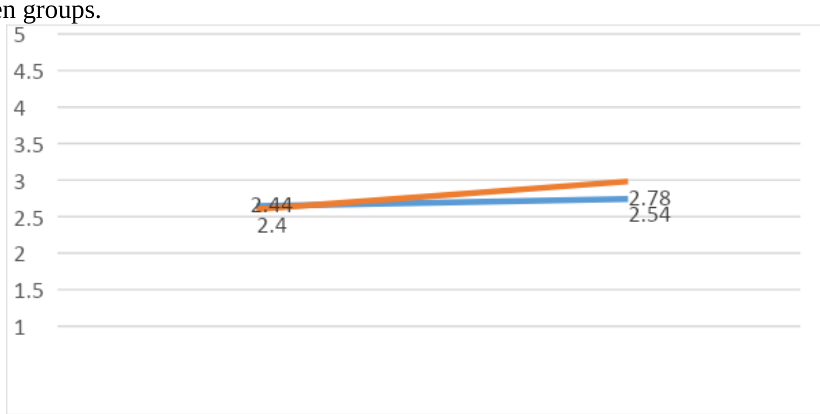

Figure 2 Performance of athletes of two groups in set skill.

Figure 1 visually shows the athletes performance for the set skill in the final and the retention measurement.

Analysis COVARIANCE of repeated measurements for the Service skill

The t-test analysis showed statistically significant differences between groups in the initial measurements ($t_{(119)}$ = 5.66, p = .001). For this reason, it was decided to perform a covariance analysis of repeated measures with the first measurement as a variable. The results of the analysis showed that the first measurement regulates the mean values statistically significantly ($F_{(1, 118)}$ = 7.289, p <.008) and there was not statistically significant interaction between the measurements and the group σημαντική ($F_{(1, 118)}$ = 003, *p* =. 646, η^2= .002) bur there was a main effect of measurement ($F_{(1, 118)}$ = 7.290, *p* <.008, η^2= .058), and there was not main effect of group ($F_{(1, 118)}$ = .248, *p* =.619, η^2= .002).

Therefore, athletes of the two groups were improved in service skill performance without any difference between groups.

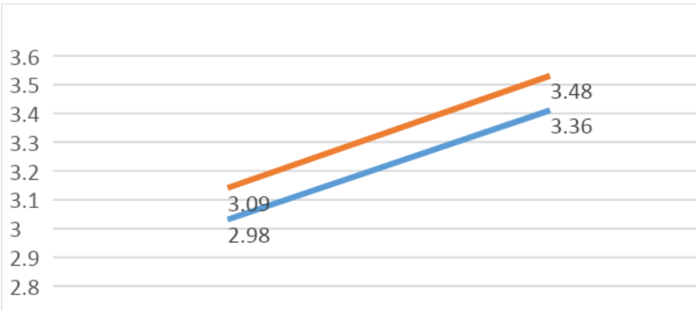

Figure 3 Performance of athletes of two groups in service skill.

Figure 3 visually shows the athletes performance for the service skill in the final and the retention measurement.

Descriptive Statistics and Index of Internal Cohesion - Reliability of Cognitive Test

The results of the McDonald ω factor for the cognitive test are presented in the following Table 2.

Table 2 Descriptive statistics and internal coherence of the cognitive test

	M (SD)	Mc Donald's ω
Technical	6.82 (1.52)	.53
Regulations	5.94 (1.72)	.50

The degree of the technique of the participants is moderate to high with the average score of the respective dimension being equal to 6.82 (T.A. = 1.52). The grade of the regulations is at moderate levels with the average score of the respective dimension being equal to 5.94 (T.A. = 1.72).

Analysis of variance of repeated measurements for the cognitive test: technique

Table 3 presents the descriptive statistics for the cognitive test in relation to the technique for each of the two-time points.

Table 3 Mean value and standard deviation of the cognitive test: technique

	Groups	M	SD
T1=Initial measurement	Experimental	5.74	1.35
	Control	5.62	1.41
	Total	5.68	1.37
T2=Final Measurement	Experimental	9.65	.882
	Control	6.12	1.82
	Total	7.95	2.26

Based on the multivariate analysis of variance there are statistically significant differences (main technical effect): the Wilks' L index is equal to .273 (F = 317.02, p <.001), while according to the n2 index the differences within the subjects interpret the 72.7% of the total dispersion.

Table 4 Results of multivariate tests of the cognitive test: technique

Wilks' *Λ*	Value	F	p	η^2
Technique	.273	317.02	< .001	.727
Technique by group	.386	189.41	< .001	.614

The analysis of variance revealed that the main effect of the technique ($F_{(1, 119)}$ = 317, p <.001, η2 = .727) and the interaction of the variables of the cognitive test: technique and the group are statistically significant ($F_{(1, 119)}$ = 189, p <.001, η2 = .614)

Figure 4 visually shows the interaction between the variables of the cognitive test: technique and the groups at each point in time.

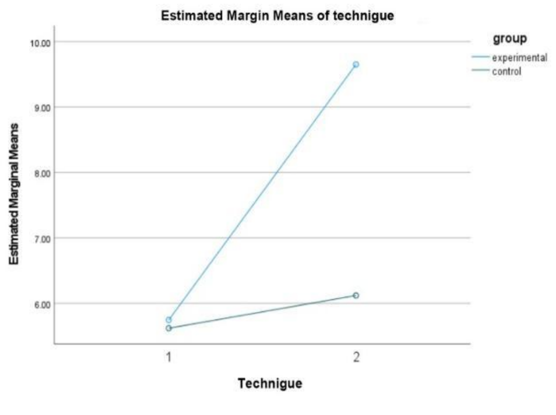

Figure 4 The score of athletes of two groups in technique cognitive questionnaire.

From the comparisons of the means of the groups it is observed that there are statistically significant differences between the experimental and control groups ($F_{(1, 119)} = 67.4$, $p < .001$, $\eta 2 = .362$).

From the application of Tukey post hoc, it appears that the participants in the experimental group improved, as they showed higher values in the second measurement than in the first measurement (t = -22.798, p <.001). Also, the experimental group had statistically higher values than the control group in the final measurement (t = 13.704, p <.001), while this difference was not present in the initial measurement (t = 0.498, p = .959).

Analysis of variance of repeated measures for the cognitive test: regulations

Table 5 presents the descriptive statistics for the cognitive test in relation to the regulations for each of the two-time points.

Table 5 Mean value and standard deviation of the cognitive test: regulations

	Groups	M	SD
T1=Initial measurement	Experimental	5	1.28
	Control	4.7	1.29
	Total	4.85	1.29
T2=Final Measurement	Experimental	8.93	.858
	Control	4.93	2.41
	Total	7.01	2.68

Based on the multivariate approach the differences of the iterative measurements are statistically significant (main effect regulations): the Wilks' L index is equal to .360 ($F_{(119)} = 211.71$, $p < .001$), while according to n2 index differences within subjects account for 64% of the total dispersion.

Table 6 Results of multivariate tests of the cognitive test: regulations

Wilks' *Λ*	Value	F	p	η^2
Regulations	.360	211.71	< .001	.640
Regulations by group	.414	168.55	< .001	.586

The analysis of variance revealed that both, the main effect of the Regulations $F_{(1, 119)} = 212$, $p < .001$, $\eta 2 = .640$) and the interaction of the variables of the cognitive test: regulations and the group are statistically significant ($F_{(1, 119)} = 169$, $p < .001$, $\eta 2 = .586$).

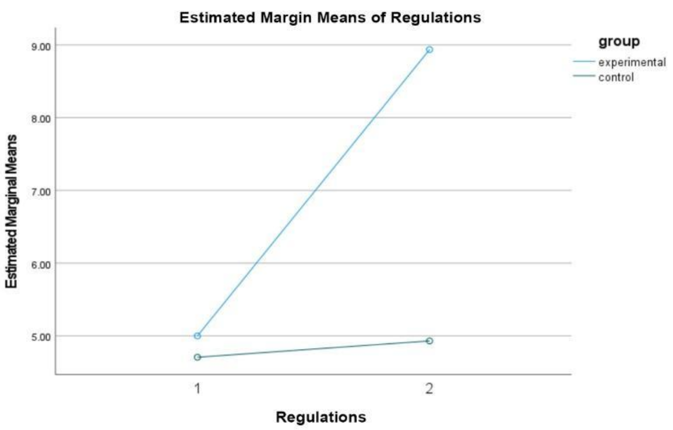

Figure 5 The score of athletes of two groups in regulations cognitive questionnaire.

From the comparisons of the means of the groups it is observed that there are statistically significant differences between the experimental and control groups $F_{(1, 119)} = 77.1$, $p < .001$, $\eta^2 = .393$.

From the application of Tukey post hoc, it appears that the participants in the experimental group improved, as they showed higher values in the second measurement than in the first measurement ($t = -19.884$, $p < .001$). Also, the experimental group had statistically higher values than the control group in the final measurement ($t = 12.326$, $p < .001$), while this difference was not present in the initial measurement ($t = 1.249$, $p = .597$).

Discussion

The purpose of this study was to examined the effect of multimedia application on basic volleyball skill performance and learning and also the athletes' technical and rules knowledge improvement in mini volley.

The physical education essentials require physical activity performing. Most physical educators associate subjects with the development of motor skills (Stanescu et al., 2017). This automatically raises concerns about the use of multimedia and to what extent they are effective and how much? Regarding this issue and to find a possible answer to this study, the site www.minivolley.gr was used, which was created for this purpose. The young female athletes of the experimental group had the right to visit and use it in their free time and to study through multimedia presentations, the technique of performing three basic volleyball skills (pass, set, service) as well as cognitive knowledge of technique and the regulations of the game. In the evaluation of the improvement of the quantitative performance in the execution of these three fundamental skills, the results show that there was a statistically significant difference in the improvement of the quantitative performance from the initial to the final measurement but the same happened in the control group that did not have the right to visit and use the site (did not know of its existence).

The results indicated that the athletes of both groups were improved on the fundamental volleyball skills performance without have differences between groups. Relatively for the technical and rules knowledge improvement in mini volley, the athletes of experimental group were better than the athletes of control group. In our case, the actual training time was identical (twelve sessions) for both groups which showed significantly but the same improvement in the final measurement and in that of retention. Two elements may have influenced this result. The relatively short duration of the practice may have been an important factor in not showing the effectiveness of the execution to the benefit of the experimental group. Improving the technique usually affects better execution in the long term. It can also be said with the relatively reservation that in case the training time was longer the experimental group would probably have better performance since the use of the multimedia application would help it to have a better understanding of the technical details of the execution of the skills and therefore would have it better efficiency. So, there was no difference in progress in terms of the quantitative performance of the groups. They improved in a similar way after completing the twelve practice sessions.

The results of this research are in line with the results of researches aimed at examining the effect of multimedia on learning sports skills. These investigations found no differences between the traditional group and the group of multimedia. In physical education and sports, it is not so clear that the use of computers is more effective than traditional teaching methods in promoting student motor execution and performance in motor skills. As Boyce, (1988) mentions, ICT enhances students' interest, understanding, and commitment, especially when used as a complement to teaching. Physical education is essentially a two-dimensional subject that includes practical application and theory. The visual presentation of the subjects helps the athletes to understand more deeply and correctly the basic structure of the movement (Liu, 2017). According to Kerns, (1989) the learning of motor skills is done with the use of three senses (hearing, sight, kinesthetic). The multimedia directly covers the two of them while the practice/execution will cover the third. Zhao and Yang (2019) had the idea to create a system based on the use of computers so that it would be useful to improve student performance. The system they created had multiple possibilities but was based mainly on the cognitive direction. It had the opportunity to enrich the didactic content, to improve the knowledge on the subject, and increase the interest of the students. Same studies did not find significant differences between athletes of traditional and multimedia groups in learning the setting skill in volleyball or the shooting in basketball (Vernadakis et al., 2002, 2004), or in long jump skill (Vernadakis et al., 2006).

The results are also consistent with researches that compared the effect of multimedia with the traditional learning method on the knowledge of sport regulations and technique knowledge. All this resulted in the effectiveness of teaching maybe we should keep in mind that all these approaches, and methods for teaching, represent auxiliary means, which accompany the well-known regular practical lessons, aiming at maximum efficiency. This is often why it is important for teachers to think twice about the role of ICT in physical education, bearing in mind that it cannot replace real physical experience (Epuran, 2005). In the present study regarding the cognitive test concerning the theoretical improvement of knowledge through the study of the site in the basic volleyball technique and the regulations the difference in the improvement of the experimental group compared to the control group was statistically significant. This was observed both in the whole and in the individual sections of the theoretical knowledge (technique, regulations). This result is identical to that of other researchers such as Kerns, (1989) and Adams et al., (1991). They report that the use of ICT for teaching is very effective in teaching rules and strategies for golf and tennis.

There are similar findings reported by Skinsley and Brodie, (1992) for students who learned badminton regulation through computers. In any case, computer education-based teaching has a very important significance. Teachers can provide an ideal knowledge to the students and develop students' thinking ability and creativity, improve students' ability to analyze and solve practical problems (Pal, 2017) Additionally, effective and efficient use of computer applications and knowledge technology is important for resolving mainly the issues of each PE teacher and student further (Hong & He, 2018).

In recent years, an effort has been made with the use of multimedia applications to develop a much better approach so that their application is even more effective in physical education. The results of this study generally validated that the utilization of computer-assisted instruction is helpful within the implementation of education programs, mostly in teaching concepts and principles of educational nature.

There were some limitations during this study that ought to be mentioned. First, the effectiveness of computer-assisted instruction trusted the standard of the multimedia program, while the effectiveness of traditional teaching trusted the effectiveness of the education teacher. Second, the sample of participants should be larger. In a very further study, if more athletes of various ages are trained, the results would be more valid.

References

[1]. AAHPERD (1984). *Skills Test Manual*. Association Drive, Reston, VA 22091.

[2]. Abramenko, M. N. (2018). Physical education of students of special medical groups using an interactive training manual for self-employment. *Scientific Notes of the University of P. F. Lesgaft, 2* (156), 9-12. (In Russ.)

[3]. Adams, T. M., Kandt, G.K., Throgmartin, D., Waldrop, & Philip B. (1991). Computer-Assisted Instruction vs. Lecture Methods. *Physical Educator Indianapolis, Vol. 48*, Iss. 3, 149.

[4]. Ashanin V., Filenko L., Pasko V., Tserkovna O., Filenko I., Poltoratskaya A., & Mulyk K. (2018). Implementation practices of the Rugby-5 into the physical education of schoolchildren 12-13 years old using information technology. *Journal of Physical Education and Sport, 18*(2), Art. 112, pp. 762 - 768, DOI:10.7752/jpes.2018.02112

[5]. Baca A. (2005) SpInSy - a web based information system for the sport scientific theory of selected sports. In: *Handbook of E-Learning*. Eds: Igel C., Daugs R. Schorndorf: Hofmann; 353-371 (In German).

[6]. Baltzopoulos V. & Papadopoulos T. (2001) Teaching forward and inverse dynamics and optimisation using the biomechanics toolbox. In: *Proc. 5th Nat. Symp. On Teaching Biomechanics in Sports*. Eds: Blackwell J., Knudson D.San Francisco, CA: 29-32Schleihauf.

[7]. Bartlett, J., Smith, L., Davis, K., & Peel, J. (1991). Development of a valid volleyball skills test battery. *Journal of Physical Education, Recreation & Dance, 62*(2), 19-21.

[8]. Born, P., Phannguyen, N., Grambow, R., Meffert, D., & Vogt, T. (2018). Embedding tennis specific teaching videos into long-term educational concepts to improve movement learning and technique performances. *Journal of Physical Education and Sport, 18*(1), Art 34, pp. 255-261, DOI: 10.7752/jpes.2018.01034

[9]. Bowman, A. (1995). Teaching ethics: telling stories. *Nurse Education Today, 15* (1): 33-38

[10]. Boyce, B.A. (1988). A computerized simulation of teaching. A glimpse of the real world. *Journal of Physical Education, Recreation and Dance, 59* (2): 31-33.

[11]. Capper, J. & Copple, C. (1985). *Computer Use in Education: Research Review and Instructional Implications.* Washington, DC, Center for Research into Practice

[12]. Chun-Hong Huang, Su-Li Chin, Li-Hua Hsin, & Yi-Pei Yu (2011). A Web-based E-learning Platform for Physical Education. *Journal of Networks.*

[13]. Clark J. M. & Paivio A. (1991). Dual coding theory and education. *Educational Psychology Review, 3*(3), 149–210. https://doi.org/10.1007/BF01320076

[14]. Coehlo, J.D. (1999). Physical education in the 21st century. *Teaching Elementary Physical Education, 10* (6): 29-30.

[15]. Epuran, M. (2005). *Metodologia cercetării activităților corporale - Exerciții fizice, sport, fitness (Ediția a 2a).* București: Editura Fest, pp. 268.

[16]. Fletcher, D. (1990). *The effectiveness and cost of interactive videodisc instruction in defense training and education* (IDA Paper P-2372). Alexandria, VA, Institute for Defense Analyses.

[17]. Goggin, N.L., Finkenberg, M.E., & Morrow, J.R. (1997). Instructional technology in higher education teaching. *Quest, 49* (3): 280-290.

[18]. Haggerty, T. (1997). Influence of information technologies on kinesiology and physical education. *Quest, 49*:254-269.

[19]. Hoffler T. N. & Leutner D. (2007) Instructional animation versus static pictures: A meta-analysis. *Learning and Instruction* 17, 722-738 [Google Scholar,

[20]. Hong, Q. & He, W. (2018). Application of computer virtual reality technology in sports training. *Journal of Beijing printing University.* 1:157–159. [Google Scholar]

[21]. Igel C. & Daugs R. (2005) *Handbook of E-Learning*. Schorndorf: Hofmann; (In German)

[22]. Karaulova, S., Boychenko, K., Malikov, N., Bogdanovskaya, N., Samolenko, T., Apaychev A., & Korobeynikova L. (2018). Innovative technologies based management of the training process of female athletes specializing in short distances running. *Journal of Physical Education and Sport*, *18* (Supplement issue 4), Art. 275, pp. 1876 – 1880

[23]. Katz, L. (2003) Multimedia and the Internet for Sport Sciences: Applications and Innovations. *International Journal of Computer Science in Sport* 2, 4-18

[24]. Kerka, S. (1990). Interactive videodisk in Vocational education. ERIC, ED325660

[25]. Kerns, M. (1989). The effectiveness of computer-assisted instruction in teaching tennis rules and strategies. *Journal of Teaching in Physical Education, 8:*170-176

[26]. Kibele, A. (2005) Multimodal learning in multimedia-based learning enviroments: theory in biomechanics. In: *Education, Research and New Media*. Ed: Wiemeyer J.Hamburg: Czwalina; 104-109 (In German) [Google Scholar]

[27]. Krstev, C. & Trtovac, A. (2014). Teaching Multimedia Documents to LIS Students. *The Journal of Academic Librarianship 40*(2). DOI: 10.1016/j.acalib.2014.02.006

[28]. Kulik, J.A. (1983). Synthesis of research on computer-based instruction. *Educational Leadership, 41* (1): 19-21.

[29]. Leser R., Baca A., Eder C., Karall E., Miko C., & Uhlig J. (2009b) Redesigning the 'Sport multimedial' E-Learning application. In: *Proc. of the 14th Annual Congress of the European College of Sport Science*. Eds: Loland S., Bø K., Fasting K., Hallèn J., Ommundsen Y., Roberst G., Tsolakidis E.126 [Google Scholar]

[30]. Leser R., Uhlig J., & Uhlig M. (2009a) Development of an application for learning and teaching soccer tactis. *International Journal of Computer Science in Sport* 8, 19-31 [Google Scholar

[31]. Liu, Y. (2017). Research on the application of computer virtual reality technology in college physical education. *Wireless Internet technology.* 1:144–145. [Google Scholar]

[32]. Najjar, L.J. (1996). Multimedia information and learning. *Journal of Educational Multimedia and Hypermedia, 5* (2): 129-150.

[33]. Pal, A. (2017) Importance of Computer Education in the Field of Physical Education. *International Journal* of *Researches in Social Sciences and Information Studies, Vol. V,* 49-50

[34]. Rintala, J. (1998). Computer technology in higher education: an experiment not a solution. *Quest, 50:*366-378.

[35]. Skinsley, M. & Brodie, D. (1990). A study of the effectiveness of computer assisted learning in physical education. *Research supplement, 7*:14-16.

[36]. Sorrentiono, R.M. (2001). Designing computer enhanced instruction for sport. In: *Proc. Computer Science and Sport III and Performance Analysis of Sport V*. Eds: Hughes M., Franks I. 57-62 [Google Scholar]

[37]. Stanescu M., Stoicescu, M., & Ciolca, C. (2011). Computer Use in Physical Education and Sports Teaching https://www.researchgate.net/publication/268185238_COMPUTER_USE_IN_PHYSICAL_EDUCATION_AND_SPORTS_TEACHING

[38]. Tavi, M., Sholev, M., & Ayalon, A. (1992) Using computer interactive programs as a teaching aid in biomechanics. In: *Proc. Int. Conf. On Computer Applications in Sport and Physical Education*. Eds: Tenenbaum G., Raz-Liebermann T., Artizi Z.Netanya, Wingate Institute; 32-35 [Google Scholar]

[39]. Tzetzis, G. & Lola, A. (2015). *The Fitts and Posner Model* (1967) (Chapter 3), Motor Learning and Development (p. 43). Zografou: Creative Commons

[40]. Vernadakis, N., Zetou, E., Antoniou, P., & Kioumourtzoglou, E. (2002). The effectiveness of computer-assisted instruction on teaching the skill of setting in volleyball. *Journal of Human Movement Studies 43,* 151-164 [Google Scholar]

[41]. Vernadakis, N., Antoniou, P., Zetou, E., & Kioumourtzoglou, E. (2004). Comparison of three different instructional methods on teaching the skill of shooting in basketball. *Journal of Human Movement Studies 46*, 421-440 [Google Scholar]

[42]. Vernadakis, N., Avgerinos, A., Zetou, E., Giannousi, M., & Kioumourtzoglou, E. (2006). Comparison of multimedia computer assisted instruction, traditional instruction and combined instruction on learning the skills of long jump. *International Journal of Computer Science in Sport* 5, 17-32 [Google Scholar]

[43]. Vernadakis, N., Zetou, E., Tsitskari, E., Giannousi, M., & Kioumourtzoglou, E. (2008). Student attitude and learning outcomes of multimedia computer-assisted versus traditional instruction in basketball. *Education and Information Technologies, 13*(3), 167–183.

[44]. Wiemeyer, J. (2008) Multimedia in sport - between illusion and realism. In: *Computers in Sport*. Eds: Dabnichki P., Baca A. Southampton: WITPress; 293-317 [Google Scholar

[45]. Wiksten, D., Spanjer, J., LaMaster, K. (2002) Effective use of multimedia technology in athletic training education. *Journal of Athletic Training 37*(suppl.), 213-219 [PMC free article] [PubMed] [Google Scholar

[46]. Xu, L. (2016). Study on Multimedia Teaching and the Reform of College Physical Education: Evaluation of Teaching Effect *International Journal of Security and Its Applications Vol. 10*, No. 2 pp.255-266 http://dx.doi.org/10.14257/ijsia.2016.10.2.23

[47]. Zhao, Z. & Yang, J. (2019). Design and implementation of computer-aided physical education platform based on browser/server architecture. *International Journal of Emerging Technologies in Learning .14*(15):40–51. doi: 10.3991/ijet.v14i15.11146. [CrossRef] [Google Scholar]