【附件三】**教育部教學實踐研究計畫成果報告格式(系統端上傳 PDF 檔)**

教育部教學實踐研究計畫成果報告

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計畫主持人：林國欽

共同主持人：陳年興

執行機構及系所：國立中山大學西灣學院運動與健康教育中心

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The learning effectiveness of an incorporative teaching method using cooperative learning strategy and badminton teaching system

一. 報告內文(Content)(請繳交 3 至 10 頁成果報告，不含封面、參考文獻、相關佐證附件與連結，檔案大小以 20mb 為限。)

1. 研究動機與目的(Research Motive and Purpose)

請描述所選擇研究議題的問題挑戰與背景、教學實務現場遇到之挑戰以及該議題的重要性與影響力。

1. Introduction

How to effectively enhance badminton skill learning has been quite an issue for instructors. In the typical and traditional badminton teaching, students learn how to play badminton through the instructor’s verbal instructions and body demonstrations at first, and then they will be grouped to practice. The instructor will guide the grouped learners and correct their erroneous movements and body positions according to the instructor’s observation by learners’ side so that physical education (PE) experience, known as traditional teaching method, can be directly gained by students.

However, there are some drawbacks in the traditional badminton teaching. First, students may feel at loss in learning. Since the entire learning is conducted by the instructor’s explanations and demonstrations, and students’ imitation, students may be confused about whether their movements and positions match the standard or not since there is no concrete and reliable comparison shown to the learners. Second, instructors are willing but unable to teach effectively. A badminton class in college usually is made of approximately 50 students and the entire class only lasts for one hundred minutes. Aside from the time for explanations and demonstrations, the rest of the class time distributed to every group of students is thus reduced. Moreover, it is nearly impossible to guide every student effectively in such a short period. It is a common problem occurring to many PE classes as Lan, Wang, and Chen (2010) and Lin, Huang, and Young. (2014) stated.

To sum up, there are two existing major problems in badminton classes: the inadequacy of the movement observation for students and the inefficiency of feedback provision from instructors. As a result, researchers have been engaged in incorporating technologies with PE to improve the effectiveness of learning and the efficiency of teaching.

In the past ten years, studies have proved that employment of technologies benefits the PE. From 2010 to 2012, online learning successfully helped learners improve the cognition of sport skills and rules through an e-learning platform (Huang, Chiu, Chin, Hsin & Yu, 2010). Basketball and table tennis skills and actions can be correctly obtained through the course with web-based multimedia (Papastergiou & Gerodimos, 2012) and the movements and techniques of table tennis are correctly acquired through a Moodle course with video recordings of world champion players’ performance (Zou, Liu, & Yang, 2012).

After 2012, more kinds of technologies were employed in teaching various sports, such as computer-aided systems, Inertial Measure Unit (IMU), tablets, Kinect, and other wearable technologies. These technologies were proved to be applicable and effective in PE (Chen, Li, Lin, &

Chang, 2015; Yang, Li, & Xu, 2017; Chang, Ho, Wang, & Lin, 2014; Lee et al., 2015; Kitagawa & Ogihara, 2016). Currently, some studies indicated that the employment of tablets could help learners perform better in table tennis, badminton, and swimming skill learning (Hung & Chen, 2016; Hung, Young, & Lin, 2017; Kretschman, 2017).

Nonetheless, the aforementioned technologies do not feature function error detection. Thus, researchers turned to Kinect, an interactive and responsive technology, to improve previous aforementioned inadequacy. Researchers used Kinect to developed different aided systems and games to enhance the teaching and learning, whose results showed Kinect indeed could be a useful agent in PE (Cassola et al., 2014; Chen et al., 2013; Huang, Kuo, & Lin, 2015; Lin, Yu, Chen, Chen, & Jang, 2016).

Despite the benefits the badminton system can bring, without a proper teaching strategy, badminton teaching and learning would not reach the best effectiveness. Many researchers have adopted cooperative learning strategy in PE, and they proved learners could obtain positive improvement through cooperative learning strategy (Dyson, 2001, 2002, 2003; Casey, Dyson & Campbell, 2009). Up to now, not many studies focused on incorporating technology and cooperative learning strategy in PE. Thus, this study tries to explore this domain in PE.

Specifically speaking, this study divided the classes into experimental group (EG) and control group (CG). Both two groups adopted cooperative learning strategy; however, EG incorporated tablets in addition to cooperative learning strategy while CG was conducted without any technologies. To explore the feasibility of the study, two badminton skills were focused, clear and smash, movements of which were more complex to be taught with traditional teaching method in a short time. Thus, the learning effectiveness of the adoption of the cooperative learning strategy and the wearable technology were focused in the present study, and two research hypotheses were proposed:

RH1: The learning effectiveness of students learning clear movement with the cooperative learning strategy and the badminton teaching system was significantly better than those learning only with cooperative learning strategy.

RH2: The learning effectiveness of students learning smash movement with the cooperative learning strategy and the badminton teaching system was significantly better than those learning only with cooperative learning strategy.

2. 文獻探討(Literature Review)

請針對本教學實踐研究計畫主題進行國內外相關文獻、研究情況與發展或實作案例等之評析。

2. Literature Review

2.1 Cooperative learning strategy on PE

Prior to 2000, Slavin (1996) had addressed the cooperative learning strategy composed of motivational, social cohesive, cognitive, and developmental perspectives, based on his former research. With regard to cooperative learning strategy, the core value of the strategy is to provide students with a grouped and interactive learning opportunity. After 2000, Dyson (2001, 2002, 2003) published three significant studies and broadened the scope of the strategy. First, he clarified the goals, benefits, and implantation of cooperative learning strategy. Next, the teachers' perspective and students' responses to the strategy were explored and examined. The third one was to testify the implantation of cooperative learning strategy in the real teaching situation. With Dyson's three studies, the knowledge and application grew solid and served as the foundation for the later research.

However, whether the cooperative learning strategy was a suitable strategy needed more discussion and verification. Hannon and Ratliff (2004) extended the ideas of Dyson and employed them in three tasks: Exercise Task Cards, Steps and Reps Challenge, and Pedometer Graphing. Every task required students to work in pair to accomplish the appointed goals. The results proved the cooperative learning strategy was beneficial to students and increased the enjoyment of physical education. Speaking of the engagement along with the learning, Gillies (2004) looked into the effect of cooperative learning strategy and engagement of junior high school students. Gillies found the structured group students outperformed the unstructured ones and the results showed the students in the structured group displayed more commitment and willingness to help the fellow students than those in the unstructured one.

All of the aforementioned studies discussed the benefits that student-centered cooperative learning strategy, and they proved the feasibility of the proposed strategy. However, compared to the student-centered cooperative learning strategy, the teacher-centered teaching strategy was equally worth investigation and clarification. As a result, Iserbyt, Madou, Vergauwen, and Behets (2011) carried out a study which compared the effectiveness centering on students and that centering on teacher. This study examined the effects of peer meditated instruction on the acquisition of Tennis. The present study featured five main purposes: First, it examined the effects of task cards using in cooperative learning. Second, it investigated different spectrum of teaching styles by comparing teacher-centered and student-centered instruction approaches. Third, it examined how specific tennis knowledge was acquired in the two teaching experimental approaches. Fourth, it hypothesized that the learning effects of teacher-centered instruction was similar to those of student-centered ones. Last, due to the barrier of time necessary to instruct students of peer mediated instruction, the study would go through a number of inherent process variables in the two experimental conditions. The results with regard to the five purposes were prominent. Particularly, the hypothesis of teaching effects of student-centered instruction being similar to those of teacher-centered ones indicated the cooperative learning strategy (peer mediated instruction) was another feasible and useful pedagogical method.

Nonetheless, the implementation of cooperative learning strategy usually required more time than general physical education, and it became a primary issue that many researchers centered on. Barret (2005) employed Academic Learning Time in Physical Education (ALT-PE) to measure how time was spent by students and investigated the pedagogical strategy deeper by treating the effectiveness of cooperative learning as an independent variable on the context of physical education. Moreover, the single-subject reversal design, ABAB and PACER were employed to examine the effects of the cooperative learning on the categories of the ALT-PE. The result showed that the proposed teaching strategy was effective and adoptable to physical education.

Even though the cooperative learning strategy emerged quite early and a great number of scholars have committed to its development and have made much contribution, more and more researchers dedicating to researching the proposed learning strategy in recent years. To verify the cooperative learning strategy, Caesy and Goodyear (2015) made a complete and comprehensive review to trace the development of such learning strategy. Moreover, they also explored the empirical research in the use of the proposed teaching strategy over the four achievement of learning domain: physical, cognitive, social, and affective domains, the result showed there were prominent outcomes in the physical, cognitive, and social domains. However, more research was needed in the affective domain. Caesy and Goodyear pointed out the benefits of the cooperative learning strategy, and that further studies should be conducted on what would happen beyond the initial unit of instruction.

Based on the advantages that previous studies have indicated, the present study adopted the proposed learning strategy in the first 30 minutes of every week in the experiment. The purpose of which aimed to increase the student's badminton movement cognition by means of a grouped and interactive learning operation.

2.2 Literature on Utilization of Mobile devices in PE

In addition to strategy, the learning interface also plays an important role to enhance students' learning performance. Mobile devices have been started to be incorporated into research to provide learning information and feedback to increase students' cognition (Hung & Young, 2015; Hutchison & Beschorner, 2015; Vogel, Spikol, Kurti, & Milrad, 2010). Chen, Hsieh, Huang and Wu (2017) developed a learning mode through the use of an instant messenger, Line, on mobile devices with flipped learning to test whether students English oral proficiency is lifted or not. Another study used mobile devices to improve language learning based on the ubiquity and interactiveness of WeChat as well as the community of inquiry (CoI) in semi-synchronous language exchange (Wang, Fang, Han, & Chen, 2016). The study featuring mobile devices with Line and WeChat was proven to be feasible development in education.

In PE, there have been studies using mobile devices currently. Crawford and Fitzpatrick (2015) reviewed the literature about technologies assisting PE before 2010, pointing out despite of the inconvenience and immaturity of technologies, these studies all implied technology and created opportunities to improve teaching approaches and make contribution in education.

With the advancement of technologies, many mobile devices have been invented. Among them, tablet computers have better potential in authentic teaching. Lin, Hung and Young (2014) utilized iPad to improve the badminton skill learning by videotaping students' badminton performances to make comparisons with professional players. Student could obtain the differences from the comparative videos on the iPad to adjust their movements successfully. Hung, Young, & Lin (2018) took advantage of intuitive operation of iPad to develop the WISER model, and proved it could enhance students' badminton skills and motivation. In the research on table tennis, tablet computers were integrated with metacognitive strategy to optimize table tennis learning, whose result was significant (Hung & Chen, 2016).

The aforementioned studies characterized videotaping as the main method, by which students could review their movements through the video and instructor could utilize the video to correct students' weakness. Thus, it can be concluded that whether or not a student could review their learning process in person is a key factor in enhance learning effectiveness. Such perspective is consistent with the previous study that video could provide feedbacks and serve as a learning agent for students self-assessment (Potdevin et al., 2018).

In the light of this perspective, this study incorporated cooperative learning strategy with tablet computers in the first thirty minutes of every class, the purpose of which was that students could instruct and receive feedbacks from the teammates by referring to the video on tablet computers under the cooperative learning environment.

2.3 Related research using the detection sensor technologies

In addition to mobile devices, the detection sensors also have been incorporated in PE field, including Kinect, IMU, and Myo armband. Kinect features movement capture, voice recording, face recognition, etc. (Zhang, 2012). IMU contains a three-axis accelerometer, a three-axis gyroscope, and a three-axis magnetometer, which enables users to accurately detect their movement trajectories and directions. Myo armband, equipped with IMU, has eight sensors to capture EMG data from users' forearm activities, which is helpful when recognizing and classifying hand gestures (Abreu, Teixeira, Figueiredo, & Teichrieb, 2016).

So far, there have been three studies developing Kinect-based systems on three types of sports, yoga, golf, and badminton. Chen et al. (2013) proposed a Yoga self-training system, YogaST, employing Kinect, to observe the practitioners' postures and provide a visualized feedback of posture rectification so that the practitioner could have a picture of how to improve his/her postures, and it demonstrated that this system helped practitioners perform asanas (static physical postures) correctly and keep themselves away from injuries due to incorrect postures. Huang et al. (2014) presented a golf analysis system incorporating Will balance board and Kinect sensors for novices to spot their common swing mistakes, and it reached a high accuracy over 80%. Tan and Ting (2017) also developed a system using Kinect sensors to detect the movement of badminton. The system quantified the movements and it assisted the coach in knowing to what extent the mistakes were serious done by learners.

In the application of IMU, this device has been widely discussed in terms of measuring the movement trajectories of foot. Chang et al. (2014) used IMU to calculate the body rotation kinematics parameters with MATLAB software, which indicated that the torso kinematics parameters could be measured accurately through IMU. Lee et al. (2016) used IMU to observe movements of low limbs. Three types of locomotions were examined (e.g., running, jumping, and walking) through installing an IMU on the shoes, and the acceleration, foot angular velocity variations and the curve variations were tested at two different intensities (high and low). The result showed that uniaxial acceleration and/or the angular velocity variation were helpful when detecting locomotion intensities, and different locomotion modes could be distinguished by the uniaxial angular velocity curve. Kitagawa and Ogihara (2016) measured the foot trajectory of people walking by placing IMU, consisting of a tri-axial gyroscope for observing human gaits with data of acceleration and angular velocity, onto their foot. The result showed the estimated and reference foot trajectories were in good agreement, indicating the accuracy of IMU was significantly high.

Most of the past studies placed the focus on movement detection. Nevertheless, some research required IMU and EMG to detect the movement and stiffness at the same time. As a result, in 2013, Thalmic Labs released Myo armband in which IMU and EMG were built in order to reach higher accuracy of movement capturing (Abreu, et al., 2016).

Yang et al. (2016) utilized a robotic teaching interface to help the tutee with his writing skills through a human-robot-human data processing, feedback of force and stiffness of the tutor, while the tutor wore the Myo armband featuring IMU and EMG. The result showed that with Myo, the learning performance of the tutee was significantly positive when such demonstration techniques were applied. Kutafina et al. (2016) utilized forearm EMG to detect and analyzed human hand motions and applied it on hand hygiene training. The error rate was significantly low and indicated that the Myo armband with EMG and IMU could be incorporated into skill learning.

Each technology product mentioned above has its own characteristics. Since Myo armband offered the convenience to wear when learners were carrying out swings, the interference that wearable devices might bring could be greatly reduced. Therefore, with that strength, the present study developed a badminton teaching system using IMU on Myo armband to detect forearm movements of learners and provide objective information in badminton learning.

3. 研究方法(Research Methodology)

可包含實驗場域、研究對象、研究架構、資料蒐集方法與工具與分析方法等項目，但不限於列舉內容。

3. Method

2.1 Participants

This study involved two classes of Sports & Health: Basic Badminton in college, and one of which was the experimental group (EG) with 46 participants, and the other was the control group (CG) with 50. Both two classes had to learn clear and smash at the same time in the experiment period. Moreover, through the eight weeks of experiment, in clear, there were 45 participant of the EG and 46 of the CG completing the trial. In smash, there were 46 participant of the EG and 47 of the CG finishing the trial. In order to meet academic ethics, the researchers had acquired the approval from the Research Ethics Review Committee at National Tsing Hua University before the experiment started. In the first week of the course, the students were informed that they were the participants of this study. The letters of consent were also distributed to students to sign up. If any students would like to withdraw from the experiment, he/she had the absolute right to do so, and his/her withdrawal would not affect the grading and right of learning for this course.

2.2 Experimental Procedure

This study conducted two trials, one of which was clear, the other was smash. The whole experimental procedure is shown in figure 1. In the first week, all the participants needed to learn how to wear the Myo armband, and connected it to the Badminton teaching system, and then the pre-test was conducted. From the second to ninth week, also the teaching experiment phase, the students in EG were instructed and then practiced with cooperative learning strategy using tablet computers in the first 30 minutes of every class. In the later 70 minutes, EG adopted Badminton teaching system to learn the two skills; on the contrary, no tablet was utilized in CG in the first 30 minutes, and traditional teaching method was adopted in the later 70 minutes. In the final week, the students had to take the post-test and the researchers collected the information for the later analysis.

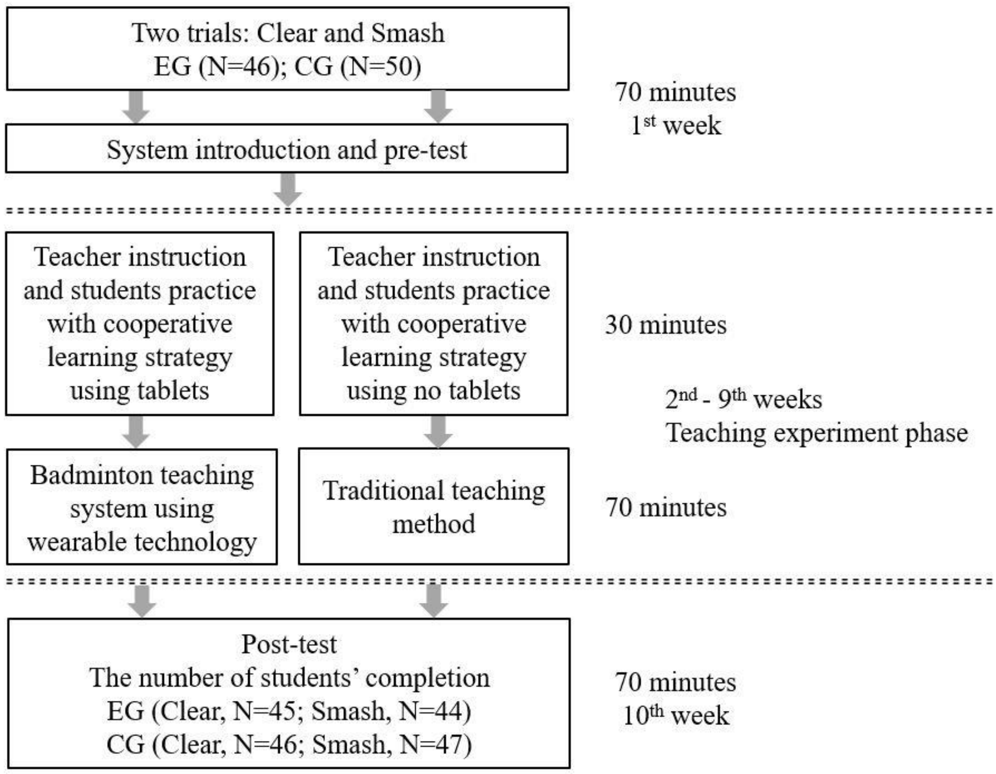

Figure 1. The entire experimental procedure

In the teaching experiment phase, the teaching content in the first 30 minutes was the same in the two groups, and both groups adopted cooperative learning strategy. To operate this strategy, the researcher divided the students into separate 6 teams of 8 or 9 students according to the scores obtained in the pre-test. The first team was made of the students who were the first four students at the top 50% and those who were the last four in the bottom 50%, and so on for the rest of the teams. Every class could be divided into 6 teams in total. EG and CG students have to note down the process of cooperative learning in cooperative learning sheets. With cooperative learning strategy, students with better ability (top 50%) in both EG and CG would guide those who had lower performances (bottom 50%). The striking difference in both groups was that EG also adopted tablets to aid the cooperative learning strategy. Students in EG could film and instruct each other by means of the instant videotaping, in/out zooming function, and replaying as a reference to boost smash and clear skills (as shown in Figure 2 and 3), but students in CG could only use visual observation, verbal reminding, and physical demonstration to instruct each other (as shown in Figure 4). Whichever approach was adopted, the ultimate goal was to help students either at the top 50% or the bottom 50% to have significant progress.

Figure 2 Cooperative learning of EG – videotape

Figure 3 Cooperative learning of EG – replay

Figure 4 Cooperative learning of CG – physical demonstration

In the later 70 minutes, EG students needed to put on Myo on their forearms of the dominant hands and research assistants would check the connection of Myo to the teaching system in the laptop set beside the badminton court. After Myo were ready on their forearms, students should enter the badminton court to carry out the designated movements and their movements were videotaped and graded instantly by the teaching system. Next, students would be off the court to the laptop and the teacher would give feedbacks according to the automatic grading and the videotaping from the teaching system (as shown in Figure 5). Should students still remain unclear about their errors, they could refer to comparative videos of expert players in the teaching system to rectify their movements. After the abovementioned steps, the students would return to the court and continue their practice.

Figure 5 Teacher’s feedback of EG

In contrast, CG students entered the court directly and performed the designated movements without teaching system. The teacher would give feedbacks according to his observations of students’ performances. If students were still confused, the teacher would demonstrate the correct movement again in person (as shown in Figure 6), and students could better the movement by imitating it. After the previous steps, the students went back to the court and went on the practice.

Figure 6 Teacher’s feedback of CG

The striking difference between the EG and CG was that the EG students could learn with videotaping and watch themselves through the footage from tablets and the teaching system. However, the CG students could only fellow instructor’s verbal explanation and physical demonstration. This study tried to explore what the benefits of learning with technology are and how much effects it could bring to PE.

2.3 Instruments

2.3.1 Badminton Teaching System

This study employed the badminton teaching system proposed by Lin et al. (2018). The system was programmed by language C# and WEKA to process the information of players' forearms. Then, back propagation neural network was introduced to train and verify the system. A student's performances was videotaped by the instant recording function of the system, and the footage would be processed in the system to be compared by the instant comparison function. The comparative database was constructed with four expert players in Taiwan; as a result, the system had high validity. After comparing, the system would produce the percentage of similarity for students as a reference.

The badminton teaching system was proved valid in recognizing and calculating backhand drive and smash (Lin et al., 2018), which served as the research ground for this study to further verify the feasibility of another difficult badminton skill - clear. The present study looked into the application of the system by examining clear and smash, and the high Kappa accuracy was acquired: clear: .90 and smash: .89. The accuracy of the two skills assured the applicability of the badminton teaching system.

Besides, the performance of learners was analyzed by the badminton teaching system proposed in the present study and presented with the combination of radar chart and similarity score. To obtain the reference data, four expert players were invited to put on Myo armband to perform clear and smash for 15 times respectively. With Myo armband recording the gyroscope signals of IMU, through looking at twists and turns of which, every skill was then divided into four sub-motions, and each sub-motion scored from 0 to 100. Other than that, because of swinging principal of clear and smash, all sub-motions should be completed in the sequential order from sub-motion 1 to sub-motion 4. In order to assure that learners perform the movements accurately, the teaching system was designed to start analyzing the next sub-motion only if the learner had reached at least 50 points in the last sub-motion; otherwise, the system would not execute anymore further analysis. For instance, if the learner was scored over 50 points in sub-motion 1, then the system would analyze sub-motion 2 automatically and so forth. Eventually, the performance of learners was scored by the teaching system on the basis of swinging principal, and the mean of four sub-motions for each learner were used for later analysis after collection.

2.3.2 Cooperative learning sheet

Cooperative learning sheets were distributed to every student after students were divided into groups with cooperative learning strategy, and they needed to note down their interactions with other students, including instructions and discussion. All of learning records in the cooperative learning sheets were examined with the triangulation to ensure the objectivity of examination so that higher validity could be achieved.

2.4 Data Analysis

This study used quantitative and qualitative analyses. In terms of quantitative analysis, paired-sample t test was first adopted to test whether the two groups progressed significantly. If there was significant difference, this study would continue to use ANCOVA to examine if there was significant difference between EG and CG. Before conducting ANCOVA, this study had to carry out a homogeneity test taking the scores of the pre-test as the covariate (X) and those of teaching method (Y) as the dependable variable to examine if the slopes were equal. If the slopes of X and Y were equal, then ANCOVA could be continued for the further analysis.

In qualitative analysis, this study adopted content analysis to analyze how students in EG and CG learned by helping each other with the cooperative learning sheets to improve their cognition of correct movements through the cooperative learning strategy.

4. 教學暨研究成果(Teaching and Research Outcomes)

(1) 教學過程與成果

4. Result

4.1 The Analysis of Learning Effectiveness of CG and EG

This study first examined whether the adoption of different teaching methods led to better learning effectiveness. The research results indicated whichever teaching method was adopted in clear and smash learning processes, the post-test scores of the two groups were better than the pre-test scores (as shown in Table 1). Particularly, the post-test scores of EG was better than those of CG. In order to explore the effects brought about by different teaching method, this study employed ANCOVA to analyze the learning differences of students in the two groups.

Table 1

Results of paired-samples *t* test of clear and smash learning between the pre-test and post-test.

Groups	Skill	Pre-test		Post-test		*t* value	*p*
		M	SD	M	SD		
CG	Clear	23.72	16.44	54.76	22.47	9.28	$.000^{***}$
	Smash	29.41	22.35	72.22	16.69	9.97	$.000^{***}$
EG	Clear	16.10	9.97	69.45	23.91	13.89	$.000^{***}$
	Smash	24.27	21.44	82.77	13.10	15.24	$.000^{***}$

$^{***}p < .001$

4.2 The Analysis Outcome of Clear

After the homogeneity test was conducted with ANCOVA, there was no significant difference shown between the interaction of the covariate and the dependable variable (p = .27). Thus, ANCOVA was adopted for the later analysis. The results of ANCOVA showed that the score of the pre-test posed effects on that of the post-test. When the effect of the pre-test score was deducted from the post-test, the significant difference would be shown between EG and CG (p < .01) as shown in the Table 2.

After adjustment was made to the marginal means of the two groups, the marginal mean of EG was 70.85, and that of CG was 53.39. The results revealed that the teaching in EG using the cooperative learning strategy and the badminton teaching system posed significant and positive effects on learning. The line charts of the learners' pre-test and post-test are shown in Figure 7.

Table 2

Analysis of covariance for clear scores

Source	**SS**	**DF**	**MS**	***F***	***p***	**Partial η^2**
Pre-test scores (clear)	2188.63	1	2188.63	4.22	.043*	.05
Group	6424.75	1	6424.75	12.38	.001**	.12
Error	45684.08	88	519.14			

*$p < .05^{*}$; $p < .01^{**}$

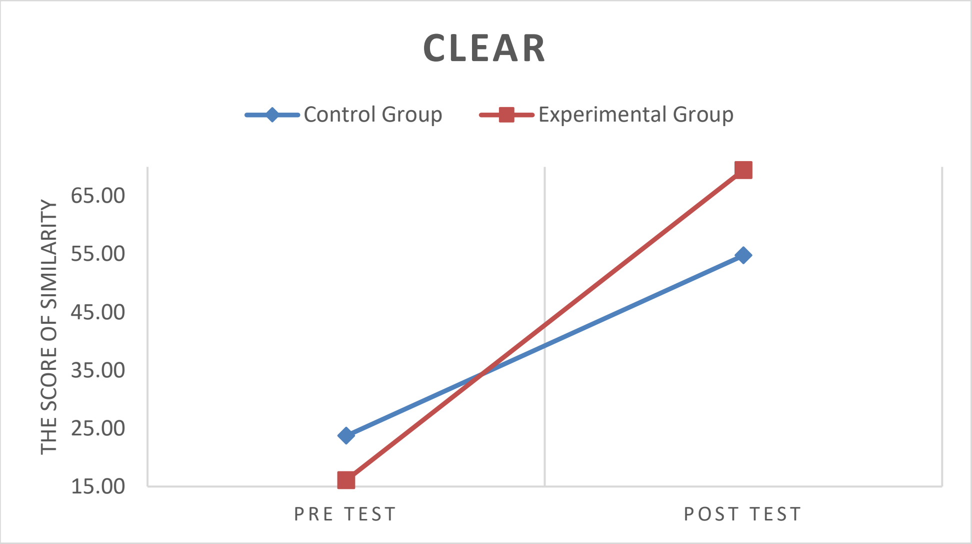

Figure 7. The clear movement performance

4.3 The analysis outcome of smash

ANCOVA was also used to test the homogeneity, and there was also no significant difference between the covariate and the dependable variable (p = .63). As a result, ANCOVA could be used to carry out the ensuing steps. However, after ANCOVA analysis, the score of the pre-test did not cause any effect on the score of the post-test, and thus this study turned to independent sample t test (Table 3) for further analysis. Then, under the assumption that the variance was equal, the p value was .001, the result showed significant difference between EG and CG in the post-test, and the score of EG was significantly higher than that of CG. The line charts of the learners' pre-test and post-test are shown in Figure 8.

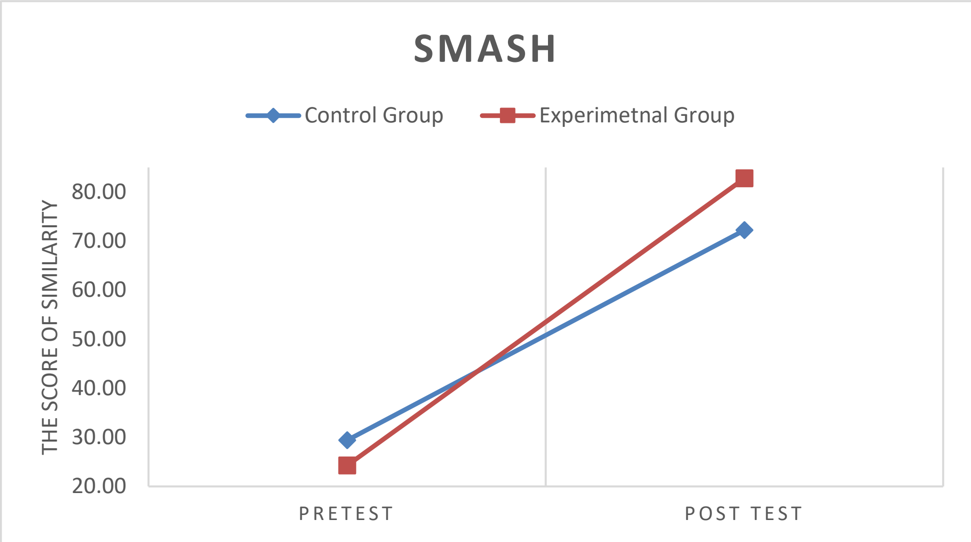

Figure 8. The smash movement performance

Table 3
Independent sample *t* test for smash scores

Construct	t	DF	*p*	Partial η2
	3.34	89	.001**	.11

p < .01**

(2) 教師教學反思

In traditional PE class, students might be confused about the teacher's verbal explanation and physical demonstration. To solve students' confusion and to elevate the learning effectiveness, in the present study, cooperative learning strategy was introduced with tablets in the first 30 minutes in EG, whereas CG only adopted cooperative learning strategy without any technologies. For the following 70 minutes, the badminton teaching system was employed in EG to detect movements of students, which provided the teacher with objective information to offer instant feedbacks; however, instant feedbacks in CG were given only through the demonstration and verbal instruction of the teacher.

According to Table 1 and 2, the results showed that no matter it was clear or smash, EG or CG, the performance of protests were significantly better than pretests. This study indicated that progresses could be clearly seen when cooperative learning strategy applied, and it supported previous research regarding cooperative learning strategy (Hannon & Ratliff, 2004; Barret, 2005; Cheng, Chiu & Tseng, 2014; Cheng, 2008). In addition, the wrong movements could be easily corrected at once for students in EG due to tablets providing the visualized reference (instant videoing), and it did reinforce the cognition of movements of students. Nevertheless, though most mistakes made by students in CG could be corrected, some students, according to the learning sheet, spent more time on improving their movements without the visualized reference. The result showed that whether the visualized reference applied was the key of the elevation of badminton skill learning efficiency, and it was in a good agreement with previous studies about mobile device (Hung, Young

& Lin, 2018; Hung & Chen, 2016; Potdevin et al., 2018).

In the later 70 minutes, this study employed the badminton teaching system developed by Lin et al. (2018) in order to correct students' movements. Different from the in the first 30 minutes, the badminton teaching system featured three characteristics. First, the system could precisely indicate the similarity scores compared with the performances done by expert players, which was extremely helpful for the teacher to initially understand which of sub-motions that should be improved. Second, the system could present and replay the footage of practice process to students so that the teacher was able to utilize this function to explain and illustrate the movement comparison in details, and students could understand what mistakes they made. Last, the comparative videos of expert players could be used for the instantaneous feedbacks by the teacher if students still had further problems with their movements. The three abovementioned characteristics could efficiently solve the problem that teachers were not able to provide students with precise and objective advice in the traditional PE teaching method.

The study results regarding the use of wearable technology also echoed the previous studies, in which the wearable technology, Myo armband, was proved to effectively provide objective information to the leaners in the pottery fabrication and the hand hygiene (Bernal et al., 2015; Kutafina, Laukamp, Bettermann, Schroeder, & Jonas, 2016). Also, it indicated Myo armband was a highly useful sensor to assist people in learning any motor skills involving forearms.

After the 100 minutes of teaching, this study found the traditional teaching method along with cooperative learning strategy was effective enough to enhance student's learning. However, if technology could be properly infused into teaching, it may play a significant role in improving students' learning. The present study employed tablets to elevate student's cognition of movements at the first stage. Next, at the second stage, the badminton teaching system was set to clarify students' blind spots about correct movements. This study proved that under the frame of traditional PE teaching, with the technology which helped them examine their learning, students' learning effectiveness of complex skills could be greatly enhanced

(3) 學生學習回饋

本教學實踐計畫，為有效評估在合作學習策略的基本架構下，實驗組有科技（平板電腦與教學系統）的輔助，與控制組無任何科技的輔助下，學習成效是否有所差異。整體上，因為研究者每週都會對學生進行一對一回饋，在回饋過程感受到兩組學生的學習態度都非常好，但在實驗組，學生都很期待教學系統的評分，對於系統的評分結果，學生的回饋是滿認同系統能客觀地顯示學習成果。這部分著實給研究者很大的信心。亦即，學生可以感受到研究者為了更有效率地提高學習成效，發展了可以偵測錯誤動作的教學系統，並努力透過這些客觀資訊，試圖讓學生更了解複雜的羽球高遠球與殺球動作如何操作，而這些回饋也為研究者未來在開發其他教學輔助系統時，提供了很好的發展基礎。

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三. 附件(Appendix)

與本研究計畫相關之研究成果資料，可補充於附件，如學生評量工具、訪談問題等等。