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| Title     | The use of information communication and technologies tools to maximise students' learning in physical education in Singapore schools |
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EDUCATION RESEARCH FUNDING PROGRAMME

# PROJECT CLOSURE REPORT



## **The Use of Information Communication and Technologies Tools to Maximise Students' Learning in Physical Education in Singapore Schools**

By

Koh Koon Teck, Kee Ying Hwa, Chow Jia Yi, Martin Camiré

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Singapore

## EXECUTIVE SUMMARY (NO MORE THAN 5 PAGES)

### INTRODUCTION/BACKGROUND

With the Ministry of Education's (MOE) focus on using ICT in resourceful and innovative ways to improve teaching and learning (MOE, 2014), PE teachers should be trained and equipped with strategies to create environments where students are given more autonomy to decide 'what' to learn and 'how' to learn, according to students' ability to use Information Communication and Technologies (ICT). For example, making available e-learning materials related to the lesson before and after the class affords students opportunities to learn more readily on their own than when these materials are absent. Using video recording to provide visual and verbal feedback from the teacher or among peers for skill performance during a lesson is just one of many ways ICT can be used to maximise students' learning and develop the affective, psychomotor, and cognitive domains set out in the PE syllabus. The advantages of providing students with opportunities to harness ICT can be directly beneficial for skills acquisition and indirectly for honing life skills.

### STATEMENT OF PROBLEMS

Despite the increased use of technology in education within the Singapore school system, there have been limited insights on PE teachers' attitudes towards the use of ICT, and how ICT can be used as a pedagogical tool in enhancing students' learning, and developing 21st century competencies in our students.

### PURPOSE OF STUDY

The purpose of the research was to conduct a baseline study to understand: a) to what extent schools are using Information Communication and Technologies (ICT) tools in the teaching of PE, and b) what are good ICT practices used by PE teachers to maximise students' learning and development in the cognitive, psychomotor, and affective domains. Findings from this project will help us better understand how to provide the necessary resources to support PE teachers, and equip them with the necessary ICT tools and pedagogical strategies to achieve the desired outcomes of the intended PE syllabus in Singapore in the future.

### PARTICIPANTS

#### Study 1: The extent of use of ICT tools in the teaching of PE Quantitative

Using convenience sampling methods, data were collected from 422 in-service PE teachers. The sample consisted of 283 male and 139 female teachers from 152 schools across Primary (218), Secondary (171), and Junior College (32) levels (1 did not report the school level).

#### Study 2: Best Practices in using ICT in PE: Qualitative

Eleven PE teachers from 7 Primary Schools, 3 Secondary Schools and one Junior College were purposefully recruited from different parts of Singapore, based on the list of schools that participated in Study 1. Recommendations were also sought from school principals, Heads of Department for PE, as well as Physical Education and Sports Teacher Academy to help identify potential participants for this study. In addition, a total of students 72 participated in the focused group discussions (FGD), coming from 7 Primary and 4 Secondary Schools.

### METHODOLOGY / DESIGN

The study employed mixed methods to gather data. For Study 1, descriptive, quantitative results were derived from questionnaire data to establish the attitudes of PE teachers in using ICT in PE in Singapore schools. For Study 2, qualitative results were derived through thematic analysis of interview transcripts from PE teachers and their students to address the research questions.

## FINDINGS / RESULTS

- Survey results from Study 1 show that the extent to which ICT tools are being used in PE can be seen by looking at the differences in PE teachers' attitudes towards ICT based on varying teaching experiences. In terms of computer literacy as well as innovative and modern teaching-related areas, male teachers seem to have more positive attitudes than female teachers. Moreover, teachers who are 40 years old and above were found to show more positive attitude towards the use of ICT in PE compared to their younger counterparts.
- Study 1 results also show that teachers who have been in the teaching profession for a longer period of time show more positive attitudes towards the use of ICT in PE. This is contrary to what was reported in past research (which suggested that younger teachers or teachers with less teaching experience are more likely to accept the use of ICT in PE).
- Based on qualitative data yielded by Study 2, teachers are using ICT tools in PE lessons in varying extents and degrees, as a pedagogical tool to improve teaching and learning. Both teachers and students recognise the benefits of ICT in PE lessons, particularly in the following areas: enhancement of cognitive and affective learning, providing evidence for feedback, reference for learning, enhancing engagement and support for self-directed and collaborative learning.
- The challenges to the use of ICT in PE involve balancing activity time with the use of ICT devices and gadgets; designing lessons that can weave in the use of ICT tools in a pedagogically sound and effective way such that class activity time is not sacrificed. Furthermore, it is a challenge to ensure that the goals of physical movement as well as opportunity for lesson innovation are both evident in the lesson. In addition, technical difficulties involving wi-fi connection should be addressed.
- In terms of identifiable good practices involving the use of ICT in PE lessons, the key elements are:
  - effective introduction of ICT to young learners by allowing them to transition to the habit of using ICT in PE;
  - harnessing ICT tools in innovative and resourceful ways that could resonate with the experiences of young people and therefore promote better engagement during PE lessons;
  - use of ICT tools to enhance visual and verbal feedback for improving performance during PE lessons; and
  - the use of ICT to create an autonomous learning climate for students.

## CONTRIBUTIONS

Description of contributions to the following:

- Theory

The study supports the case being made in most literature about the benefits of using ICT in lessons to achieve the desired outcomes in education, and upholds the perspective that appropriate pedagogical approaches are required when using ICT in PE lessons to achieve quality learning.
- NIE Programmes and Practice

The study allowed for participants' articulation of the need to level up the ICT proficiency of teachers (in terms of its use and potential as a pedagogical tool) as early as during pre-service training.
- Student/Teacher assessment, Capacity, Curriculum

The study's findings reveal that teachers will benefit from capacity-building efforts towards increased professional development in terms of ICT use, both in terms of pedagogical knowledge and the various technology-related platforms/devices which they can use.

Evidence from the ground shows the viability of technology used by PE teachers, in particular, the use of videos as a potential tool to aid periodic evaluation and assessment of student movement and performance improvement. It provides a mechanism that allows feedback and learning reference/review for the learners.

- Policy

Differences found in PE teachers' attitudes towards ICT provided a better understanding across diverse groups. These findings revealed which specific groups required extra attention, and this allows policymakers and stakeholders of educational institutions to plan specific strategies for different targeted groups to promote ICT use in PE.

- Practice

The study provided insights from teachers and students on how ICT's potential as a pedagogical device can be better leveraged by teachers to support students' learning.

## **CONCLUSION**

Based on the data, despite challenges and difficulties encountered, practitioners have learned to navigate around the factors that tend to inhibit certain aspects of ICT use for PE lessons. Undoubtedly, while there are infrastructures in place supporting the use of ICT in schools in Singapore, minor technical hitches need to be overcome every now and then. Factors such as receptivity, buy-in on the part of the students, as well as the propensity to look at non-ICT based lessons as the appropriate approach to teaching PE remain among the key challenges. However, with continued support from the system and school leaders, as well as sustained buy-in on the part of teachers, the use of ICT in PE lessons may reap its desired fruits in the long-run.

## **ACKNOWLEDGEMENTS**

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## **KEYWORDS**

Physical education, information and communication technologies, teacher attitudes, demographic differences, physical education teachers

# **The Use of Information Communication and Technologies Tools to Maximise Students' Learning in Physical Education in Singapore Schools**

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## **INTRODUCTION/BACKGROUND**

Easy access to rapidly advancing information technology today has transformed the world and its people, specifically the current generation of young learners who have been exposed to technology from their early days. Technology has become “culturally and socially relevant” (Casey, Goodyear & Armour, 2017) as it affects almost all areas of life. The impact made by the new digital environment has highlighted the need for evolution and change in education. Moreover, the changing needs and characteristics of today’s learners has initiated a search for new ways to integrate Information and Communication Technologies (ICT) with pedagogy and curriculum as traditional methods of teaching no longer appeal to students. While studies have documented multiple benefits of using ICT in education, there has not been much discussion on how ICT initiatives affect teaching in PE lessons where the focus has traditionally been on bodily movement and practise.

Given MOE’s focus on using ICT in resourceful and innovative ways to improve teaching and learning (MOE, 2014), PE teachers should be trained and equipped with strategies to create environments where students are given more autonomy to decide ‘what’ to learn and ‘how’ to learn, according to a student’s ability to use ICT. For instance, making available e-learning materials related to the lesson before and after the class affords students opportunities to learn more readily on their own than when these materials are absent. Using video recordings to provide visual and verbal feedback for skill performance during lessons is another way ICT can be

used to maximise students' learning and develop the affective, psychomotor, and cognitive domains set out in the PE syllabus. The advantages of using ICT in PE can be directly beneficial for skills acquisition and indirectly for honing life skills. Directly, development of meta-cognitive thought processes necessary for the acquisition of embodied skills can be supported through video analysis of movements performed to promote mastery or improvement of motor skills (Nakashima, 2006), and by providing students with opportunities for peer feedback necessary for their acquisition and improvement of motor skills. The indirect impact pertains to developing the 21st century skills and competencies of the students such as improving their metacognition, developing life skills such as teamwork and communication, as well as enhanced motivation for learning (Soparat, Aronld, & Klaysom, 2015).

## **STATEMENT OF PROBLEMS**

Despite increased use of technology in education within the Singapore school system, there have been limited yields in how PE teachers use ICT as a pedagogical tool in enhancing the learning of students. ICT is defined as "...technologies that facilitate the transfer of information or various types of communication electronically" (Zuppo, 2016). Internationally, research on how PE teachers can harness ICT for helping students acquire psychomotor and critical thinking skills more effectively is also limited. The study was timely as the findings can be useful to inform the Ministry of Education (MOE) on the current state of ICT usage in PE in Singapore schools, as well as how ICT tools might be used to support PE teachers' pedagogical skills usage to enhance students' learning. Data was collected from both teachers and students.

## **PURPOSE OF STUDY (INCLUDING RESEARCH QUESTIONS AND/OR OBJECTIVES)**

The purpose of the research was to conduct a baseline study to understand the state of ICT usage in schools in teaching of PE, and to document good ICT practices used by PE teachers in maximising students' learning and develop their cognitive, psychomotor, and affective domains in PE. Specifically, the following research questions guided the present study:



1. To what extent are ICT tools used in the teaching of PE?
2. What are the best practices employed by PE teachers in using ICT tools and reasons for using them?
3. What are the benefits and challenges perceived by PE teachers and their students during ICT-based PE lessons?
4. What are the recommendations by PE teachers and their students to better promote and support ICT-based lessons to enhance teaching and learning?

## **PARTICIPANTS**

### **Study 1: The extent of use of ICT tools in the teaching of PE: Singapore PE Teachers' Attitudes towards ICT in PE**

All full-time qualified PE teachers working in primary schools, secondary schools, and junior colleges under the purview of the MOE in Singapore were eligible to participate in the on-line survey. The aim of this study was to understand the status of ICT usage in PE lessons in schools. There are more than 400 schools in Singapore and PE teachers in at least 40% (150-180 schools) of schools were targeted for the survey. To ensure a high response rate and good representation between primary, secondary, and junior college from four zones, we worked closely with Physical Education and Sports Teacher Academy to reach out to more schools through their networks. Using convenience sampling methods, data were collected from 422 in-service PE teachers. The sample consisted of 283 male and 139 female teachers from 152 schools across Primary (218), Secondary (171), and Junior College (32) levels (1 did not report the school level). The response rate was 42.3% (152 out of 359 schools).

### **Study 2: Best Practices in using ICT in PE**

Eleven PE teachers from 7 primary schools and 3 secondary schools and one junior college were purposefully recruited from different parts of Singapore, based on the list of schools that participated in Study 1. Recommendations were also sought from school principals, Heads of Department for PE, as well as Physical Education and Sports Teacher Academy to help identify potential participants for this study. The criteria used to identify potential participants for best

practices include: 1) at least three years of PE teaching experience; 2) they must be formally trained in PE; 3) they must actively teach PE (at least 30% of total lessons allocated to PE per academic year). Out of the 11 teachers interviewed, 9 were males and 2 were females. Six of the teachers were in their 30s at the time of the interviews, 2 were in their 40s, one in his 60s while another 2 were in their 20s.

Pertaining to the student participants, a total of 72 participated in the focused group discussions (FGD), coming from 7 primary and 4 secondary schools. Out of the 72, 39 were female and 33 were male. The age composition of the FGD student participants ranged from 10 to 17 years old, as they came from the following levels: Primary 4 to Primary 6, Secondary 1 to Secondary 3, Junior College year 1.

## **METHODOLOGY/DESIGN**

### **Survey**

The physical education teachers' subjective theories questionnaire (PETSTQ; Kretschmann, 2015) was used to measure participants' perspectives towards the integration of ICT in PE teaching practice (see Appendix A). There were 64 questions in total, relating to students, teaching, teachers, equipment, computer literacy, classroom management and organisation, social interaction, innovation and modern teaching (Kretschmann, 2015). The respondents rated their agreement with each statement based on: Strongly Agree, Agree, Uncertain, Disagree, and Strongly Agree. Additionally, demographic information was collected.

### **Interview Guides**

Semi-structured interview guides were designed and used in Study 2 based on the qualitative studies in PE and sport (e.g. McNeil & Fry, 2012) to elicit good practices from PE teachers who are active in using ICT tools during PE lessons, the challenges faced, and recommendations proposed by them and their students (see Appendix B). A total of 14-18 individual interviews were conducted with PE teachers who are active users of ICT (10-12 pax) as well as inactive users (4-6 pax) respectively. A total of 14-18 focus group discussions were

likewise conducted with their students (See Appendix B) to triangulate the PE teacher interview data.

#### Study 1: Descriptive, Quantitative

The purpose of Study 1 was to gather quantitative data, using an on-line survey, to understand the extent of the use of ICT by Singapore PE teachers by looking at attitudes towards ICT in PE across different demographic groups that included gender, age, teaching experience, and school level. Study 1 was designed to answer the first research question. The survey questions can be found in Appendix A. The questions are adopted from Kretschmann (2015), which examined PE teachers' subjective theories about integrating ICT into PE.

#### Study 2: Descriptive, Qualitative

The purpose of Study 2 is to gather useful information to answer research questions two to four. Specifically, there were two aims in this study: 1) to gather good practices employed by PE teachers in using ICT tools, especially why and how they design and carry out ICT-based lessons, and 2) to understand the benefits and challenges in using ICT-based PE lessons, as well as recommendations from PE teachers and their students to better support and promote ICT-based lessons in schools. The interview guides for PE teachers and students can be found in Appendix B.

## FINDINGS / RESULTS

### Study 1

The findings of Study 1 are meant to address RQ 1 of the research project. The purpose of Study 1 was to gather quantitative data, using an on-line survey, to understand the extent of the use of ICT by Singapore PE teachers by looking at attitudes towards ICT in PE across different demographic groups that included gender, age, teaching experience, and school level.

#### Gender

Among the subjective theories measured in the PETSTQ, two showed significant differences in regard 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 for 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 attitudes towards the integration of ICT into PE, especially in areas related to computer literacy and innovative teaching as compared to female teachers.

#### Age

Significant differences were found for subjective theories related to classroom management and organisation, equipment, innovative and modern teaching, and social interaction. In the area of classroom management and organisation, 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 regard 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.

#### Teaching Experience

Participants were categorised into three groups based on their years in service (< 11 years, 11-20 years, and >20 years). Teachers' experience was found to be significantly associated with teachers' attitudes towards ICT in the area of classroom management and organisation,  $H(2) = 14.844$ ,  $p = .001$ , 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 regard to classroom management and organisation-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.

#### School Level

No significant difference was found in attitudes towards ICT among teachers of different school levels. This suggests that school levels did not influence PE teachers' attitudes towards integrating ICT into their teaching practices.

## Study 2

The findings of Study 2 are meant to address RQ numbers 2-4 of the research project (i.e. best practices, benefits, challenges and recommendations from students and teachers). The summary of thematic findings are found in Appendix C.

#### Best Practices

##### *Use of variety of ICT tools to enhance teaching of PE and assessment*

The teachers expressed that the use of ICT tools served to enhance their teaching of PE and motivated students to engage better during the lesson (please refer to Table 1 of appendix C).

For instance, for both primary and secondary school teachers interviewed, iPads, mobile devices and tablets were used to record how students executed certain moves during PE lessons. Watching the replay of such videos allowed students to engage in peer learning as they gave feedback to one another. These tools were also useful for providing online video demonstrations particularly for gymnastics. They also allowed access to visual tools and photos to show to students and guide them in their execution of gymnastics moves. School K (a Junior College) allowed their students to benefit from the affordances of using iPads by allowing them to do online searches when necessary during a lesson. For a teacher at school C, which is a primary school, the use of tablets for recording the movements of students during lessons provided convenience in identifying mistakes, showing transitions and providing feedback. School I, which is a secondary school, found the use of the iPads helpful for recording feedback, which can be an important part of assessment for the learning journey of students.

Beyond aiding skills acquisitions, certain applications were likewise identified by teachers to be helpful in supporting other aspects of lesson execution. For instance, Plickers, an interactive technology tool, assisted a teacher in assessing students cognitively, as well as improving student motivation and participation:

So that's when I started to use things like Plickers...so plickers cards are used as a way to assess students especially in the cognitive area. So ever since we tried plickers cards. . .it serves the purpose because of the unique way that we allow students to go up to the whiteboard to reposition the card to indicate the answers. Actually because of the novelty, it indirectly improves their motivation also to participate and contribute their answers. (Teacher, School J)

A teacher in a primary school found the use of the Edmodo application helpful in engaging students outside the classroom. This particular application enabled the students to create individual accounts that allowed them to access learning resources beyond the lesson period. This provided a platform for students to continue learning despite time constraints. The teacher described this in detail:

So they will go online after school to access our questions, access our quiz, watch videos, even videos recording of themselves in action, and with some guiding questions, we can enhance their learning, and to extend their learning beyond the classroom. This also promotes some parallel learning because the kids will be able to go online at their own time to engage in their learning. (Teacher, School E).

Google applications have also been useful in administering quizzes which students can answer online and within a few minutes (Schools J) as well as in implementing self-assessment (School H). Teachers have also leveraged on the use of technology to improve classroom management and communication among students (e.g. via whatsapp and social media platforms). Applications such as Dijo and Ses Saw were mainly used for keeping portfolio and making communication with parents more efficient. Running apps helped improve motivation among students, as it provided them information about their performance in running distance, motivating them to be in friendly competition with their classmates. Certain apps were used to enhance outdoor experiences with the support of the school (e.g. Thrill Shutter) while Go Pros were useful for capturing bigger fields of play and for assessing tactical understanding (School K). In addition to the variety of ICT tools that teachers were trying to use and leverage on to implement lesson plans and activities or achieve lesson goals, a few observable approaches employed by teachers to using ICT in PE lessons are worth noting:

*Providing ample space and time for young learners' transition*

Teachers who have introduced the use of ICT to young students in the primary level bear the responsibility of allowing them to develop the comfort level necessary in using the technology effectively during the lesson. The initial experience with the device or technology will have a profound impact on young learners' mindsets and attitudes towards the use of ICT. One teacher pointed out the need to establish certain routines that can allow habits to develop with regard to the use of technology in class. While habits and routines for non-ICT classes are currently in place to some degree, routines for the use of ICT in class can likewise be developed. One teacher from a primary school described it well:

So, P3 and P6 again, once the routine is set, maybe the first lesson when they do this, they will be excited ... as the lesson progress ... I introduce bit by bit first. So they will take pictures first and have them on their iPads. (Teacher, School B)

Another teacher shared a similar practice, saying:

I will get them to do my routines right first, and then after that I slowly introduce ...my P2s already started using iPads on dance. So far, they have no issues, so

they will place the iPads and then they will learn dance, and then I will just teach along the way. . . (Teacher, School A)

*Using ICT in resourceful and innovative ways to improve teaching and learning*

Using ICT creatively can allow the students to engage in various ways which are more meaningful or relevant to them. It will also generate support and buy-in on the part of the students for greater and more frequent use of ICT in their PE lessons. One teacher had designed her lesson by using images and popular fiction characters that resonated with the experiences and interests of the current generation of learners:

It should be fun, engaging and interesting. This is why I like to use ICT to come out with something new, something interesting for the students. Because as I have said, our students nowadays, as you can see, they are IT savvy, they are digital native [sic]. If you can't beat them, you can't stop them, we engage them in what they are already very good in or what they are interested in. So, actually in my many lessons currently, I am trying out to give indication, concept, I don't let them play games, but the concept is similar to the key concept, so they will work towards the poise [sic] and the poise [sic] will allow them to unlock certain hero characters and they will collect the superheroes. So, the concept is similar to the games, but they are not playing games, they are doing their work, and by completing [sic] certain amount of work with certain quality, then they will have more points. So that is the concept of the game. They may have support. (Teacher, School E)

*Enhancing learning by providing visual and verbal feedback for performance*

Across the transcripts analysed from the interviews with teachers and students, a key practice that has proven to yield benefits for both teachers and students in varying degrees is the video recording component of ICT in PE lessons. This has undoubtedly allowed students to look at their performance and that of their peers'. It has also been helpful in providing teachers a mechanism for improving the students' learning of motor skills.

Benefits of using ICT Tools for Teachers and Students

*Evidence for feedback and reference for learning*

A common benefit of integrating ICT tools was that it provided evidence for feedback on students' learning. One teacher shared how the use of video recordings helped students to refer back to their past performances to identify the areas for improvement, as compared to the



limitation of having one teacher to provide feedback to the whole class of students using the traditional approach of teaching PE. One of the teachers expressed that:

You can't give feedback to all 40 students at once. Whereas [sic] technology, they can see for themselves what is being done, because it's recorded, and feedback is given continuously, not just at that particular point in time or that particular lesson. So that's how technology can help. Because you can still refer back to their skill, their video, what they have done and get them to improve on it. (Teacher, School I)

Another teacher also shared how ICT tools helped to capture data to better inform their teaching to address the learning needs of students:

So as I mentioned, the use of Plickers card, because of the fact that teachers are able to gather concrete data about the students' learning gaps, so indirectly the students, and the teacher is able to position himself/herself to provide better feedback. So in that sense the student actually benefit [sic]. (Teacher, School E)

Among students themselves, the use of ICT as a tool for giving feedback and reference for their learning was acknowledged. As the following students have noted:

So you use ICT to record them to show to the teacher, because many people will say that they do very well, but in fact some people actually do very badly, but they do not admit it. So, this ICT can record and help them learn ... maybe some people are too embarrassed to really say, you know, they are not really good at that thing, but when they watch the video, they know their problems... (Student, School E)

Students recognised how the use of ICT benefitted their learning during PE lessons, particularly during games that are quite difficult, through the online videos and resources that the teacher tapped for purposes of demonstrating certain moves. In this sense, ICT tools reinforced teacher-led demonstrations and instructions. A student from School H shared his experience:

For baseball we all don't have the foundation...so our teacher will show us YouTube on how each player plays each role, how we can execute our moves...everything about the moves. We also only have one teacher and he can't play so many roles in one lesson. So the YouTube video can cover everything that the teacher can't. So, together with the teacher reinforcing that.

#### *Promotes engagement and self-directed learning*

Teachers have likewise cited how the use of ICT creates situations for students to be "on their own" after teaching them. Students can practice individually and in groups. Stating her observation of her students during a PE lesson supported by ICT, a teacher from School H expressed that "it is all about self-directed learning. I'll teach them and then they will gather in their groups of four, then they will learn and do it step by step."

Another teacher cited how ICT helped in reducing the need for teachers to manage and discipline students during the class:

The students are good at adapting. They adopted [sic] this (ICT) if they know how it can help them in their games. No more the teacher shouting at them and telling them they should have done that, they know because they can see. So it (ICT) help [sic] them to realise that...there are improvement [sic] that I can make, and these are all student directed. These do not need to come from the teachers. (Teacher, School E)

Validating teachers' observations, the use of ICT for PE lessons does create opportunities for students to learn on their own and with the help of their peers. Guided initially by technology, students attempt to execute the performances on their own:

We try it (watching video) ourselves sometimes...we should rely on ourselves sometime to practice more. Because if you do it with your peers it's fun, they won't criticise you if you made [sic] mistake...rather than keep watching [sic] the device and try to figure out yourself. (Student, School I)

#### *Promotion of collaborative and social learning*

The use of ICT in PE creates opportunities for students to reach out and provide help to one another by way of offering feedback to refine one another's movements. One teacher explicitly mentioned "I have to use ICT to create collaborative learning (Teacher, school J)", particularly the creation of photo feedback which allows students to communicate information about their learnings. Another teacher observed how over time, the tendency of his students "to help one another during the lesson developed among the members of the class (Teacher, School K)".

Besides being able to make references to an individual student's learning, ICT tools also helped students to learn from their peers. One student shared how the use of google classroom and video recording helped in learning from his or her peers' mistakes:

ICT is good for PE, we get to learn from our friend's mistake, because we post it on the google classroom. So all of us will get to post our own videos with our friends on the app itself. So we get to see each other especially when our teacher gives us the homework to actually go and comment on others' video [sic], so we will actually get to look for the mistakes of our friends and try not to follow the mistakes they did [sic]. So it's like learning from one another. (Student, School I)

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*Efficiency in teaching and learning*

Participants also reported how the use of ICT tools helped to improve efficiency in their teaching work. One teacher shared how one ICT tool helped in capturing feedback from the whole class of students within a short period of time:

If you keep doing verbal Q&A, you only get that same few to answer. And even if you're good at getting random students to answer, you are only hearing a handful of answers out of the 40. But with Plickers cards, I can get all 40 responses, and within 3 seconds, I can get all the data collected on my phone. (Teacher, School E)

Teachers likewise reported how the use of ICT allowed better ways for preparing, managing and storing teaching resources.

...the cost, the process of the printing then after that cutting and laminate [sic] all these, takes a lot of time also. So when I transfer all these things to the website, first thing is that it's always there. It will never get damaged in that way, and students will get the same set of instructions that they will get from the use of pass cards also. So I thought that is the way that the students will benefit. (Teacher, School H)

The use of ICT has helped teachers to impart lessons more effectively even in their absence, as elaborated by the following teacher:

So far, I think (it is) pretty positive. ...because I remember there was one lesson whereby I wasn't around, then the relief teacher who went in will just tell them, ok, access these few links and then to [sic] watch the video. At the time there was a laptop with the screen projecting. So what happens is that after the lesson, I remember it was a basketball lesson, so I asked the class okay what are the 3 basic passes then they can recall from the video that we have learnt this and this, and pass this and so on. So I thought [sic] very comfortable for the students. (Teacher, School D)

Among students, a certain level of efficiency in the way the lessons were conducted with the use of ICT was recognised. One student described his experience:

When we don't have things on ICT we tend to be less objective...they will ask question like, "Are you at 1st level?" because they do not know my timing...and they may ask me to run one more round ... Also, we tend to write notes (to keeping records) ... But with ICT, we know everything is accurate, everything is fair and efficient... (Student, School H)

*Enhancement of students' cognitive and affective learning*

The teachers noted students' enhanced understanding of the movements being demonstrated during the lesson, as well as an improved strategic and tactical grasp of what

learners are expected to do and execute. Students were able to clearly understand whatever they needed to do through the use of videos which allows them to receive feedback on their movements and performance:

...they are able to be aware of whatever I'm trying to teach them compared to just talking to them and showing them my demonstration...when they see themselves and getting peer feedback or comments from me, they clearly understand whatever they need to do. . .And they can identify their strength and weaknesses. That gives me an idea that actually cognitively they understand whatever they are supposed to do better, even tactically. (Teacher, school K)

Beyond facilitating cognitive learning, one teacher expressed that it could also facilitate affective learning among students through their interactions with one another during the lessons, as they work and interact together:

...for [sic] affective side, because it's a lot of pair work, they have to deal with their friends. There will be a mismatch in partner even though they may choose their own friends. So in this particular class, they get to choose their own partners. It's a seasonal partnering. (Teacher, School G)

One student expressed how the use of ICT had improved his/her understanding during PE lesson:

...they're doing something like a skill technique or a strategy using ICT...you're watching your own movement and trying to make sense out of it...basically it's breaking down the complexity of the strategy/skill so that we can understand ourselves better. So I guess that's the function of these ICT [sic]. (Student, School K)

Teachers also see the use of ICT as another platform for teaching conceptual knowledge more effectively, as they strive to balance the sharing of meaningful information and the need for executing movement and action. ICT allowed one teacher to better organise knowledge and information on the concept of movement. It also allowed the teacher to “spend more time in action, movement (and) refinement (Teacher, School E)”.

## Challenges in using ICT for PE lessons

### *Technical difficulty connectivity, software-related difficulties and troubleshooting*

One common challenge in using ICT for PE lessons is the occurrence of technical difficulties. These difficulties affected the lesson time, as connectivity issues were reported to hinder 30-40% of one entire lesson. The process of getting connected in schools can prove to be

tedious with too many steps to go through as expressed by a teacher from School F, saying that “even with Wi-Fi, student need to press [sic] password, so [sic] really a lot of passwords, I cannot take it...even with [sic] password, doesn't mean you can get in.”

Another teacher shared the same experience. He said:

Sometimes you have to keep pressing, pressing, and pressing...then it will finally load the thing up. You have to keep giving permission, permission [sic] ...but sometimes it will not work. So some of these things are quite troublesome when connecting to [sic] school Wi-Fi...they have to understand these issues we are facing when using ICT... (Teacher, School H)

Time is always a crucial element in achieving the targets and goals for each PE lesson. Issues on connectivity and functionality of the device remain as key challenges and greatly affect teachers' disposition towards the use of ICT in their respective lessons:

So [sic], ICT tool, it needs to be time saving, it needs to be [sic] effective and efficient process, and it needs to be reliable . . . it works sometimes and doesn't work sometimes, there is no point for me, and gives me frustration. Because if I bring something in to my class, I need to handle all these . . . and if the thing don't [sic] work, I get very frustrated. (Teacher, school E)

Students themselves provided accounts of their difficulties in using ICT tools during PE lessons:

If you shoot a video, it has got to be between a certain times like 20secs. If it's not in-between that 20secs, that video will take forever to load. So sometimes you have to take longer than 20secs, and then will take so long to load and there's no point already, the period's already over. (Student, School A)

The same student shared another frustrating experience when using ICT, saying, “If you try to login to Wi-Fi, most of them requires [sic] password, and sometimes your teacher doesn't know the password, then you can't use the app at all (Student, School A)”.

#### *Reduced physical activity time/fewer outdoor opportunities for students*

One common challenge associated with ICT-based PE lessons was that the use of ICT tools reduced the physical activity time for the students. One student shared how the use of digital gadgets reduced the time for practice when asked whether he preferred PE lessons with or without ICT.

I like the one without ICT because you have more time to actually practice, because you have more time to actually practice and do things, while with the iPad you have to record them, have to save up under their name, then you have to show your

friend, then you have to comment. So it takes up time...it's a long process. So you'd rather go into the practice just do it. And then your friend can just feedback and then switch around. So it's easier and it saves times. (Student, School A)

This challenge was also due to the increased amount of time needed to give the special instructions for ICT tools, as explained by this student, saying:

For ICT, we need to know how to use the computer before we even do the actual PE. For normal PE, the instructions time is lesser because we only get to do things with the sport equipment given to us. Like soccer ball, we just have to take it and go kick it after listening to instructions. But the thing is ICT we have to use the computer, then we have the instructions for using the computer, and figure out what to do. (Student, School J)

Moreover, as ICT-based PE lessons may take place indoors, students reported frustrations that they did not have opportunities to head outdoors:

For PE lessons, we get to go out and not be cooped up in the classroom all day. We only have like 4 periods of PE a week. If we spend it both in class, it'll be like the whole week, every single day we are staying in the classroom. (Student, school I)

Teachers recognised that one of the challenges of using ICT tools is that time for physical activities indoors and outdoors may be affected. A teacher (School G) said, "They are not very receiving because . . . in a sense that if [sic] too much ICT, there will be too much downtime, because at each time, we want the student to be as engaged as possible."

Another teacher highlighted the need to give more time for students to be actively engaged in physical activity during lessons and learn more sport skills:

. . . let's say they are at the level where they can look at the strategy that is recommended on the website, and apply it and understand how to modify it, I think that will still be very helpful. But what I'm talking about is how do we teach them to understand the strategy and then from there modify and put in place in practice. . .that is the part where I feel that it's going to be quite time consuming and it will be a different focus from our PE syllabus. Because our PE syllabus don't [sic] really focus so much on how, we're like not training them to be a coach, but more of exposing them to the different sports and make sure at the end of their 4 years, they're exposed to at least these few sports from different categories. (Teacher, School H)

*Students' buy-in (preference for non-ICT lessons /traditional PE lessons)*

Teachers reported how the level of buy-in on the part of the students can still be very low, despite efforts to veer away from the traditional teaching approach in order to highlight the affordances of using ICT during PE lessons:

They are not ready for it. Not used to it. They are used to a very passive learning approach . . . When the students are then required to collaborate and then discuss and talk and create something, they are really not used to it. So that actually reduces the speed at which I can get them to do what I want them to do...They are very used to 'tell me what I need to know' (Teacher, School K)

Interviews with students validated the prevalence of the preference for non-ICT PE lessons. A key challenge that inhibits students from fully embracing and seeing the benefits of using ICT in PE lessons is the prevailing mindset that traditional PE lessons is the best way to learn. This is due to the perceived convenience of referring to the teacher whenever there is the need to improve and correct one's execution of a game or movement rather than referring to videos for self-directed learning. This also arises from the students' preference to actually watch the movement (demonstrated by their teacher) and do the movement themselves, rather than watching videos and do themselves. For instance, one student opined:

I would still prefer that the way without ICT because instead of watching a video over and over again, you can ask your teacher to help you improve, because even just watching a video right, you are not actually doing it. You can still make mistakes whether if you do it and your teacher or friend is watching, they can easily help you improve right [sic] then and correct your mistakes. (Student, School A)

#### *Perceived inconveniences of using ICT*

Students expressed that using ICT tools during PE lessons can prove to be inconvenient as they hampered free movement and the gadgets run the risk of becoming damaged:

Sometimes I prefer using the tablet, sometimes I don't. Because if it's a favourite sport you like, and you need to carry that device with you around [sic], and if in that excitement you drop it, you are responsible for it. You will feel like the rest of the day will not be so good. So I would like tend to focus on what if I drop instead of having fun. (Student, School J)

Another student shared the same sentiment, saying:

Because sometimes, we have water break, we want to drink water, then we are carrying the iPad and the water, it's very heavy...the iPad is also attached to your neck, then you have to carry it, it is very heavy. Then in case of anything, you still have to hold it when you

drink....in case when you spill any water, you have to hold it, because in case the lid come [sic] out, then it will drop on the floor. (Student, School E)

On the part of the teachers, certain inconveniences in using ICT tools also surfaced during the interviews. A teacher from School K provided some solutions to solve the large class size when using ICT tools:

Maybe we have to think about breaking the class into one class...maybe one group have practice without video and do a certain activity whereas the other half of the class doing the video feedback, then we switch them around, so that they don't get too bored because the waiting time is too long. So that's the challenge in operation even though it is significantly good. Other things are preparation of the materials, let's say if I want to use a demonstration using a tactic board, [sic] electronic one, I have to prepare the board beforehand, so that takes up some time. If I use videos, I have to cut out snippets from it. Next thing is let's say I want to use the videos taken for feedback, it's a tough process to check out the entire video.

A teacher from School H also shared his struggles and frustrations:

At the start, I would say that when you loan out the devices from the school so like either tablets or laptop, it is a hassle, because when you carry around, it is very heavy. Then plus the charging part also. When it runs out of battery, you have to return it.

#### *ICT can be an inhibitor of social interactions in class*

Among some students interviewed, the use of ICT tools can cause reduced interaction and interpersonal engagement with both teachers and classmates during the lesson period:

When using [sic] iPad during ICT lessons, you're by yourself and just watching the video, then you're not really socially interacting with your classmates. Whereas if you don't have the iPad, and you work together with your classmates to help each other to improve, then you're interacting a lot compared to ICT PE lessons.  
(Student, School J)

#### *Students' differentiated skills and level of comfort in using technology*

For some teachers, one of the challenges that needs to be overcome is making the use of ICT in lessons as meaningful as possible to students whose disposition towards its use is relatively less favorable than most of their peers, or are simply not very comfortable with using ICT tools such as videos, devices or apps. This may also arise from students' lack of appreciation and understanding of the benefits that can be derived from using ICT in PE lessons.

They want to use, they are motivated to use, but they may not know why they are using it, and the benefit of using it. So I will need to take time to show them that, how to use the



video to show their movement...I can't just record and don't [sic] show them. . . there will always be students who are not comfortable with this kind of teaching... (Teacher, School E)

This was validated by some remarks from students who said that they feel uncomfortable being video recorded or watched, especially if a student is shy:

One disadvantage is that the person is an introverted person, very shy that type of person. When we show their Standing Board Jump on the big screen, and when you epic fail [sic], then the person might feel quite embarrassed. So it depends on the person [sic] is very open to everyone being able to see the replay. (Student, School K)

#### *Level of buy-in of fellow teachers*

The interviews with the teachers revealed that one of the key challenges to fully embracing the use of ICT tools in PE lessons is the low level of buy-in among some of their fellow teachers:

For [sic] PE teacher, from time to time it [sic] will have some resistance when using different types of ICT tools... sometimes ICT tool A, I have maybe 7 accepting, 2 rejecting, ICT tool B, I have half of them rejecting, half of them accepting. At the end of the day, we will not have 100% adoption, and we don't want to force them because this is depend [sic] on the needs and logic...It is not a syllabus, it is not their learning objective... (Teacher, School E)

The key reasons identified by teachers which account for the low level of buy-in among some teachers to use ICT in PE lessons are due to the fact that it can take away a significant amount of lesson time, and that the teacher could lack the skills to use ICT tools for lessons in PE.

Not all teachers may be very receptive to this as well, especially those who are not very tech-savvy and they are not very familiar with the tool, which will then take up more time for them. So the buy-in is the critical thing. Because once you don't have the buy-in it's hard to motivate people...Yes it (ICT) does take away lesson time, and it may create some constraint or difficulty in conducting the lesson because you know it will take some time and a million things can go wrong. So the teacher must have the capacity and ability to know what he or she is doing, and making [sic] sure that the session is effective and not taking up too much time. But I think that boils down to teaching experience with the ICT tool. (Teacher, School K)

#### *Preparation of lesson design*

As there is no defined framework to guide the use of ICT in planning of PE lessons, teachers faced challenges in repetitive processes of refining their own lessons. A more thorough process of planning should be embarked upon by teachers who wish to use ICT in their lessons to make it more effective. This can be tedious and requires a good sense of purpose and proper timing on the part of the teachers on when to use ICT:

It's a bit like trial and error. You know this, and you heard about this particular app or whatever somewhere, then you see opportunities for it to be integrated into your lesson and you try, sometimes you encounter problem [sic], you refine the lesson, and the process sometime can go on for quite a while. So I will say that there is no shortcut. (Teacher, School J)

Another teacher shared the same concerns:

First of all I would think about what are the stages of development, let's say I teach a softball module, what comes first. Is it throw [sic], catching, batting or the gameplay first? So after I settled the unit plan, I would then go into the lesson plan. So let's say this lesson plan is supposed to help in the development of the softball overarm throw for example, it may run across [sic] a few lessons. It's not just one lesson ... But so when I do this right, I will throw in at a certain point in time where it's [sic] appropriate video assessment. It may not be at the first lesson, because then I may just want to experiment just try first, get the idea, and then once they get some knowledge about how the movement is like, then its timely enough for the videoing because they now know what they are supposed to see. So it depends, [sic] every module how I bring it in. (Teacher, School K)

#### Recommendations from Teachers

##### *Sustained buy-in and commitment on the part of teachers and school leaders*

Teachers highlighted the importance of the continuing support of school leaders and fellow teachers as key elements to making the use of ICT in PE lessons sustainable with meaningful gains for both teachers and students. A good level of buy-in on the part of most teachers will likewise create an environment conducive for sharing learnings and opportunities for growth in the use of ICT in PE:

I think school support is one big factor . . . then you see your PE teachers are open to trying out new devices. For me, I'm always on the lookout, there is sharing of this kind of thing. I think if it helps us, why not? So I think more sharing would be great. If there's a course-- I think course will be a bit too long, so just a few of us, officially, will be fine. (Student, School A)

With school leaders and HODs as key drivers in the use of ICT in PE lessons, one teacher believes that ICT-based PE lessons will flourish, despite the challenges. This, together with a continuing recognition of the importance of PE vis-à-vis other subjects, are important factors in motivating PE teachers to explore and try new ways of delivering the lessons:

The boss - HOD is important. When the HOD believes in it, when the HOD has a say and he leads by example, when he creates and forces things like workshops, then I think it helps. I think the environment must be conducive, the school must support PE as well and to provide the resources like, "Oh I give each department 10 iPads." It helps... So actually there are a lot of factors that come into play that are able to convince the teachers to use ICT. (Teacher, School K)

To improve the level of buy-in, one teacher proposed that ICT be packaged as a beneficial and efficient way for teachers to carry out their PE lessons:

... We can package it as something beneficial and useful, and help the teacher to save time. Because one of the usefulness of ICT is it will improve efficiency and save teacher time. We know that all teachers are very packed from day to day [sic]. If you plan and package the ICT tool to help you to save time, that would be very useful. For instance, yesterday I was at the PST forum, they finally showed us the 1.6km camera, the machine...they finally showed it (ICT tools) to us, and we are very impressed because that helps us to save time. (Teacher, School K)

### *Community sharing*

Teachers recognised the importance of sharing their experiences in using ICT for PE lessons within school and across communities of teachers. In order to encourage incorporation of ICT in PE, teachers suggested that there is a need for more sharing between colleagues in the teaching community. One teacher emphasised the need to share the benefits of ICT-based PE lessons to convince more teachers to join this effort:

... So again, I really hope more schools attend more sharing sessions to find out more about ICT...maybe the next conference, we can learn more about all these ICT tools and pedagogies to be used in PE. I think that would be one great avenue to get us better [sic]. (Teacher, School A)

Another suggestion shared by the following teacher:

I think they need to see the effectiveness of it first. If let's say they understand how to use it but they may not want to use it unless they see the effectiveness of it. So perhaps there could be more case studies or examples or schools that are doing it and they see the results. But it's very difficult to quantify the results as to how ICT has helped the student to improve. So the documentation is quite important. (Teacher, School C)

### *Continuous improvement on ICT lesson design*

In order to examine the true benefits of incorporating ICT into PE lessons, participants shared that it is important for teachers to persist with ICT use and continuously explore ways to improve their own lessons. Teachers should continuously experiment and be open to trying different ways to use ICT for the purpose of enhancing the students' PE learning. This will also contribute to the enhancement of their skills in using ICT for pedagogical purposes:

I think more time has to be given to think about how to have a continuity. Because this is the first time I'm using it throughout the year, I think I can learn from the various things and see how it can be improved to next year and to make the use of ICT more consistent. (Teacher, School A)

Another teacher also remarked:

. . . It shouldn't be just one way and it also doesn't mean that have to try a lot of ways but you have to always experiment for the benefit of the kids . . . depend on a wide variety of experience. When I was in primary 5, I have this teacher . . . then suddenly we got one project, had to do PowerPoint so we must talk out PowerPoint . . . (Teacher, School F)

### *Formal training/professional development*

Teachers recognised the key roles played by institutions of higher and professional learning in training teachers. The data from teacher interviews show that they are cognisant of the valuable help and input that formalised training will provide to improve PE teachers' pedagogical competence with ICT tools.

I think if PESTA has gathered enough for them to come up with a solid full module on that, I think that would be nice. Like what I said, during my time there was just a module which was very generic. So that didn't help us PE teachers a lot at all actually. So if on PESTA side they are able to gather, I mean with help from NIE researchers maybe, can gather most of these best practices, possible solutions through certain things, then I think that would be nice in our pre-service training, equip our future PE teachers with that base knowledge already. (Teacher, School J)

A teacher from School H agreed and provided another example, saying:

. . . I feel that in future, NIE could help to level up this proficiency. I feel (it) is a key step to at least make them feel more confident dealing with ICT tools, and at the same time understanding that even for people who are comfortable with ICT tools ah, we also meet with failures... and how do we embrace it and then make use of this to enhance the future application. That is my opinion. . (Teacher, School H)

## Recommendations from Students

### *Increase the variety of ICT tools and activities*

To prevent monotony and perceptions of repetitiveness on the part of the students, teachers should diversify the ICT used tools and the activities being done during the lesson. Student participants reported that as repetitive use of similar ICT tools might make the lessons boring, they suggested more variety of mobile applications during lessons:

Sometimes using the iPad will get a little boring. Because we're using the same thing over and over again. There's like a routine. You open the app and then there's WIFI, then QR code, then after that have to take this take that. It will all clash and there's no time. So as she said we can limit it to once a week. It gets monotonous. I'm just using big words because it sounds cool. (Student, School A)

To address this the above issue, a student from School J suggested that "...we need to use ICT in a fun way... in a sense that you get to use more, not exactly one app but multiple apps at the same time."

### *Lessen technical problems*

Students expressed hopes that some of the difficulties associated with logging in to iPad devices or computers, wi-fi settings and connectivity, can be reduced and that distribution of devices can be better managed so as to lessen the technical difficulties encountered when using ICT tools during PE lessons.

If we have two periods during that lesson, we can exchange the iPads, let's say like 5, then everybody takes turn to use them. Because when you have everybody using it at once, there's many people trying to use the wi-fi, there's too many people. So lesser [sic] people using the iPad will be better. What we could also do is before the iPads are handed out to us, make sure that there is wi-fi, because sometimes the wi-fi isn't there and you'd have to go on to settings to get the WIFI which will take time. So before the PE lesson, just make sure that the wi-fi is on. (Student, School A)

### *Balance between the use of ICT and traditional PE lessons*

Students expressed the view that for ICT to be effective as a tool for learning in PE, it has to be combined in a balanced way with traditional way of learning PE. Moreover, from the perspective of the students, there are specific games for which ICT can be successfully used and there are those for which ICT may not be appropriate:

I think for example you want to learn [sic] new sport, like rugby, instead of showing it first, which is what they are doing. I think they should just try it first. From that then you know what you know, what you don't know, what you're good at, then you watch. For understanding broad jump, you watch like a model, your legs should be 90 degrees all these, but for different person different case what, maybe the person need [sic] to bend all the way down to 45 degree then can jump further. I think if you show like how you should do it first, it restricts your freedom to stretch your potential. Along that line. It's like fixing a way into students. You should bend your legs properly then you can jump properly, like that do it [sic]. (Teacher, School K)

## CONCLUSION

There has been a plethora of studies establishing a multitude of benefits emanating from using ICT in education (Kretschmann, 2015; Redecker, 2009; Soparat, Arnold, & Klaysom, 2015; Stoicescu & Stanescu, 2015). Recognising the relevance of ICT in education, many studies have documented how government agencies have integrated ICT into pedagogical practices with the aim of designing curricula that is both purposeful and appealing to students (Goktas et al., 2012; Tearle & Golder, 2008). In Singapore, the MOE invested close to \$6.4 billion to develop basic ICT infrastructures in Singapore schools over a twelve-year period from 1997 to 2008. The measures were aimed at incorporating ICT into school curriculum to build learning contexts that nurture the cognitive abilities of students (Koh & Lee, 2008).

There is undoubtedly a prevailing optimism on the ground with regard to the possibilities which the use of ICT can bring to both teachers and learners. Based on the data, despite the challenges and difficulties encountered, practitioners have learned to navigate around the factors that tend to inhibit certain aspects of ICT use for PE lessons. Undoubtedly, while there are infrastructures in place supporting the use of ICT in schools in Singapore, technical hitches need to be overcome every now and then. Receptivity, buy-in on the part of the students, as well as the propensity to look at non-ICT based lessons as the superior approach to teaching PE, remain among the key challenges teachers face in using ICT in schools. For the use of ICT in PE lessons to reap the intended fruits and long-term goals for teaching and learning, teachers will benefit from

a multi-pronged effort to support capacity-building, be it in terms of technical skills or pedagogical learning.

The ways in which ICT as a tool can be effectively and meaningfully weaved into a PE lesson may vary depending on the goals and perspectives of the teacher. Despite the existing constraints faced by PE teachers, they have been able to use the available ICT resources in school to harness some of ICT's potential as a learning and pedagogical device. However, as this study has shown, much more can be done.

## **CONTRIBUTIONS OF STUDY**

### **Theory**

The study supports the case being made in most literature about the use of ICT in lessons, and upholds the perspective that ICT tools have the potential to be used as a pedagogical approach to impact the teaching and learning of PE. Moreover, this study alludes to the need to consider the contextual nuances (e.g. demographic characteristics of teachers, profile of students, school support and levels of buy-in) which surround the use of ICT by teachers. For instance, while extant literature may make the case for relatively greater openness and acceptability of younger teachers towards the use of ICT in lessons, factors such as longer teaching experience, strong systemic support for the use of ICT in schools, may actually elicit greater openness and more receptive attitudes on the part of older, more experienced teachers.

### **NIE Programmes and Practice**

The study allowed for participants' articulation of the need to level up the ICT proficiency of teachers (in terms of its use and potential as a pedagogical tool) as early as during pre-service training.

### **Student/Teacher assessment, Capacity, Curriculum**

The study's findings reveal that teachers will benefit from capacity-building efforts towards increased professional development in terms of ICT use, both in terms of pedagogical knowledge and the various technology-related platforms/devices which they can use.

Evidence from the ground shows the viability of technology, in particular the use of videos, as a potential tool to aid periodic evaluation and assessment of student movement and performance improvement, as it provides a mechanism that allows feedback and learning reference/review.

#### Policy

Differences found in PE teachers' attitudes towards ICT provided a better understanding across diverse groups. These findings revealed which specific groups required extra attention, and this allows policymakers and stakeholders of educational institutions to plan specific strategies for different targeted groups to promote ICT use in PE.

#### Practice

The study provided insights from teachers and students on how ICT's potential as a pedagogical device can be better leveraged by teachers to support student learning.

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The views expressed in this paper are the author's and do not necessarily represent the views of NIE.

**To maintain confidentiality, pseudonyms have been used in place of the actual names of schools, teachers and pupils in this study.**



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## APPENDIX

### Appendix A Survey Questions (Study 1) Kretschmann (2015)

|     |   |
|-----|---|
| C1  | I can't integrate ICT because I am under time pressure to include the content standards completely.         |
| C2  | If I had smaller class sizes, I could imagine using ICT in PE.  |
| C3  | PE class time is too short to use ICT.  |
| C4  | The use of ICT decreases PE movement time.  |
| C5  | ICT is good for preparing PE lessons.   |
| C6  | A complex PE equipment set-up can easily be planned using ICT.  |
| C7  | ICT is most likely placed best in the last two years of secondary school PE.                                |
| C8  | Preparation effort and learning outcome efficiency are in fair relation to each other when using ICT in PE. |
| CL1 | I do not have sufficient experience to integrate ICT in PE.   |
| CL2 | I have too few knowledge about possible pedagogical scenarios using ICT in PE.                              |
| CL3 | If my computer literacy were better, I would use ICT in PE more often.                                      |
| CL4 | There are many webpages containing ideas for diversified PE lessons.  |
| CL5 | Younger PE teacher colleagues are more engaged into ICT integration.  |
| CL6 | I am not interested in continuing education events in the area of ICT and PE.                               |
| CL7 | I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students.           |
| CL8 | I use ICT frequently to prove my ICT skills.  |
| CL9 | My students are better in using ICT than I am.  |
| E1  | Most of our school's PE equipment is so outdated that it does not meet current standards.                   |
| E2  | Our school can't afford to buy new PE equipment.  |
| E3  | Even if the equipment were there, I would not use ICT in PE.  |
| E4  | Our school supports ICT diversity.  |
| E5  | I would absolutely integrate ICT into my PE lessons, if it would be available.                              |
| E6  | I think it would be more sensible to refurbish or expand our PE-related facilities than purchasing ICT.     |
| E7  | The instructional videos at our school are outdated.  |
| I1  | Even though ICT is ubiquitous in the lives of children and adolescents, it does not belong into PE class.   |
| I2  | I could imagine ICT in PE-related school projects or after school programs.                                 |
| I3  | Modern (PE) teaching promotes ICT integration.  |
| I4  | ICT should play a bigger role in physical education teacher education programs.                             |
| I5  | The importance of ICT in PE will increase in the future.  |
| I6  | ICT can't replace traditional teaching and learning methods, but complement and accompany it successfully.  |
| I7  | I frequently heard from other schools' PE teachers that they use ICT in their respective PE classes.        |
| S1  | Students' study motivation can be increased by integrating ICT.   |
| S10 | Boys get more into ICT in PE than girls.  |
| S2  | Working with a Laptop is a team activity.   |
| S3  | Students can gather new information on their own.   |

|     |   |
|-----|---|
| S4  | ICT-supported education is as equal effective in regard to learning outcomes as traditional education.                      |
| S5  | Instructional tips, hints, and images on the computer make students become more adventurous.                                |
| S6  | Not actively participating students can be mentors and advisors at PCs.   |
| S7  | If students are not motivated, ICT will not motivate them anyways.  |
| S8  | ICT integration fosters independent learning.   |
| S9  | ICT integration fosters social and communicative learning.  |
| SO1 | Students learn to use ICT at home.  |
| SO2 | Demonstrating a movement or technique by a student is more efficient than using video.                                      |
| SO3 | Letting students work with a laptop in PE fosters their ability to work in a team (collaboration, communication in groups). |
| SO4 | Using ICT in PE facilitates collaboration among teacher colleagues.   |
| SO5 | Using ICT in PE frequently makes the personal teacher-student relationship suffer.  |
| SO6 | A webpage for our PE classes would be useful.   |
| SO7 | Playing sports and movement games increase PE enjoyment and facilitate communication better than ICT.                       |
| SO8 | Internet forums are helpful for PE teachers located at various schools to communicate and compare notes.                    |
| T1  | ICT integration does not lead to better content knowledge.  |
| T2  | Media as blackboard and (printed) images are more suitable in physical education.   |
| T3  | My teaching in physical education is successful without integrating any technology.   |
| T4  | Animated images (or short videos) can illustrate the diverse aspects of a movement or a technique well.                     |
| T5  | Internet searches (e.g. ball games) are well suited as homework.  |
| T6  | Video recordings are better for individual feedback than personal feedback of the PE teacher.                               |
| T7  | Despite ICT integrating, manifold movement, exploration, and free trial should remain the focus of the PE lesson.           |
| T8  | Using educational software, PE content knowledge can be learned playfully.  |
| TE1 | Using video in PE means thorough preparation, guidance, and post-processing by the teacher.                                 |
| TE2 | The physical education teacher is relieved through self-reliant learning scenarios using laptops.                           |
| TE3 | ICT is the building block of the development of new teaching and learning methods.  |
| TE4 | I do not need ICT for getting students motivated.   |
| TE5 | Using modern teaching methods increases my reputation with the students.  |
| TE6 | To give the students more freedom, I gladly switch to the role of a moderator.  |
| TE7 | Computer programs facilitate a fast sorting and analyzing of assessment data (e.g. competition results).                    |

#### Demographic Information

|        |  |
|--------|--|
| Age    | <input type="radio"/> Under 30<br><input type="radio"/> 30 to 39<br><input type="radio"/> 40 to 49<br><input type="radio"/> More than 50 |
| Gender | <input type="radio"/> Male   |

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2016

|                                 |   |
|---------------------------------|---|
|                                 | <input type="radio"/> Female  |
| Year of Teaching Experience     | <input type="radio"/> Less than 1 year<br><input type="radio"/> 1-3 years<br><input type="radio"/> 4-10 years<br><input type="radio"/> 11-20 years<br><input type="radio"/> 21-30 years<br><input type="radio"/> More than 30 years |
| Average Student Per Class       | <input type="radio"/> Less than 10<br><input type="radio"/> 10-15<br><input type="radio"/> 16-20<br><input type="radio"/> 21-25<br><input type="radio"/> More than 25   |
| Average Teaching Hours Per Week | <input type="radio"/> Less than 10 hours<br><input type="radio"/> 10-15 hours<br><input type="radio"/> 16-20 hours<br><input type="radio"/> 21-25 hours<br><input type="radio"/> More than 25 hours                                 |

## Appendix B Interview Guides (Study 2)

### For PE Teachers

1. Warm-Up Questions:
  - Can you describe your experiences that led to your current position as a PE teacher?
  - Can you talk about your training/certifications to become a PE teacher?
    - Probe as it relates particularly to usefulness for using ICT tools in teaching PE
  - Can you talk about other learning situations that inform your teaching (especially ICT tools/strategies) aside from your certification training?
    - Informal: Books, DVD, Internet
    - Non-Formal: Mentorship, workshops, seminars, conferences
2. Key Questions:
  - a. Philosophy:
    - Can you describe your teaching philosophy?
    - What type of support do you receive or feel you need to receive to successfully implement your teaching philosophy?
  - b. Reasons, strategies, and challenges for using ICT tools in PE lessons:
    - Can you share with me the reasons for using ICT in your PE lessons?
    - Can you provide examples of ICT tools and strategies you use to teach your students during PE lesson?
    - How do you learned to develop these tools and strategies?
    - Can you elaborate on some of the challenges or obstacles you might face in implementing such tools and strategies?
    - Describe your students' level of receptivity to this type of teaching approach and materials used?
  - c. Environmental Factors/Recommendations:
    - Provide your thoughts on if/how teacher training could be improved with respects to using ICT tools and strategies to better engaged students' learning in PE lessons?
    - Describe your interactions with different people and their influence on your ability to use ICT tools and strategies in teaching PE?
      - Teachers from other schools
      - Colleagues in schools
      - Administrators
  - d. Closing Questions:
    - In summary, can you provide a final comment that encompasses your perspective on the use of ICT tools and strategies in teaching PE lessons?
    - Anything we haven't discussed that you would like to add?

### **Questions for Students:**

The purpose of the interview is to investigate students' perspectives of ICT-based PE lessons in facilitating their learning.

### **Perspectives on PE:**

- How important would you say PE is in your life?
- What do you like most about PE?
- What do you like least about PE?

### **Benefits of ICT-based Lessons**

1. You have experienced ICT-based PE lessons and regular face-to-face PE lessons.
  - a. Can you tell me which approach you liked the most? Why?
  - b. Can you provide me with some examples of why one type of lesson was more enjoyable than the other?
2. If I ask you to compare ICT-based PE lessons and regular face-to-face PE lessons, from which one would you say you learned the most?
  - a. If ICT: In what ways? Give some examples.
  - b. If regular: In what ways? Give some examples.
3. In your opinion, how can the ICT materials and lessons be further improved to make learning more interesting and engaging? Please give examples and state reasons.
4. In your opinion, how do ICT-based lessons engage you in learning?
  - a. Does the ICT material help you better execute the movements and techniques taught in PE lessons (psychomotor)?
  - b. Does the ICT material help you better understand how/why to execute the movements and techniques taught in PE lessons (cognitive)?
  - c. Does the ICT material help you further connect with and relate to teachers and peers during PE lessons (affective)?

### **Challenges Faced**

5. Did you experience any difficulties or challenges during PE lessons delivered by teachers who used ICT material?
  - a. If yes, how did these challenges affect you and your learning? Give some examples.
  - b. If yes, moving forward, in your opinion, what could be done to reduce the challenges faced and equip teachers to use ICT material in ways that benefit you and your learning? Give some examples and state reasons.

### **The Role of the PE teacher:**



6. Can you describe the things you like about your current PE teacher?
7. Is there anything you dislike about your current PE teacher? If yes, provide examples?
8. Can you explain what your PE teacher does to engage you in learning the subject of PE?
9. Can you explain what kind of skills and knowledge you have learned from your PE teacher? Describe how and in what ways with examples.
10. In your opinion, do you think the role of PE teachers changes during ICT-based lessons compared to the regular face-to-face lessons? If yes, in what ways? Give examples.
11. How do you use the skills and knowledge you have learned in PE in other settings, such as at school, home, or with your friends?

#### **Concluding Questions**

12. Sum up the key points mentioned and discussed during the interview, and ask the participant whether he/she has any further comments to make?

#### **APPENDIX C**

TABLE 1

| <b>RQ 2: What are the best practices employed by PE teachers in using ICT tools and reasons for using them?</b> |   |
|---|---|
| Use of variety of ICT tools to enhance teaching of PE and assessment  | <b>Applications (n = 17)</b><br><br>Plickers (n = 5); Sworkit Kids (n = 1); Whatsapp (n = 1); Google form (n = 3); Running app (n = 1); Video Assist tool (n = 1); Edmondo (n = 1); Dojo (n = 1); See Saw (n = 1); iMovie (n = 1); Thrill Shutter (n = 1) |
|   | <b>IPads and Tablets (n = 11 )</b>  |
|   | <b>Others (n = 4)</b><br>Go Pro (n = 1); Apple TV (n = 1); mobile phone devices (n = 2); mobile projector (n = 1)   |
| <i>Note-worthy approaches to using ICT in PE lessons</i>  | Enhancing learning by providing visual and verbal feedback for assessment and performance (n = 12)  |
|   | Providing ample space and time for establishing routine in introducing ICT use (n = 7 )   |
|   | Using ICT in resourceful and innovative ways to improve teaching and learning (n = 6 )  |

TABLE 2

| <b>RQ 3: What are the benefits and challenges perceived by PE teachers and their students during ICT-based PE lessons?</b> |
|--|
| <b>BENEFITS</b>  |
| <b>For teachers and students</b>   |
| Evidence for Feedback and Reference for Learning (n = 15)  |
| Promotes Engagement and Self-Directed Learning (n=11)  |
| Promotes Collaborative and Social Learning (n = 11)  |
| Efficiency in teaching and learning (n =7)   |
| Enhancement of cognitive and affective learning (n =7)   |

| <b>CHALLENGES</b>  |  |
|--|--|
| <i><b>For both teachers and students</b></i>   | <i><b>For students</b></i>   |
| Technical difficulty (connectivity and software-related difficulties) ( <i>n</i> = 16)     | ICT can be an inhibitor of social interactions in class ( <i>n</i> = 5)                  |
| Reduced physical activity time/less outdoor opportunities ( <i>n</i> = 12)                 | <i><b>For teachers</b></i>   |
| Students' Buy-In (preference for non-ICT lessons /traditional PE lessons) ( <i>n</i> = 8 ) | Students' differentiated skills and level of comfort in using technology ( <i>n</i> = 3) |
| Perceived inconveniences of using ICT ( <i>n</i> =8)                                       | Level of buy-in of fellow teachers ( <i>n</i> = 3)                                       |
|  | Preparation of Lesson Design ( <i>n</i> = 2)   |

TABLE 3

| RQ 4: What are the recommendations by PE teachers and their students to better promote and support ICT-based lessons to enhance teaching and learning? |  |
|--|--|
| <i><b>Students</b></i>   | <i><b>Teachers</b></i>   |
| Increase variety of ICT tools and activities ( <i>n</i> = 5)   | Sustained buy-in and commitment on the part of teachers and school leaders ( <i>n</i> = 6) |
| Lessen Technical Problems ( <i>n</i> = 3)  | Need for Formal training ( <i>n</i> = 4)   |
| Balance between the use of ICT and traditional PE lessons ( <i>n</i> = 3)  | Need for Community sharing ( <i>n</i> = 3)   |
|  | Continuous improvement and effort by teacher on ICT lesson design ( <i>n</i> = 2)          |