Title	Singapore teachers' attitudes towards the use of information and communication technologies in physical education
Author(s)	Nien Xiang Tou, Ying Hwa Kee, Koon Teck Koh, Martin Camiré and Jia Yi Chow

This is the accepted author's manuscript of the following article:

Tou, N. X., Kee, Y. H., Koh, K. T., Camiré, M., & Chow, J. Y. (2020). Singapore teachers' attitudes towards the use of information and communication technologies in physical education. *European Physical Education Review, 26*(2), 481–494. https://doi.org/10.1177/1356336X19869734

Singapore teachers' attitudes towards the use of information and communication technologies in physical education

PE TEACHERS' ATTITUDES TOWARD USE OF ICT

Abstract

The purpose of the present study was to examine and compare Singaporean physical

education (PE) teachers' attitudes towards information and communication technologies

(ICT) in PE across different demographic groups that included gender, age, teaching

experience, and school level. A total of 422 Singapore full-time PE teachers (*M* age = 38.47

years, SD = 8.31) completed the Physical Education Teachers' Subjective Theories

Questionnaire (PETSTQ; Kretschmann, 2015) to assess their perspectives towards the

integration of ICT into PE teaching practice. Mann-Whitney U and Kruskal-Wallis H tests

were conducted to examine the differences in participants' attitudes across different

demographic groups. Results revealed that attitudes towards ICT significantly differed

between teachers of different gender, age, and teaching experience. However, no significant

difference was found in attitudes towards ICT among teachers of different school levels. The

findings of this study can inform policymakers and stakeholders with an interest in promoting

the integration of ICT in PE.

Introduction

In the present age, information and communication technologies (ICT) are increasingly employed in education (e.g., Lim and Oakley, 2013). Defined as technologies that facilitate the transfer of information through electronic means (Zuppo, 2012), ICT tools, including computers, electronic tablets, and web boards, are prominent in today's classrooms for their associated benefits in students' learning. Considering the potential to better support young people's learning, the integration of ICT in school subjects such as English, mathematics, and science has greatly increased (e.g., Hennessy, Ruthven, and Brindley, 2005). Some ICT tools are also making use of learners' data to facilitate personalised forms of learning (Apple, 2007). However, some researchers have raised concerns regarding the benefits of ICT in education (e.g., De Witte and Rogge, 2014; Talebian, Mohammadi, and Rezvanfar, 2014). In physical education (PE), one concern could be the requirement of mandating students to wear heart rate monitors to check whether they conform to the exertion demands of their PE teachers (Lupton, 2015), which can pose additional logistical demands on both teachers and students. Nevertheless, many researchers recognise the possible benefits of using ICT to better engage learners (e.g., Casey et al., 2017; Velestianos, 2016).

The potential of ICT lies in such tools being readily accessible and already integrated in the daily lives of most young people (Casey et al., 2017; Greenhow and Lewin, 2016). Moreover, ICT usage aligns with 21st century learners' needs and enables teachers to evolve beyond the traditional instructor-centred 'demonstrate-explain-practice' approach in PE (Østerlie, 2018; Zainuddin and Halili, 2016). A recent study has demonstrated the effectiveness of using ICT in motivating secondary school students to participate in PE (Østerlie, 2018). For educators, it is important to recognise the evolving education landscape by constructing and delivering learning situations that are attractive and engaging to support young people's learning in optimal ways (Fullan, 2013; Kong et al., 2014).

Singapore's Ministry of Education (MOE) has recognised the importance of using ICT to enhance students' learning experiences. Indeed, the MOE's ICT masterplan is designed to develop 21st century competencies (i.e., civic literacy; global awareness and cross-cultural skills; critical and inventive thinking; communication, collaboration and information skills) among today's students (MOE, 2015). Given the ongoing debate surrounding the perceived benefits and challenges related to ICT usage in education, it is important for researchers to continue this line of research to advance knowledge.

It has been suggested that the use of ICT in education is largely influenced by teachers' attitudes towards these tools (Albirini, 2006; Al-Zaidiyeen et al., 2010). Indeed, it was reported that pre-service teachers who had positive attitudes towards ICT showed greater intentions to integrate technological tools into their future teaching than their counterparts with more negative attitudes (Teo, 2009). In recent years in PE, there has been a significant increase in the number of ICT tools available to teachers (e.g., heart rate monitors, pedometers, mobile applications). However, the integration of ICT tools remains relatively scarce in PE when compared to other academic subjects (Kretschmann, 2015; Thomas and Stratton, 2006). Considering the uniqueness of PE classrooms, the integration of ICT has been perceived to be more difficult than other academic subjects (Villalba and González-Rivera, 2016). For example, ICT have been regarded as incompatible with PE classes given their movement-based nature of activities conducted in PE (Collins, 2011; Papastergiou, 2009). Teachers perceived that integration of ICT might hinder the time spent in physical activities (Kretschmann, 2015) and it was reported that PE teachers lacked the competencies in using ICT tools (Kretschmann, 2015; Thomas and Stratton, 2006). PE teachers' apprehensions and perceived lack of competencies to integrate technologies remain an issue as there is no established pedagogical approach for optimal ICT use in PE (Casey et al., 2017; Koekoek et al., 2018). Furthermore, some researchers have expressed concerns that the use of

ICT in PE might diminish the roles of teachers in educating students about physical activity (Gard, 2014; Lupton, 2015). Such apprehensions have possibly contributed to the underutilization of ICT in PE. Given that teachers are at the forefront of educational initiatives and have the greatest impact on students' learning, any debate surrounding the role of ICT in PE must consider the role of teachers (Hargreaves and Fullan, 2012; Hattie, 2012). Further, ongoing discussions should be focused on how to best meet the needs of young learners who live in a digital world (Casey et al., 2017).

Not all teachers are alike and capable of planning strategies that optimise ICT usage. It is important to first identify differences in teachers' attitudes across different demographic groups. Existing literature suggests that individual characteristics such as gender, age, teaching experience, and school type could influence teachers' attitudes towards ICT (Bisgin, 2014; Kretschmann, 2015; Villalba and González-Rivera, 2016). First, past research has suggested gender differences in attitudes towards technologies. Since the introduction of computers, use of technology has been perceived to be more masculine (Sang et al., 2010). A survey that examined the extent of ICT use in schools revealed that female teachers expressed significantly less confidence than their male counterparts in using ICT with students for teaching and learning (Jamieson-Proctor et al., 2006). Such gender stereotypes may still be pervasive among today's teachers, and it is important to examine whether PE teachers' attitudes towards ICT differ between gender groups.

Second, teachers' attitudes towards ICT may possibly differ across age groups in that younger teachers are perhaps more disposed to use technologies as compared to older teachers. A recent study that assessed the attitudes of PE and sport teachers towards technology revealed that teachers over 40 years of age are the least willing to use technologies (Bisgin, 2014). This could be attributed to older teachers feeling more reluctant to move away from traditional teaching methods (Hammond et al., 2009). It has also been

suggested that older teachers who were less exposed to digital technologies may be more resistant towards integrating technologies into their pedagogical practices (Villalba and González-Rivera, 2016).

Third, teaching experience, which is a variable closely associated with age, could influence teachers' attitudes towards ICT. One study has demonstrated that the fewer the years of experience, the higher the knowledge of ICT and its use (Tezci, 2009). It was found that teachers with less professional experience had more positive attitudes towards ICT. Similar findings were found among PE teachers, as teachers with less experience reported greater intentions to include ICT in their lessons (Kretschmann, 2015).

Lastly, school level is another variable to consider regarding teachers' attitudes towards ICT. Since teaching practices may differ across different grade levels, the school levels could influence teachers' perspectives on the appropriateness of using ICT (Kretschmann, 2015). One Australian survey study among Queensland state schools revealed differences in teachers' confidence in using ICT across different school types (Jamieson-Proctor et al., 2006). Specifically in PE, teachers felt that ICT was more suitably implemented in the last two years of secondary school (Kretschmann, 2015). The study results suggested that PE teachers perceived integration of technologies to be more advanced and complicated for students than traditional teaching methods. Hence, students at secondary school levels might be more cognitively prepared for such integration as opposed to primary school levels (Kretschmann, 2015).

The purpose of the present study was to examine and compare Singapore PE teachers' attitudes towards ICT in PE across different demographic groups that included gender, age, teaching experience, and school level. The 'subjective theory' framework developed by Kretschmann (2015) was used to guide the present study. This framework helps to explain PE teachers' beliefs towards ICT across eight different categories related to student, teaching,

teacher, equipment, computer literacy, classroom management and organization, social interaction, as well as innovative and modern teaching. Example items for each category are provided in the method section for reference. The items of each subjective theory were constructed based on focus group discussions with PE teachers, after gathering their views on the integration of ICT in PE (Kretschmann, 2015). Findings from the present study will provide important insights into the current state of Singapore PE teachers' attitudes towards the use of ICT in PE, and highlight possible strategies to facilitate and enhance learning.

Method

Participants and procedure

Data were collected from 422 full-time PE teachers (M age = 38.47 years, SD = 8.31, 6 did not state their age) who agreed to participate in the study. The sample consisted of 283 male and 139 female teachers from 152 schools across Primary (218), Secondary (171), and Junior College (32) levels (1 participant did not report the school level) in Singapore, where PE is a mandatory subject of the school curriculum. The response rate was 42.3% (152 out of 359 schools).

Prior to data collection, ethical clearance from the university review board and permission from MOE were first attained. Subsequently, all school principals and heads of department for PE listed in the MOE database were contacted via emails and phone calls by the research assistant to invite their PE teachers to participate in the study. PE teachers were briefed on the purpose of the study, the required involvement, and assured of the confidentiality of their responses. They were also informed that their participation was voluntary, and they were free to withdraw from the study at any time. Informed consent was obtained from all individual participants before they completed the questionnaire online using Qualtrics survey services.

Measures

Physical Education Teachers' Subjective Theories Questionnaire (PETSTQ). The 63-item instrument was used to measure participants' perspectives towards the integration of ICT in PE teaching practice (Kretschmann, 2015). Participants were surveyed on eight categories: classroom management and organization (eight items; e.g., 'I cannot integrate ICT because I am under time pressure to include the content standards completely'), computer literacy (nine items; e.g., 'I do not have sufficient experience to integrate ICT in PE'), equipment (six items, e.g., 'Even if the equipment were there, I would not use ICT in PE'), innovative and modern teaching (seven items, e.g., 'The importance of ICT in PE will increase in the future'), student-related (ten items; e.g. 'Students' study motivation can be increased by integrating ICT'), social interaction (eight items; e.g., 'Using ICT in PE frequently makes the personal teacher-student relationship suffer'), teaching-related (eight items; e.g., 'ICT integration does not lead to better content knowledge'), and teacher-related subjective theories (seven items; e.g., 'ICT are the building block of the development of new teaching and learning methods'). Participants responded by indicating the degree to which they agreed with the statements on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Demographic variables. In addition to the questionnaire items, participants were asked to report information related to gender, age, teaching experience, and the school levels they were teaching.

Data analysis

All data were analysed using the Statistical Package for the Social Sciences (SPSS 23.0) and R-based Jamovi package (version 0.9.1.0). First, descriptive statistics were used to assess missing data, outliers, and normality assumptions as well as to describe the demographic

characteristics. Second, psychometric properties of the measures were examined using the Cronbach's alpha and confirmatory factor analysis (CFA). Reliability of the measures was deemed acceptable if the Cronbach alpha values were at least .70 (Nunnally and Bernstein, 1994). The maximum likelihood procedure was used to assess the model fit based on multiple fit indices such as the chi-square (SBχ^2), comparative fit index (CFI), Tucker-Lewis index (TLI), root mean squared error of approximation (RMSEA) with 90% confidence interval (90% CI), and standardised root mean squared residual (SRMR). Recommended cut-off values (Hu and Bentler, 1999) were used to indicate whether the model had adequate fit (i.e. CFI $\geq$ .90, TLI $\geq$ .90, RMSEA $\leq$ .08, SRMR $\leq$ .08) or excellent fit (i.e. CFI $\geq$ .95, TLI $\geq$ .95, RMSEA $\leq$ .06, SRMR $\leq$ .06). As the data were found to deviate from normal distribution, Mann-Whitney U and Kruskal-Wallis H tests were conducted to examine the relationships between demographic variables (i.e. gender, age, teaching experience, school level) and PE teachers' perceptions and attitudes towards ICT usage in PE.

Results

Preliminary analysis

Descriptive statistics including mean scores, standard deviation, skewness and kurtosis were employed to determine outliers, invalid data resulting from invalid responses or input error, and the normality and linearity of the observed variables. Skewness and kurtosis values were found to be within the recommended range of $\pm$ 2.0 and $\pm$ 7.0 (Hair et al., 2010). Mean scores of each variable were computed based on the CFA results, and tested for normality assumptions. Shapiro-Wilk tests revealed that the mean scores deviated from normality ($p < .05$), and examination of box plots and Q-Q plots revealed slight skewness and kurtosis in some variables.

Psychometric properties of the measures were examined using the Cronbach's alpha and CFA. The model fit of the PETSTQ was assessed in terms of each subjective theory individually. Problematic items were identified and removed to achieve adequate fit for each subjective theory based on the CFA and reliability tests. For the classroom management and organization subjective theory, three items (C5, C7, and C8) were removed to achieve good model fit: $SB\chi^2$ (5) = 10.30, CFI = .98, TLI = .95, RMSEA = .05, 90% CI (.00, .09), SRMR = .03. For the computer literacy subjective theory, five items (CL4, CL5, CL7, CL8, and CL9) were removed to achieve a good model fit: $SB\chi^2$ (2) = 4.54, CFI = .99, TLI = .97, RMSEA = .05, 90% CI (.00, .12), SRMR = .02. For the equipment-related subjective theory, two items (E3 and E5) were removed to achieve a good model fit: $SB\chi^2$ (2) = 2.16, CFI = .99, TLI = .10, RMSEA = .01, 90% CI (.00, .10), SRMR = .01. For the innovative and modern teaching subjective theory, one item (I6) was removed to achieve a good model fit: $SB\chi^2$ (9) = 12.80, CFI = .99, TLI = .99, RMSEA = .03, 90% CI (.00, .07), SRMR = .02. For student-related subjective theory, four items (S2, S3, S7, and S10) were removed to achieve a good model fit: $SB\chi^2$ (9) = 16.50, CFI = .98, TLI = .97, RMSEA = .04, 90% CI (.00, .08), SRMR = .03. For social interaction, three items (SO1, SO5, and SO8) were removed to achieve a good model fit: $SB\chi^2$ (5) = 13.50, CFI = .95, TLI = .90, RMSEA = .06, 90% CI (.02, .11), SRMR = .03. Both teacher and teaching-related subjective theories were excluded from further analyses due to poor reliability (α = .45 and .35) and inadequate model fit.

In summary, the six dependent variables used to measure teachers' perspectives towards the integration of ICT into PE were: 1) classroom management and organization, 2) computer literacy, 3) equipment, 4) innovative and modern teaching, 5) student, and 6) social interaction-related subjective theories. Internal consistency of the measures according to the model fit were found to fulfil the recommended .70 cut-off for innovative and modern teaching and student. Classroom management and organization (α = .61), computer literacy

(α = .62), equipment (α = .62), and social interaction-related subjective theories (α = .55) were close but below the .70 cut-off.

Gender

Mann-Whitney U tests were conducted to examine gender differences in PE teachers' attitudes towards ICT usage in PE. The results and the relevant descriptive statistics are summarized in Table 1.

—————————————————————

Insert Table 1 Here

—————————————————————

Among the six subjective theories, two showed significant differences in regards to gender. The Mann-Whitney test indicated that the scores for computer literacy-related subjective theories were significantly greater for male teachers (*Mdn* = 3.50, *Range* = 1.00 – 5.00) than female teachers (*Mdn* = 3.00, *Range* = 1.75 – 4.75), *U* = 16601, *p* = .009. For innovative and modern teaching-related subjective theories, there was also a significantly higher mean score in male teachers (*Mdn* = 3.67, *Range* = 1.50 – 5.00) than their female counterparts (*Mdn* = 3.50, *Range* = 1.33 – 4.50), *U* = 17082.50, *p* = .027. These results suggest that male PE teachers have more positive perspectives towards the integration of ICT into PE, especially in areas related to computer literacy and innovative teaching as compared to female teachers.

Age

We followed the classification of participants based on Kretschmann's study (2015). The participants were divided into two age groups (i.e., less than 40 years old, 40 years old and above). Mann-Whitney U tests were conducted to examine age group differences on the measured dependent variables. The medians and ranges of each group are illustrated in Table

2. Significant differences were found for subjective theories related to classroom management and organization, equipment, innovative and modern teaching, and social interaction. In the area of classroom management and organization, teachers who were 40 years old and above (*Mdn* = 2.80, *Range* = 1.20 – 4.80) had significantly higher mean scores than the younger teachers (*Mdn* = 2.60, *Range* = 1.20 – 4.00), U = 16690, p < .001. Similarly, older teachers (*Mdn* = 3.75, *Range* = 2.00 – 5.00) scored higher than younger teachers (*Mdn* = 3.25, *Range* = 1.25 – 5.00) in regards to equipment-related subjective theories, U = 15858, p < .001. For innovative and modern teaching-related subjective theories, significantly higher scores were found among older PE teachers (*Mdn* = 3.67, *Range* = 1.83 – 5.00) as compared to their younger counterparts (*Mdn* = 3.50, *Range* = 1.50 – 4.83), U = 17873, p = .007. PE teachers in the older age group also showed significantly higher scores (*Mdn* = 3.20, *Range* = 1.20 – 5.00) than the younger teachers (*Mdn* = 3.20, *Range* = 1.60 – 4.40) in the area of social interaction, U = 18235, p = .016. These results suggest that teachers who were 40 years old and above seemed to have more positive attitudes towards ICT compared to their younger counterparts.

_____

Insert Table 2 Here

_____

Teaching experience

Kruskal-Wallis H tests were conducted to investigate the effects of teachers' experience on their perspectives towards ICT. Participants were categorized into three groups based on their years in service (< 11 years, 11-20 years, and >20 years). Tests of the three a priori hypotheses were conducted using Bonferroni adjusted alpha levels of .0167. The analysis revealed that statistically significant differences were found between the three groups for both ICT perspectives. The results are summarized in Table 3.

Teachers' experience was found to be significantly associated with teachers' attitudes towards ICT in the area of classroom management and organization, H (2) = 14.844, p = .001, with a mean rank of 195.49 for teachers who were in the teaching profession for less than 11 years, 215.05 for teachers with teaching experience between 11 and 20 years, and 260.89 for teachers who were in service for more than 20 years. Pairwise comparison post-hoc tests revealed that teachers who were in the teaching profession for less than 11 years (p < .001) and between 11 and 20 years (p = .04) showed statistically significant lower scores than teachers who were in service for more than 20 years in regards to classroom management and organization-related subjective theories. Teachers' experience was also found to have a significant effect in the area of equipment-related subjective theories, H (2) = 22.114, p < .001, with a mean rank of 191.55 for teachers who were in the teaching profession for less than 11 years, 217.06 for teachers with teaching experience between 11 and 20 years, and 270.84 for teachers who were in service for more than 20 years. Pairwise comparison post-hoc tests revealed that teachers who were in the teaching profession for less than 11 years (p < .001) and between 11 and 20 years (p = .011) showed statistically significant lower scores than teachers who were in service for more than 20 years. These results suggest that teachers who were in the profession for longer seemed to have more positive attitudes towards ICT compared to teachers with less teaching experience.

———————————————

Insert Table 3 Here

———————————————

School level

Mann-Whitney U tests were conducted to examine school level differences on PE teachers' perceptions and attitudes towards ICT usage in PE. Participants were divided into two groups (primary level, and secondary and above level) for analysis. The results are

reported in Table 4. No significant differences were found between the two groups in regards to their perceptions towards integration of ICT in PE.

_____

Insert Table 4 Here

_____

Discussion

The purpose of the present study was to examine and compare PE teachers' attitudes towards ICT in PE across different demographic groups that included gender, age, teaching experience, and school level. We found significant differences in Singaporean PE teachers' perspectives towards the integration of technologies in their pedagogical practices in terms of different demographic factors.

Our results contribute to the current literature in a number of ways. First, gender differences were found in terms of teachers' attitudes towards ICT in PE, especially in computer literacy, as well as innovative and modern teaching-related areas. Male teachers seemed to have more positive attitudes in these two aspects compared to their female counterparts. This is aligned with past findings of similar studies, which revealed such gender differences in PE teachers' attitudes towards ICT (Goktas, 2012; Kretschmann, 2015). Differences in the area of computer literacy suggest that male PE teachers felt more confident and competent in using ICT tools as compared to females. This could stem from gender stereotypes that usage of technological tools is commonly perceived as male dominant (King et al., 2002; North and Noyes, 2002; Sang et al., 2010). Although earlier work with a sample of Singaporean female pre-service teachers showed how the participants had positive attitudes toward the use of ICT (Teo, 2009), our results suggest that certain gender differences may still persist despite the abundance of digital tools available in teachers' daily

lives. While we acknowledge that innovative pedagogies may not necessarily include the use of technologies, the results suggest that male teachers viewed ICT more positively as an exemplar of a creative pedagogical approach when compared to females. To help female teachers integrate ICT to PE, intervention programmes considering their needs, without the presence of male counterparts, may be particularly useful, as observed in the case of promoting computer science and computational thinking with girls (Seneviratne, 2017). Since increased exposure to technology during pre-service teacher training could help address such gender differences (Teo et al., 2015), such women-only interventions could be purposefully utilised when developing PE teachers.

Second, age differences were found in teachers' attitudes towards ICT in PE. Teachers who were 40 years and above were found to report more positive attitudes than their younger counterparts, specifically in areas related to classroom management and organization, equipment, innovative and modern teaching, and social interaction. This is a finding that contrasts with those found in past research, which revealed that younger teachers reported more positive attitudes towards the use of technologies in PE (Bisgin, 2014; Hammond et al., 2009; Villalba and González-Rivera, 2016). Past studies have shown that since older teachers are likely to receive less exposure to digital tools than their younger counterparts, they may be more resistant towards use of technologies in their teaching practice (Villalba and González-Rivera, 2016). As Casey et al. (2017) argued, the sociocultural environment plays a key role in shaping emerging technologies and pedagogical practices. The finding related to age in the present study could be attributed to the strong emphasis towards technology usage for teaching by Singapore's MOE. Being older and having acquired a better understanding of the expectations surrounding ICT use in education might have help older teachers appreciate the benefits of integrating ICT in PE. In addition, situational factors could play a role since Singaporean teachers are required to devote many

hours of training for their professional development. For example, a recent study revealed that teachers in Singapore dedicated an average of at least two hours per week for professional development, including use of ICT (Lee and Poon, 2014). Our results showed that older PE teachers understood the need to devote more time in learning ICT-related skills to meet the demands of the changing education landscape in Singapore. It is also plausible that such age differences could be confounded by teaching experience, which is closely associated with age as discussed below.

Third, differences in teachers' attitudes towards ICT in PE were also found between teachers with varying teaching experiences. Teachers who were more experienced seemed to have more positive attitudes towards ICT compared to teachers with less teaching experience, particularly in areas related to classroom management and equipment. These results do not align with the findings from past research, which suggested that teachers with less experience were more likely to accept use of ICT in PE, specifically in areas related to computer literacy and equipment (Kretschmann, 2015). Although past research suggested that more experienced teachers reported less computer literacy, the contrasting results of the present study could be attributed to the Singapore context. In particular, Singapore teachers have relatively easy access to professional development courses (including those that focus on ICT usage) organised by the MOE (Lee and Poon, 2014), schools and classroom are conducive to ICT use (Fullan, 2013), and teachers have a general belief that ICT can enhance young people's learning (Casey et al., 2017). Thus, readers should be mindful of the cultural and environmental differences when comparing the results of different studies. Less positive attitudes among teachers with less experience could also be due to the lack of ICT training among pre-service teachers (Goktas et al., 2009). Some PE teachers may feel incompetent integrating ICT due to their lack of related training opportunities prior to becoming teachers (Casey et al., 2017). Furthermore, PE teachers who just joined the profession may possibly be

overwhelmed with other priorities and responsibilities in their jobs, thus perceiving little to no time to explore new tools such as ICT to incorporate into their teaching practices (Teo et al., 2015). Such results suggest that more attention could be directed towards teachers with less teaching experience. For example, school leaders could consider allocating time for these teachers to learn from their experienced colleagues. Strategies for school-based ICT use can thus be shared in-house without drastically increasing the time required for out-of-school professional development for teachers. Any additional hours required to learn the required ICT skills for less teaching experience teachers may hinder their interest in using ICT in PE.

While differences were found in regards to demographic variables such as age, gender, and teaching experience, no significant difference was found in attitudes towards ICT among teachers of different school levels. Although it is understandable that PE teaching practices would likely be different based on school levels, the present findings suggest that school levels did not influence PE teachers' attitudes towards integrating ICT into their teaching practices. These results are also in contrast with previous findings that suggested ICT integration in PE was considered only appropriate for older students (Kretschmann, 2015). Given the ubiquity of digital gadgets today, students are exposed to such devices at younger ages than those of previous generations. Younger student's familiarity with ICT-related tools is perhaps contributing to why teachers may consider integrating ICT tools to enhance their lessons across all school levels. Furthermore, since appropriate use of ICT tools in PE can help promote 21st century skills such as independent learning, communication, and collaboration skills, which are essential for younger learners (Oliver et al., 2012; Strayer, 2012), the attraction for such ICT use are accordingly enhanced.

Limitations, future directions, and implications

While the present study has contributed to the literature in providing empirical evidence on PE teachers' attitudes towards the integration of ICT in PE across different

demographic groups, it is also important to acknowledge the limitations of the study. The first limitation is related to the generalizability of the results of this study. Since the data were collected only from PE teachers in Singapore, readers should be cautious when interpreting and generalizing the results as people's attitudes on technological acceptance may be influenced by technologies-related biases that are particular to different physical regions (Kretschmann, 2015). While having a sample specific to Singapore may be considered a limitation, it can still have important implications. To this end, our results have provided valuable insights by demonstrating that in an environment where ICT usage is largely encouraged by the government (e.g., MOE), there remains challenges in creating a universal openness to ICT usage in PE, as evidenced by differences observed for gender, age, and teaching experience.

The second limitation is associated with the descriptive nature of the present study, which limits the extent of the inferences that can be made based on the results. Nevertheless, the results offer a snapshot of the state of ICT usage in Singapore PE. This research provides a valuable knowledge base to guide future interventions at the national level for increasing ICT usage in PE across Singapore.

The last limitation pertains to the use of PETSTQ. A large number of items had to be removed from the PETSTQ in order achieve a good model fit. This step was necessary as Kretschmann (2015) did not validate the questionnaire when developing it. Rather, the author only examined teachers' perspectives on an item by item basis instead of measuring at a construct level. As we administered this scale to a different sample and reported the item selection refinement, an incremental contribution to the enhancement of PETSTQ has been made. Alternatively, future studies may explore using other instruments to examine the differences in teachers' attitudes towards using ICT in PE.

In summary, the results of the present study provide some understanding of Singaporean PE teachers' attitudes towards ICT across different demographic groups. These findings revealed which specific groups require extra attention, and this will enable policymakers and stakeholders of educational institutions to plan specific strategies for different targeted groups to promote ICT use in PE. For example, strategies could be implemented to change gender stereotypes related to the use of technology and help female PE teachers to be more confident and comfortable in utilising ICT tools. In addition, younger teachers and teachers who just joined the profession also deserve more attention. These teachers could be given more time to learn and use ICT strategies, guided by their experienced colleagues to facilitate targeted learning. In addition, research-informed ICT-based approaches, such as how video feedback facilitated through ICT can be relevant for PE (Palao, Hastie, Cruz, and Ortega, 2015), could be introduced during the teacher education phase to positively influence pre-service PE teachers' attitudes towards ICT and their competencies.

Conclusion

The present study examined PE teachers' attitudes towards ICT in PE, and the results have suggested that attitudes differed across teachers of different age, gender, and teaching experience. Although ICT use affords the potential to enhance learners' educational experience, the lack of ICT use in PE is still apparent. The current research provided valuable insights on the general attitudes of Singapore PE teachers towards the use of ICT in PE. In order for PE to achieve greater adoption of ICT as part of Singapore MOE's masterplans, the findings of this study would be valuable for policymakers and stakeholders who would like to promote integration of ICT in PE. We also recognise that some of the findings could be relevant to education systems in international contexts, beyond the shores of Singapore.

While it is beyond the scope of this paper, we would encourage readers of this paper to see how the current findings could be relevant for their local context.

Acknowledgement

References

Albirini A. (2006) Teachers' attitudes toward information and communication technologies: The case of Syrian EFL teachers. *Computers & Education* 47: 373-398.

Al-Zaidiyeen NJ, Mei LL and Fook FS. (2010) Teachers' attitudes and levels of technology use in classrooms: The case of Jordan schools. *International Education Studies* 3: 211-218.

Apple MW. (2007) Ideological success, educational failure? On the politics of no child left behind. *Journal of Teacher Education* 58: 108-116.

Bisgin H. (2014) Analyzing the attitudes of physical education and sport teachers towards technology. *The Anthropologist* 18: 761-764.

Casey A, Goodyear VA and Armour KM. (2017) Rethinking the relationship between pedagogy, technology and learning in health and physical education. *Sport, Education and Society* 22: 288-304.

Collins O. (2011) The use of ICT in teaching and learning of physical education. *Continental Journal of Education Research* 4: 29-32.

De Witte K and Rogge N. (2014) Does ICT matter for effectiveness and efficiency in mathematics education? *Computers & Education* 75: 173–184.

Fullan M. (2013) The new pedagogy: Students and teachers as learning partners. *Learning Landscapes* 6: 23-29.

Gard M. (2014) eHPE: A history of the future. *Sport, Education and Society* 19: 827-845.

Goktas Z. (2012) The attitudes of physical education and sport students towards information and communication technologies. *TechTrends: Linking Research and Practice to Improve Learning* 56: 22-30.

Goktas Y, Yildirim S and Yildirim Z. (2009) Main barriers and possible enablers of ICTs integration into pre-service teacher education programs. *Journal of Educational Technology & Society* 12: 193-204.

Greenhow C and Lewin C. (2016) Social media and education: Reconceptualizing the boundaries of formal and informal learning. *Learning, Media and Technology* 41: 6-30.

Hair JF, Black WC, Babin BJ, et al. (2010) *Multivariate data analysis,* Englewood Cliffs, NJ: Prentice Hall.

Hammond M, Crosson S, Fragkouli E, et al. (2009) Why do some student teachers make very good use of ICT? An exploratory case study. *Technology, Pedagogy and Education* 18: 59-73.

Hargreaves A and Fullan M. (2012) *Professional capital: Transforming teaching in every school*, New York: Teachers College Press.

Hattie J. (2012) *Visible learning for teachers: Maximizing impact on learning*, London, UK: Routledge.

Hennessy S, Ruthven K, and Brindley S. (2005) Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution, and change. *Journal of Curriculum Studies* 37: 155–192.

Hu LT and Bentler PM. (1999) Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling* 6: 1-55.

Jamieson-Proctor RM, Burnett PC, Finger G, et al. (2006) ICT integration and teachers' confidence in using ICT for teaching and learning in Queensland state schools. *Australasian Journal of Educational Technology* 22: 511-530.

King J, Bond T and Blandford S. (2002) An investigation of computer anxiety by gender and grade. *Computers in Human behavior* 18: 69-84.

Koekoek J, Van Der Mars H, van der Kamp J, et al. (2018) Aligning digital video technology with game pedagogy in physical education. *Journal of Physical Education, Recreation & Dance* 89: 12-22.

Kong SC, Chan TW, Griffin P, et al. (2014) E-learning in school education in the coming 10 years for developing 21st century skills' critical research issues and policy implications. *Educational Techonology and Society* 17: 70-78.

Kretschmann R. (2015) Physical education teachers' subjective theories about integrating information and communication technology (ICT) into physical education. *Turkish Online Journal of Educational Technology-TOJET* 14: 68-96.

Lee YJ and Poon C. (2014) The professional work of teachers in Singapore: Findings from a work-shadowing study. *Asia Pacific Education Review* 15: 525-535.

Lim CP and Oakley G. (2013) Information and communication technologies (ICT) in primary education. In: Tay LY and LIM CP (eds) *Creating Holistic Technology-Enhanced Learning Experiences*, pp.1-18.

Lupton D. (2015) Data assemblages, sentient schools and digitised health and physical education (response to Gard). *Sport, Education and Society* 20: 122-132.

Ministry of Education. (2015) *4th Masterplan for ICT in Education*. Available at: https://ictconnection.moe.edu.sg/masterplan-4/overview.

North AS and Noyes JM. (2002) Gender influences on children's computer attitudes and cognitions. *Computers in Human Behavior* 18: 135-150.

Nunnally JC and Bernstein IH. (1994) *Psychometric theory,* New York, NY: McGraw-Hill

Oliver A, Osa JO and Walker TM. (2012) Using instructional technologies to enhance teaching and learning for the 21st century prek-12 students: The case of a professional education programs unit. *International Journal of Instructional Media* 39: 283-296.

Østerlie O. (2018) Can flipped learning enhance adolescents' motivation in physical education? An intervention study. *Journal for Research in Arts and Sports Education* 2: 1-15.

Papastergiou M. (2009) Exploring the potential of computer and video games for health and physical education: A literature review. *Computers & Education* 53: 603-622.

Palao JM, Hastie PA, Cruz PG and Ortega, E. (2015) The impact of video technology on student performance in physical education. *Technology, Pedagogy and Education* 24: 51–63.

Rogers EM. (2010) *Diffusion of innovations,* New York, NY: Simon and Schuster.

Sang G, Valcke M, Van Braak J, et al. (2010) Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education* 54: 103-112.

Seneviratne O. (2017) Making computer science attractive to high school girls with computational thinking approaches: A case study. In: Rich P and Hodges C. (eds) *Emerging Research, Practice, and Policy on Computational Thinking. Educational Communications and Technology: Issues and Innovations*, pp.21-32.

Strayer JF. (2012) How learning in an inverted classroom influences cooperation, innovation and task orientation. *Learning Environments Research* 15: 171-193.

Talebian S, Mohammadi HM and Rezvanfar, A. (2014) Information and communication technology (ICT) in higher education: Advantages, disadvantages, conveniences and limitations of applying e-learning to agricultural students in Iran. *Procedia - Social and Behavioral Sciences* 152: 300–305.

Teo T. (2009) Modelling technology acceptance in education: A study of pre-service teachers. *Computers & Education* 52: 302-312.

Teo T, Fan X and Du J. (2015) Technology acceptance among pre-service teachers: Does gender matter? *Australasian Journal of Educational Technology* 31: 235-251.

Tezci E. (2009) Teachers' effect on ICT use in education: The Turkey sample. *Procedia-Social and Behavioral Sciences* 1: 1285-1294.

Thomas A and Stratton G. (2006) What we are really doing with ICT in physical education: a national audit of equipment, use, teacher attitudes, support, and training. *British Journal of Educational Technology* 37: 617-632.

Veletsianos G. (2016) *Emergence and innovation in digital learning: Foundations and applications*, Athabasca, CA: Athabasca University Press.

Villalba A and González-Rivera MD. (2016) Teachers' perceptions of the benefits of ICT in physical education. In: D. Novak, Antala B and Kjnaz D (eds) *Physical education and new technologies.* Zagreb: Croatian Kinesiology Association, 217-227.Zainuddin Z and Halili SH. (2016) Flipped classroom research and trends from different fields of study. *The International Review of Research in Open and Distributed Learning* 17: 313-340.

Zuppo CM. (2012) Defining ICT in a boundaryless world: The development of a working hierarchy. *International Journal of Managing Information Technology* 4: 13-22.

Table 1. Medians and ranges of variables for respective gender groups

Variables	Male (N = 283)		Female (N = 139)	
	Median	Range	Median	Range
Classroom management and organization	2.60	1.00 – 4.80	2.60	1.20 – 4.40
Computer literacy	3.50	1.00 – 5.00	3.00	1.75 – 4.75
Equipment	3.50	1.25 – 5.00	3.50	1.50 – 5.00
Innovative and modern teaching	3.67	1.50 – 5.00	3.50	1.33 – 4.50
Student	3.67	2.00 – 5.00	3.50	2.00 – 4.67
Social interaction	3.20	1.60 – 5.00	3.20	1.20 – 4.40

Table 2. Medians and ranges of variables for respective age groups

Variables	20-39 (N = 236)		40 and above (N = 179)	
	Median	Range	Median	Range
Classroom management and organization	2.60	1.20 – 4.00	2.80	1.00 – 4.80
Computer literacy	3.25	1.50 – 5.00	3.50	1.00 – 5.00
Equipment	3.25	1.25 – 5.00	3.75	2.00 – 5.00
Innovative and modern teaching	3.50	1.50 – 4.83	3.67	1.83 – 5.00
Student	3.67	2.00 – 4.83	3.67	2.00 – 5.00
Social interaction	3.20	1.60 – 4.40	3.20	1.20 – 5.00

Table 3. Medians and ranges of variables for respective teaching experience groups

Variables	< 11 years (N = 229)		11-20 years (N = 128)		>20 years (N = 65)	
	Median	Range	Median	Range	Median	Range
Classroom management and organization	2.60	1.20 – 4.00	2.70	1.00 – 4.60	3.00	1.60 – 4.80
Computer literacy	3.25	1.50 – 5.00	3.25	1.00 – 5.00	3.50	1.50 – 5.00
Equipment	3.50	1.25 – 5.00	3.50	2.00 – 5.00	4.00	2.25 – 5.00
Innovative and modern teaching	3.50	1.33 – 4.83	3.67	1.83 – 5.00	3.67	1.83 – 5.00
Student	3.67	2.00 – 4.83	3.67	2.00 – 5.00	3.83	2.00 – 4.83
Social interaction	3.20	1.60 – 4.40	3.20	2.00 – 5.00	3.20	1.20 – 5.00

Table 4. Medians and ranges of variables for respective school level groups

Variables	Primary (N = 218)		Secondary and Junior College (N = 203)	
	Median	Range	Median	Range
Classroom management and organization	2.60	1.00 – 4.40	2.60	1.20 – 4.80
Computer literacy	3.25	1.00 – 5.00	3.50	1.50 – 5.00
Equipment	3.50	2.00 – 5.00	3.50	1.25 – 5.00
Innovative and modern teaching	3.67	1.33 – 5.00	3.50	1.67 – 5.00
Student	3.67	2.00 – 5.00	3.67	2.00 – 4.83
Social interaction	3.20	1.20 – 4.80	3.20	1.60 – 5.00