

Impact of Information and Communication Technology tools on the teaching-learning processes of Physical Education

Abstract of PhD Thesis

Attila Varga

Doctoral School of Sport Sciences
Hungarian University of Sports Science



**HUNGARIAN UNIVERSITY
OF SPORTS SCIENCE**
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Supervisor: Dr. Ágnes Kokovay associate professor, PhD
Dr. László Révész associate professor, PhD

Official reviewers: Dr. István Soós research professor, PhD
Dr. Anikó Kálmán associate professor, PhD

Head of the Final Examination Committee:
Dr. János Gombocz professor emeritus, CSc

Members of the Final Examination Committee:
Dr. Lívia Borosán associate professor, PhD
Dr. Péter Antal college associate professor, PhD
Dr. Johanna Takács senior lecturer, PhD

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Introduction

In the 21st century modern technology plays a dominant role. Due to its radical development and prevalence in everyday life and the workplace along with the related expectations ICT devices tend to play an increasing role in the education process. Accordingly the changes impacting teaching and learning lead to new requirements to teachers and teaching programs alike. While Physical Education is seemingly not a subject in which ICT plays a crucial role (Varga and Révész 2023) the integration of technology into the respective lessons implies a logical and irreversible change (Yildiz, Güzel and Zerengök 2019).

The key to the application of ICT devices and the introduction and propagation of ICT-based methods in the classroom is enabling teachers to meet the given requirements via training programs (Fehér 2004). Although there is a close connection between public education and teacher training, research related to this phenomenon in the higher education sphere and especially in teacher training programs is limited (Dringó-Horváth and Gonda 2018). Consequently, the starting point of the present thesis is the examination of applicants and graduates of Physical Education teacher training programs.

In the current digital world the target oriented and deliberate use of various modern technological devices in the classroom contributes to the renewal of public education. Teachers can play a central role in this process. Since ICT-supported teaching entails new challenges and opportunities, the exploration of the conditions and status of in-service Physical Education teachers is the second pillar of our thesis. This part of the research focuses on lesson preparation and the actual teaching effort in addition to attitudes related to ICT device use. The third section of the dissertation includes an empirical examination focusing on the impact of the educational application of selected ICT devices, among them the smart phone, on such factors as the effectiveness of the learning process, the respective motivational environment, and motivation. Since an empirical scholarly examination of ICT-integrated and supported teaching and learning has not yet been performed in the field of Physical Education in Hungary, our research serves a gap filling purpose in domestic sports science.

Objectives

Our doctoral research aimed to explore and compare the ICT use-related attitude and the attendant background variables of recent graduates, teacher training programs applicants, and in-service teachers of Physical Education in the public education sphere.

Additional goals include performing a scholarly inquiry of the ICT use of in-service Physical Education teachers and the factors influencing such use along with the respective views. Finally, the research also focused on the impact of ICT device use on student performance and motivation during the Physical Education teaching process.

Methods

The testing process took place in the Institute of Sports Science of the Eszterházy Károly Catholic University of Eger. The sample of 366 participants included applicants to and graduates of Physical Education teacher training programs for the 2016/17, 2017/18, and 2018/19 academic years. The sample included 153 (41,8%) graduating and 213 (58,2%) applicant students. The average age of the graduates was $29.96 \pm 7,56$ years, while in case of those applying to the the program the figure was $23,23 \pm 7,20$. As far as the category of the study schedule is concerned 201 (51,9%) was full time, 165 (48,1%) were part time students. The sample included 232 male (63,4%) and 134 female (36,6%) participants.

The research utilized the Computer Attitude Scale modified and further improved by Goktas (2012) from the SFA-T3 measuring device developed by Papanastasiou and Angeli (2008). Our efforts focused on the beliefs and attitudes of teachers regarding the educational use of computers and the Internet. Furthermore, we applied a self-generated ICT-use related questionnaire (A version) in order to explore the ICT-use, informatics knowledge and Internet use characteristics of the respondents.

The research aimed at the public education sphere relied on the Computer Attitude Scale enhanced by a self-compiled ICT use questionnaire (B version) to explore the frequency of and related teacher attitudes to the educational application of ICT devices along with the participants' ICT-device use habits, informatics background and Internet use features.

Participants of the research project included Hungarian students in the 11th grade of the Demonstration Primary, Secondary School (Basic Art Institute and Vocational Education Institution) of the Eszterházy Károly Catholic University. The sample included 21 male and 64 female students ($M_{age} = 16,72$ years, $SD = 0,50$). The participants were allocated into three groups. Test group 1 (Class 11B) with 26 members was subjected to ICT supported intervention

receiving ICT-based teaching, while Test group 2 (Class 11C) containing 34 members was taught by traditional teaching methods and did not receive ICT support. In case of the control group (Class 11A) consisting of 25 participants there was no intervention or ICT support either.

The psychomotor performance of students in the context of academic achievement was tested by the NETFIT 20 m shuttle run test, aimed at the assessment of cardiovascular fitness (aerob capacity). Students had to complete a maximum number of 20 m portions with a speed dictated or determined by the enclosed audio material. The main feature of the test is progressive intensity, with a gradually increasing difficulty level from the beginning. The audio text related to the test prescribed 21 levels with continuously increasing difficulty grade every minute. Students were allowed 9 seconds to fulfill the distance in the first stage and the time requirements continuously decreased with 1,5 seconds indicated by a sound marking the separate segments. The test ended if the student had committed their second error, that is, they couldn't reach the line by the warning sound, or couldn't continue running.

In order to assess the Perceived Motivational Climate we relied on the PMCSQ-2 /Perceived Motivational Climate in Sport Questionnaire's (Newton et al. 2000) validated Hungarian version, the H-PMCSQ-2 (Révész et al. 2009). The questionnaire included two main scales Task, Ego and three subscales respectively. The subscale belonging to the Task main scale contained the following items: Cooperative learning, Intra-team role, and Effort at improvement The subscale related to the Ego main scale consisted of Fear of errors, Unequal recognition, and Intra-team member rivalry.

In the assessment of motivation we relied on the Hungarian version of the SMS questionnaire /Sport Motivational Scale/ (Pelletier et al. 1995) prepared by Tsang and associates in 2005. The questionnaire containing 28 questions assesses the athletes' motivational orientation in three categories: amotivation, extrinsic motivation, and intrinsic motivation.

Results

Results achieved in the area of teacher training

The research findings indicate that both applicants and graduates of teacher training programs maintain a positive attitude towards the use of computers as ICT devices while these tools are also considered valuable for enabling effective learning. We have identified significant differences regarding the given background variables.

According to the MANOVA test the sex of the participants has a significant impact on the attitudes ($F=2,299$, $df=2$, $p=0,005$). The exploration of the attitudes of full and part-time students revealed significant differences in two cases. The MANOVA test also confirmed a significant impact of the study schedule (full time or part time) of the participants ($F=2,352$, $df=2$, $p=0,004$).

Results achieved in the area of public education

The attitude test of Physical Education teachers of the public education sphere revealed significant differences related to the two types of institutions, primary and secondary schools.

In the primary school category the attitude test of Physical Education teachers demonstrated significant differences in case of the respective sex in several instances, while such digression was discerned only in two occasions regarding secondary schools. According to the MANOVA test the sex of teachers employed in primary schools has a significant impact on the respective attitudes ($F=2,592$ $df=2$, $p=0,001$) and such significant impact was not identified in case of secondary education.

Regarding the age variable significant differences were identified in two cases in the primary and secondary education category respectively. The MANOVA test did not affirm any significant impact regarding the first category, while in secondary education the age variable generates a significant impact on attitude ($F=2,023$ $df=2$, $p=0,001$).

Results related to ICT-device use among Physical Education teachers working in public education institutions show a relatively low level of ICT use during lessons. In the primary and secondary school categories as well the highest average use value was allocated to multimedia devices followed by the tablet and the presentation.

As far as the sex of the given teacher is concerned significant differences were indicated in numerous instances in primary education, while only two such cases were identified in the secondary education category. The MANOVA test confirmed that the sex of the respective teacher does not significantly influence ICT device use in either school category.

As far as age and teaching experience are concerned significant differences were ascertained regarding the use of two devices, the tablet and the projector and only in the primary school category. The MANOVA test revealed that the professional experience of primary school Physical Education teachers has a significant impact on ICT use ($F=1,507$ $df=2$, $p=0,003$). Regarding secondary schools the age and experience of teachers do not generate a significant impact on ICT device use.

Having taken the full scale of the education process into consideration we explored the frequency of ICT device use during lesson preparation and the actual teaching effort. One subsample included teachers of other subjects besides Physical Education while the other group included only Physical Education instructors. During lesson preparation participants of both groups preferred to use certain ICT-devices (laptop, notebook, netbook, smart phone). Our results showed that the role of traditional printed materials along with that of personal computers has declined as compared to that of the abovementioned devices. The ICT devices most frequently used during lessons included the multimedia tools, tablets, and projectors. Our research findings confirm that teachers of other subjects besides P.E. use a wider variety of ICT devices more frequently than those teaching only Physical Education.

In order to explore the attitudes and individual perspectives of Physical Education teachers working in the public education sphere to digitalized instruction we relied on various hypotheses.

According to the MANOVA test the computer literacy of primary school Physical Education teachers ($F=3,421$, $df=2$, $p=0,000$) and the respective professional experience ($F=1,612$, $df=2$, $p=0,002$) have a significant impact on their attitude towards ICT use, while in case of secondary schools only computer literacy played a dominant role ($F=2,003$, $df=2$, $p=0,001$).

The intervention

Examining the efficiency of the learning process Academic performance / Motor performance

The psychomotor performance of students in the context of academic efficiency was tested by the NETFIT 20 m shuttle run test before and after the intervention. Our results suggest that a significant difference can be discerned concerning the pre and post-intervention data in both test groups (Table 1).

Table 1. A group-based breakdown of student performance prior to and after intervention

Group	Pre-test (20 m shuttle run test-in meters)	Post-test (20 m shuttle run test-in meters)	Pre-and Post-test difference (in meters)	Sig.
	<i>M ± SD</i>	<i>M ± SD</i>		
Test group 1	726,15±448,27	843,85±471,01	117,69	*0,04
Test group 2	529,41±267,43	614,71±303,52	85,29	*0,00
Control group	510,40±264,77	512,80±277,60	2,4	0,07

* p < 0,05

The ICT-supported group has achieved significantly better results both on the pre- and post-intervention measuring. The average pre-intervention figure of 196,74 m increased to 229,14 m on average after the post-intervention measuring (Table 2).

Table 2. Differences between the two test groups (pre and post-intervention measuring).

Group	Pre-test (20 m shuttle run test-meter)	F	Sig	T	Post-test (20 m shuttle run test-meter)	Pre-and Post-test difference (in meters)	F	Sig.	T
	<i>M ± SD</i>				<i>M ± SD</i>				
Test group 1	726,15±448,27	12,43	*0,03	2,11	843,85±471,01	117,69	7,17	*0,02	2,28
Test group 2	529,41±267,43				614,71±303,52	85,29			

* p < 0,05

Exploring the Perceived Motivational Climate

We administered the PMCSQ questionnaire before and after the intervention. Regarding Test group 1 the pre-intervention test revealed a higher result (M=3,19) in case of the Task scale over that of the Ego scale (M=2,47). The one sample T probe indicated a significant difference in total in case of the Task main scale along with the Cooperative learning (p=0,02) and Effort at improvement (p=0,00) subscales. In both cases the respective results improved in a statistically detectable manner.

In case of Test group 2 the Task and Ego main scale showed similar results to those of Test group 1 as no significant differences were discerned. The highest values were received in the Effort at improvement and Intra-team member rivalry subscales. During the post-intervention tests no significant differences were shown in case of the Task main scale and its subscales, but significant difference was determined between the Ego main scale ($p=0,00$) and its two subscales: Punishment for mistakes ($p=0,03$) and Unequal recognition ($p=0,00$).

Motivation-related inquiry

The project included the examination of the change of motivation in both test groups by the Sport Motivation Scale (SMS). In case of Test group 1 the highest values were scored pertaining to extrinsic motivation ($M \pm SD=2,89\pm0,63$), as students were primarily externally motivated in the pre-intervention stage. The value of amotivation was the lowest ($M \pm SD =2,73\pm0,53$).

Following the implementation of the project extrinsic motivation showed a minimal increase ($M \pm SD=2,91\pm0,57$) similar to amotivation while intrinsic motivation significantly rose ($p= 0,01$). Consequently, by the end of the project the level of intrinsic motivation was the highest as a result of the aforementioned significant growth.

In Test group 2 the level of intrinsic motivation was the highest ($M \pm SD =2,86\pm0,45$) before the project surpassing even the same value at Test group 1. The lowest level was related to amotivation ($M \pm SD =2,35\pm0,56$). While by the end of the project the level of intrinsic motivation decreased ($M \pm SD =2,72\pm0,37$), the value of extrinsic motivation increased along with a significant growth in case of the value of amotivation ($p=0,04$).

Conclusions

The first hypothesis of our treatise was related to the attitude tests of participants of Physical Education teacher training programs and in-service teachers of public education institutions. We proposed that applicants to Physical Education teacher training programs and the respective graduates have a positive attitude, while those working in public education institutions maintain a negative perspective toward the use of ICT devices.

Our research results confirmed that in addition to applicants to and graduates of Physical Education teacher training programs P.E. teachers in public education institutions maintain a positive outlook towards the use of ICT devices as well. Thus our research in the area of teacher training reinforce international research results (Yaman 2007, Bebetos and Antoniou 2009, Goktas 2012) concluding that students of Physical Education teacher training programs have a positive attitude towards ICT-device use. Consequently such findings are still valid today.

Likewise the positive attitude of Physical Education teachers in the public education sphere is equally important as research results confirm that the success of the educational integration of ICT devices is substantially influenced by the respective teachers' attitude to the use of technology and the incorporation of such tools in the lessons (Albirini 2006, Baylor and Ritchie 2002, Lee and Lee 2014). Our research results confirm these findings as well.

Hypothesis H1 was partially substantiated regarding the sample under inquiry.

Our second hypothesis (H2) proposed that in case of certain background variables attitudinal differences can be discerned to ICT-device use by participants in teacher training programs and in-service teachers.

As far as sex is concerned significant differences or digressions could be identified in two cases concerning applicants and graduates of Physical Education teacher training programs. Our findings indicate that the sex of the participants does have a significant impact on attitudes. Our research results reinforce the previous findings of Goktas (2012) obtained by administering a CAS questionnaire to participants in Physical Education training programs. The questionnaire results suggested that the sex of the given participant can be a crucial factor regarding the respective ICT-device use attitude. Concerning study schedule we identified significant differences in two cases as it can be concluded that the study schedule (full time or part time) generates a significant impact on attitudes.

In case of Physical Education teachers teaching in domestic public education institutions we found significant differences according to instruction level between men and women. Our research results confirm that the sex of primary school teachers has a significant impact on attitudes, while in secondary education such difference cannot be discerned. As far as age is concerned we ascertained significant differences in two cases in primary and secondary education.

Thus our research findings reinforce international conclusions identifying significant differences regarding the age and ICT-use attitude of teachers (Cavas et al. 2009, Deniz 2005, Seraji et al. 2017). Our research confirms that the age variable has a significant impact on attitude in secondary education, while in primary education such significant impact cannot be discerned.

Hypothesis H2 was substantiated in case of the sample under examination.

Hypothesis 3 (H3) held that the sex, age, and experience of teachers of the public education sphere can have an impact on their use of ICT devices. Tests performed among Physical

Education teachers of primary education institutions revealed significant sex-based differences in several cases, while in the secondary education category such differences were ascertained only in two instances. Our research results thus partly differ from previous international findings, which did not identify significant differences between the attitudes of male and female P.E. teachers (Ilomaki 2011; Vekiri 2012), while justify other previous findings (Woods et al. 2008; Yaman 2008). Our research findings suggest that the sex of the participants does not have a significant impact on ICT device use in either school category.

Regarding age as an independent variable we were somewhat surprised to find that older teachers in primary schools use such devices more frequently than their counterparts in secondary education institutions where the use of such devices is more characteristic of the younger colleagues. According to the distribution of the participants' age significant difference was ascertained in one case in the primary education category. Although various international research results hold that the age of the teacher has a significant impact on ICT device use in the respective lessons (Buabeng-Andoh 2012), our research results did not reveal a significant impact of age on the ICT device use of teachers in either school category.

Professional experience or the number of years spent with teaching shows a tendency similar to that of the age variable. In primary education teachers with higher seniority display a more frequent ICT use than their colleagues in secondary education institutions. Thus our findings revealed that in primary education the professional or teaching experience of teachers has a significant impact on ICT device use while in case of secondary education significant impact was not discerned.

Hypothesis 3 (H3) was partially justified regarding the sample under inquiry.

Hypothesis 4 (H4) held that teachers teaching other subjects besides P.E. display a differing frequency of ICT use in the teaching and learning process as compared to their colleagues only teaching Physical Education. The cross section inquiry revealed that during lesson preparation participants of both subsample prefer the use of certain ICT devices including laptop, notebook, netbook, or smart phone. We also found that in addition to the use of traditional printed texts reliance on personal computers has declined. In case of two subsamples we identified significant differences regarding lesson preparation and in-class application both in the primary and secondary education category.

Our inquiry confirmed that teachers of subjects besides Physical Education show a greater variety and more frequent use of ICT devices than their colleagues solely teaching Physical

Education. It can be assumed that ICT use in humanities and science subjects can promote and strengthen the deployment of technology in the Physical Education lesson.

Hypothesis 4 (H4) has been substantiated.

Hypothesis 5 (H5) assumed that the sex, age, teaching experience, and computer literacy level of teachers have a significant impact on ICT use.

While in several cases significant differences were discerned between the perspectives of male and female teachers regarding ICT use, sex on the whole does not have a major influence on the attitudes of teachers working in public education institutions.

Having explored the role of age we ascertained differences regarding various age groups as older Physical Education teachers justified their limited use of ICT with the lack of appropriate knowledge. At the same time younger teachers show a greater interest towards digital technology. On the whole it can be concluded that the age of teachers does not have a significant impact on ICT use-related attitudes.

Taking computer literacy as an independent variable it can be revealed that a growing level of the respective knowledge is simultaneous with increased readiness and willingness for educational use. As far as teaching experience is concerned it can be concluded that Physical Education teachers with a lower level of experience are more open toward the achievements of digital technology. Our findings confirm that computer literacy and teaching experience generate a significant impact on ICT use-related attitudes.

Hypothesis 5 (H5) was partially substantiated.

Hypothesis 6 (H6) held that: (a) since learning is more efficient in P.E. classes supported by ICT devices than in P.E. lessons not using such tools, students participating in the intervention will perform better in the former case, (b) the ICT supported test group has a task-oriented perceived motivational climate and the intervention will result in an increasingly task-oriented attitude, (c) the use of ICT devices has a positive impact on motivation and as a result of the intervention intrinsic motivation will become stronger.

The psychomotor performance of learners in both test groups (test group 1, 2) showed significant difference during pre and post-intervention measuring. It must be pointed out, however that the ICT-supported group (Test group 1) displayed significantly better results both before and after intervention on the 20 m shuttle run, than Test group 2, which learned with traditional methods. The respective post-intervention results show that student performance is correlated with ICT use and psychomotor performance was higher in the group where the use

of ICT devices was allowed. Regarding the self-definition theory (SDT, Deci and Ryan, 2000) we sought an answer to the question as to how the autonomy-friendly environment impacts performance and task-related attitudes. On the whole it can be concluded that performance improved in both groups, but in a group where the use of ICT devices was allowed significant differences were ascertained during pre and post-intervention measuring.

The inquiry focusing on the motivational context did not reveal any significant difference regarding either the main or subscale in the pre-intervention stage. In Test group 1 motivation related to Task orientation showed an overall, across the board increase, in other words students were more task oriented. Furthermore, post-intervention measuring in case of the Effort at improvement and Cooperative learning subscales revealed significantly higher values. We can conclude that ICT use had a positive effect, especially manifested in increased task orientation. Gonçalves, Coelho, Cruz, Torregrosa and Cumming (2010) established that task oriented students perform better along with displaying a higher level of intrinsic motivation. Our findings corroborate such research findings as ICT supported students performed at a higher level and displayed greater task-orientation besides being more motivated in realizing their goals and increasing their performance level.

Our research results confirm that ICT supported learners were more motivated in goal realization. By the end of the project they fulfilled the original objective, completing a virtual run around Lake Balaton (221,8 km). In the student group supported by ICT devices intrinsic motivation significantly increased while the amotivation level hardly changed. As Ntoumanis (2002), Baena-Extremera and associates (2013) and Manninen and Campbell (2022) assert students with a higher level of intrinsic motivation have a stronger self-esteem if the given task implies an appropriate challenge for them. Furthermore, if they are allowed to choose the level of task fulfillment they can outperform expectations. These research results are corroborated by our findings as in an ICT-supported learning environment the level of intrinsic motivation showed a significant increase. Accordingly students selected steadily increasing terms and distances requiring a greater effort to fulfill the goals of a project implying a meaningful challenge.

Hypothesis 6 (H6) was substantiated during the inquiry.

Our overall research results confirm a positive attitude of the participants of teacher training programs to ICT device use. Consequently, we call for the improvement of such schemes in order to enable prospective teachers to meet the challenges posed by digital education. Thus a perspective change and paradigm shift in Physical Education teacher training programs appear

inevitable. Based upon our test results obtained in the public education sphere we call for the intensification of the integration of digital devices in Physical Education classes. We recommend that Physical Education teachers use certain digital devices (smart phone, mobile applications) during the lessons. We must emphasize, however, that in-class use should be preceded by thorough pedagogical preparation as device use must be harmonized or reconciled with curricular content, objective and task system, and the desired level of learning efficiency related to the specific lesson.

List of own publications

Publications related to the dissertation:

Varga A, Révész L. (2023) Digital Physical Education: illusion or reality? Examination of ICT tools usage characteristics of Physical Education teachers. *Inf. Soc*, 23.1: 80-99.

Varga A, Révész L. (2023) Impact of Applying Information and Communication Technology Tools in Physical Education Classes. *Informatics*, 10.1: 20.

Varga A, Karsai I, Révész L. (2021) Examination of the applicability of the CAS questionnaire (Computer Attitude Scale) on the sample of Hungarian physical education teachers. *Acta Universitatis De Carolo Eszterházy Nominatae: Sectio Sport*, 50: 19-30.

Varga A, Révész L. (2021) Use of ICT tools in the process of Physical Education teaching and learning. Investigation of Physical Education teachers in the Northern Hungarian region. *Hungarian Review of Sports Science*, 22.94: 34-43.

Varga A. (2021) Graduated and applicants physical education teachers attitudes toward ICT: a comparative study. *Hungarian Review of Sports Science*, 22.89: 50-56.

Varga A, Bácsné Bába É, Ráthonyi G, Müller A. (2019) The Attitudes Of Pete Program Applicants Towards Information And Communication Technologies. *Appl. Stud. Agribus. Commer*, 13.1-2: 75-80.

Varga A. (2018) ICT use in Physical Education Teacher Education students. *Acta Universitatis De Carolo Eszterházy Nominatae: Sectio Sport*, 45: 17-24.

Publications unrelated to the dissertation:

Vácz P, Herpainé Lakó J, **Varga A**, Maklári G, Müller A. (2020) The popularity of the university basketball championship. *Slovak Journal of Sport Science*, 7.2: 63-71.

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