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Non-resuscitative first aid training and assessment for junior secondary school students
A pre-post study

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Abstract

School-based first aid interventions can contribute to the number of adults trained in first aid in the community over time but few studies have examined the effectiveness of teaching non-resuscitative first aid on knowledge, attitudes and skills. Currently, there is no consensus on the optimal content and duration of first aid training for junior secondary students. The aim of this study was to evaluated the effectiveness of a 2.5 hour introductory non-resuscitative first aid course for junior secondary students.

This prospective, single-centre, pre-post study included 140 students (11–13 years old). Students completed a questionnaire on first aid knowledge, attitude towards first aid and self-confidence to perform first aid before and after a training session. Six emergency medicine physicians taught practical first aid skills training. A game-based formative assessment was undertaken where the instructors assessed small teams of students' role-playing injured classmates and first aid responders (and vice-versa) treating abrasions, ankle sprain, choking and a scald injury.

Few students had prior first aid training (14%). After adjusting for student's age, sex, prior first aid training and format delivery, the course was associated with increased mean knowledge score (pre-training 53%, post-training 88%; mean difference [MD] 35%, 95% CI: 32% to 38%), positive attitudes and more confidence in performing first aid after training (all $P < .001$). All teams showed a good level of competency in treating simulated injuries with first aid kits.

This brief non-resuscitative first aid course was associated with noticeable and valuable changes in knowledge score and self-confidence level in performing first aid. The game-based formative assessment facilitated a positive learning environment for skill competency evaluation.

Abbreviations: HKRC = Hong Kong Red Cross, IQR = interquartile range.

Keywords: adolescents, attitudes, experimental game, first aid, health knowledge, practice

1. Introduction

Unintentional injury is the leading cause of death among adolescents worldwide.[1] Many bystanders (44%) are unable to correctly apply pressure dressing to a wound to control for bleeding.[2] This may be due to inadequate first aid knowledge, unwillingness to perform first aid and a lack of confidence to perform first aid. In Hong Kong, less than half of all adults knew how to correctly manage common injuries, such as bleeding,

choking, poisoning, scalds and jellyfish sting.[3] Therefore, the Hong Kong Red Cross (HKRC) recommended that first aid knowledge be compulsory in the senior secondary school curriculum.[3]

School-based first aid interventions can significantly contribute to the number of adults trained in first aid in the community over time.[4,5] Students will also be more confident and more likely to provide first aid and cardiopulmonary resuscitation to a victim promptly if they have been trained in first aid.[4,5] While most school-based first aid programs have taught resuscitation alone, few studies have examined the effectiveness of teaching non-resuscitative first aid knowledge and skills.[6]

Currently there is no consensus on the optimal content and duration of first aid training for junior secondary students. The educational goals of first aid training recommended by De Buck and colleagues[7] for junior secondary school include knowledge and skills in calling emergency number, choking, recovery positioning, wound and burn care, stopping bleeding and managing minor injury to bones, muscles or joints. In Hong Kong, a layman older than 15 years old can enroll in a basic non-resuscitative four-hour first aid course at the HKRC or be older than 8 years old to enroll in a 16-hour basic first aid course at St John Ambulance Association.

To address the limited availability of time in the school curriculum, we developed a 2.5-hour introductory non-resuscitative first aid course with a game-based formative assessment component for junior secondary students. The primary objective of the study was to evaluate the effectiveness of a single 2.5 hour introductory non-resuscitative first aid course on student's knowledge of, attitudes towards, and self-confidence level in performing first aid. The secondary objective of the study was to compare the performance of student team's application of knowledge and skills in responding to a game-based formative assessment (casualty case study scenario) by the mode of delivery

format (interactive cloud-based versus traditional paper-based) as the use of interactive cloud-based student response systems may improve students' motivation, participation, engagement and learning satisfaction.[8] The purpose of the study was to evaluate the effectiveness and feasibility of incorporating a brief non-resuscitative first aid course with a game-based formative assessment on first aid knowledge, attitudes and performance skills into a school curriculum.

2. Methods

2.1. Setting and participants

Approval for the project was obtained from The Chinese University of Hong Kong Survey and Behavioral Research Ethics Committee (SBRE-18–580) on May 8, 2019. Written informed consent from the school principal and parents were obtained before training. Students in their first year of secondary school were invited to participate in the study. Class teachers provided assistance in obtaining parental consent before the study and with data collection during the first aid training session. We conducted a prospective pre-post study on May 27, 2019 at a private coeducational international school in Hong Kong. The first aid training and formative assessment took place in 4 consecutive classrooms with flexible open plan learning spaces.

2.2. Instruments

Students completed an identical 14-item questionnaire immediately before and after the training session (Fig. 1). The written questions were adapted from the HKRC 15-item knowledge and attitude questionnaire[3] if the topic was included in the training session. The management of jellyfish sting and snake bite questions were therefore excluded as we expected a low
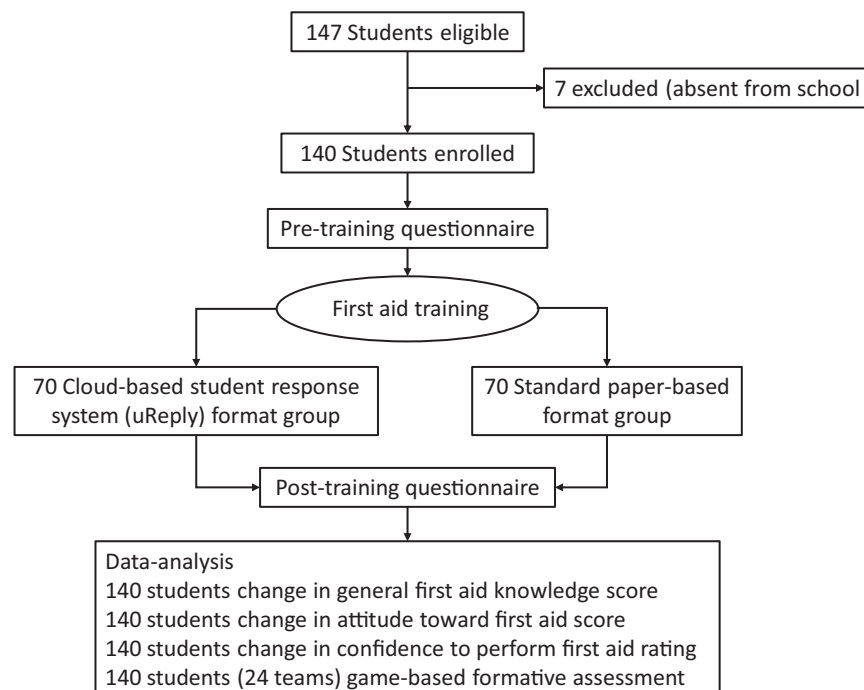

Figure 1. Student flow diagram.

likelihood of students coming across such events and due to training time constrains. The 15-item HKRC questionnaire was previously used in a 2011 telephone survey of 1003 randomly selected adults from the general population but the psychometric performance associated with the questionnaire has not been published.[3] Our bilingual questionnaire contained 8 multiple choice questions about general first aid knowledge, 5 statements with 5-item Likert scales about respondent's attitudes towards first aid and a self-reported confidence rating in performing first aid to a person in need using a visual numeric rating scale from 0 (not at all confident) to 10 (very confident). The passing mark for the knowledge test was set at 50%. We considered a 20% increase in knowledge score to be a noticeable and valuable change[9] associated with the training course. The responses to the 5 attitude statements were summated to give an overall attitude score, ranging from 5 to 25, with higher scores representing a more positive attitude towards first aid. No feedback about the questionnaire from instructors was given to the students after completing it. We also collected data on student's age, sex and previous first aid course attendance.

2.3. Intervention

The Head of Year (AS) conceived the idea of first aid training as part of a project-based learning "Health Week" module. Six emergency medicine physician instructors for the course were recruited. The students were trained in groups of 70 students per session, with a student-to-instructor ratio that did not exceed 13:1 (Fig. 1). The course contents were adapted from existing elementary first aid courses from local organizations and using evidence-based age-appropriate educational goals of first aid training in the school curricula.[7] The first 0.5-hour of the 2.5-hour training session covered the definition of first aid, objectives of first aid, principles of first aid and a standard first aid procedure using the Danger, Response, Airway, Breathing, Circulation, Disability, Exposure (D.R.A.B.C.D.E) approach.[10] This was followed by covering topics on the management of choking (20 minutes), bleeding (30 minutes), sprain and strain (15 minutes) and burns (15 minutes). We adopted a strategy of skill practice following a demonstration by the instructors, such as back blows, Heimlich manoeuvre, simple spiral bandaging and board arm sling. All students were given opportunities to practise each of these skills with each other under the supervision of their instructors. Each student was provided with a first aid kit that included 3 triangular bandages, 2 roller bandages, a piece of gauze and a pair of gloves.

After completing the first aid training (Fig. 1), students formed small groups (4 to 7 students/team) to compete with 1 another on responding to a case study scenario over 30 minutes (Table 1). The scenario was developed by one of the authors (CYY) and reviewed by other authors (YHC, KYS, HFK and AL) for content validity. The game-based formative assessment was designed to assess the team's performance on applying the acquired first aid knowledge and skills. Students (within their class) were free to discuss with other team members in deriving the correct responses. In the morning session, 12 teams answered an eight-item quiz using uReply (single-item session component), an interactive cloud-based student response system[11] on iPad devices. The other teams in the afternoon training session answered the same quiz using a paper-based format. The allocation of format delivery was class-based rather than student-based. The difference in format delivery was due to time constraints in moving teams together to complete the eight-item quiz and then breaking out into individual teams for performance skills assessments in the afternoon. For both sessions, the instructors assessed students' role play of injured classmates and first aid responders (and vice-versa) for treating all 4 injuries: knee abrasions with some bleeding, ankle sprain, choking and

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Table 1

Game-based casualty case study scenario for formative assessment.

Scenario

    You and your classmates are going camping in Sai Kung Country Park on a sunny day. Suddenly, one of your classmate sprains his ankle while hiking and falls down. He has abrasions with some bleeding to both knees. At lunch, another classmate chokes when eating a fish-ball. A third classmate accidentally pours boiling water onto his forearm, resulting in second degree scald (burn) injury. How would you respond?

Multiple choice questions (Choose best answer)	Responses (* correct answer)	
Q1. Which of the following is not an objective for first aid?	A. Confirm patient is dead*	B. Preserve life
	C. Prevent worsening of injuries	D. Promote recovery
Q2. What is the most important first step when performing first aid treatment?	A. Assess airway of patient	B. Count number of patients
	C. Assess scene safety*	D. Prepare first aid equipment
Q3. Which of the following injuries has the top priority to receive treatment?	A. Knees abrasion	B. Forearm scald injury
	C. Choking*	D. Sprained ankle
Q4. What is the most effective way to stop bleeding?	A. Indirect pressure	B. Direct pressure*
	C. Cover wound	D. Haemostatic powder
Q5. Cyanosis refers to the mouth and mucosa of patients turning into what colour?	A. Yellow	B. White
	C. Red	D. Blue*
Q6. Which of the following is not an ideal improvised dressing?	A. Clean bed sheet	B. Clean handkerchiefs
	C. Plastic bag*	D. Clean towels
Q7. Which of the following is not a correct management for ankle sprain?	A. Massage ankle*	B. Rest ankle
	C. Ice compression	D. Elevate ankle
Q8. Which of the following is an appropriate management for scald wound?	A. Puncture blister	B. Apply soy sauce onto wound
	C. Irrigate wound with plenty of running water*	D. Tear off clothing sticking on wound
Q9. Abrasions to knees		
Q10. Ankle sprain	Correct treatment (instructors mark Pass/Fail)	
Q11. Choking		Total score: _____/12
Q12. Scald injury		

scald injury, using the first aid kits provided. The total team score was out of 12 for both types of format delivery, with the winning teams declared after obtaining the highest scores.

2.4. Data analysis

No sample size calculation was performed as we used a convenient sample of students. The students' knowledge scores, attitude scores, self-confidence levels and overall team scores are reported as means and standard deviations or median and interquartile range (IQR) as appropriate after checking for normality by visual inspections and using the Shapiro–Wilk's tests. A nil response to knowledge questions was considered incorrect for the purpose of calculating an overall knowledge score if the students attempted the test. While drinking milk was the correct response to treating a person swallowing a caustic agent,[3] drinking milk or a having a mouthwash with clear water were acceptable responses when calculating the revised overall knowledge scores according to contemporary practice.[10] The McNemar's test was used to compare the overall knowledge passing rates over time. Missing data for estimating the overall attitude score was imputed by sample median but no imputation was carried out for missing responses to individual attitude statements. We used diverging stacked bar charts to visually compare the Likert scale responses[12] to the 5 attitude towards first aid statements between time periods. Generalized estimating equation models, with exchangeable correlations, were used to estimate the change over time for knowledge, attitude and self-confidence levels after adjusting for student's age, sex, previous first aid training and format delivery group.

Individual items in the game-based formative assessment were compared by mode of format delivery using Chi-Squared test or Fisher's exact test. The overall team scores between mode of format delivery groups were compared using a Mann–Whitney U test. SPSS version 24.0 (IBM Corp, Armonk, NY) software and Stata version 16.0 (StataCorp, College Station, TX) were used for data analyses. The level of significance was set at $P < .05$.

3. Results

3.1. Study population characteristics

Of the 147 eligible students, 140 (95.2%) students attended the first aid training session (Fig. 1). The median IQR age was 12 (11 to 12) years old and 69 (49.3%) were females. One student came late and did not complete the pre-training questionnaire and another student left early without completing the post-training questionnaire. Nineteen (13.7%) students had participated in prior first aid training. The format delivery groups were similar for age ($P = .60$), sex ($P = .13$) and prior first aid training ($P = .78$).

3.2. General first aid knowledge

The proportion of correct responses to individual multiple choice questions before and after training are shown in Table 2, along with the results of the HKRC survey[3] in adults for reference. Few students (13.1%) knew how to manage scalds before training. The before and after passing rates using the original HKRC knowledge marking criteria were 63.0% and 96.4% respectively; revised knowledge score passing rates before and after training were 72.5% and 97.1% respectively (Table 2). The difference in paired proportions of students passing the knowledge test over time was 32.8% (46/137 improvement and 1/137 decrement) and 24.0% (34/137 improvement and 1/137 decrement) using the original and revised marking criteria respectively (both $P < .001$). Using the original HKRC marking criteria, the course was associated with an increased mean knowledge score (pre-training 49%, post-training 78%; mean difference [MD] 29.0%, 95% CI: 26.1% to 31.9%; $P < .001$) after adjusting for student's age, sex, prior first aid training and format delivery group (Table 2). Similarly, using the revised marking criteria, the course was associated with an increased adjusted mean knowledge score (pre-training 53%, post-training 88%; MD 35.0%, 95% CI: 31.8% to 38.1%; $P < .001$) [Table 2].

3.3. Attitudes towards first aid

Over 85% of students agreed or strongly agreed with the need to learn first aid knowledge and over 75% agreed or strongly agreed that public education of first aid was essential, with higher proportions seen after training (Fig. 2). Approximately one-third of students strongly disagreed or disagreed that a medical professional was solely responsible to save a life and perform first aid at both time periods (Fig. 2). After training, 117 (85.4%) agreed or strongly agreed to performing first aid to people in need if they had adequate first aid knowledge and skills. After

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Table 2

Success rate (%) of correct responses to knowledge questions before and after first aid training.

Question	Before (%)	After (%)	HKRC survey[3] (%)
1. What will you do if there is foreign body (eg. sand) in your eye?	110/137 (80.3)	136/139 (97.8)	822/995 (82.6)
2. What will you do if you are scalded and a blister is formed?	18/137 (13.1)	97/138 (70.3)	433/985 (44.0)
3. What will you do to stop bleeding if your finger is cut by a knife?	78/138 (56.5)	119/139 (85.6)	483/996 (48.5)
4. What will you do to stop nose bleeding?	89/134 (66.4)	133/137 (97.1)	849/984 (86.3)
5. What will you do if your witnessed a person drinking caustic agent?	21/134 (15.7)*	7/139 (5.0)*	244/991 (24.6)
6. What will you do if you find a conscious but flushing and sweating victim under burning sun?	77/137 (56.2)	126/139 (90.6)	906/978 (92.6)
7. What will you do if someone suffered from choking while eating?	66/134 (48.5)	133/139 (95.7)	258/984 (26.2)
8. What will you do if you sprained your ankle?	82/135 (60.7)	116/139 (83.5)	636/992 (64.1)
Overall mean (SD) knowledge score (%)	49.0 (15.8)	78.0 (13.4)	Not reported
Adjusted mean (SD) knowledge score (%)	53.4 (16.4)†	88.3 (14.7)†	Not applicable

HKRC = Hong Kong Red Cross, SD = standard deviation.

* If drinking milk or mouthwash with clean water responses were considered acceptable, proportion of students with correct responses before and after training were 69/134 (51.1%) and 122/139 (87.8%) respectively; corresponding correct responses from HKRC Survey was 791/991 (79.8%).

† Taking revised correct responses to treatment of person drinking caustic agent (Question 5) into account.
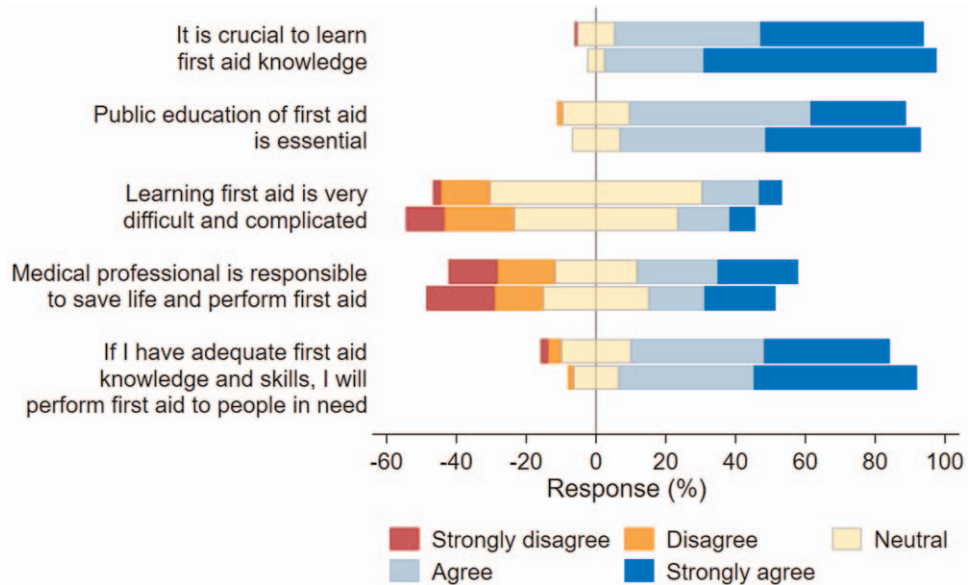
Figure 2. Likert scale responses to various attitude statements before (first row) and after (second row) training.

adjusting for student's age, sex, prior first aid training and format delivery group, the course was associated with a small increase in mean attitude score (pre-training 18.1, post-training 19.3; MD 1.3, 95% CI: 0.9–1.7; $P < .001$).

3.4. Self-confidence level to perform first aid

The mean (standard deviation) self-confidence level to perform first aid before and after training were 4.9 (2.3) and 7.0 (1.9), respectively. The course was associated with a higher self-confidence level in students (adjusted MD 2.2, 95% CI: 1.8–2.4; $P < .001$).

3.5. Game-based formative assessment

Irrespective of the mode of format delivery, all teams were able to prioritize which injuries to receive treatment first, define cyanosis, identify unsuitable improvised dressing and demonstrate how to treat knee abrasions (Table 3). All 24 teams completed 2 or more skills assessments satisfactorily. The median IQR team score was

higher in the uReply group (11.5, 10.3–12.0) compared with the paper-based format group (10.0, 9.3–11.0) ($P = .05$).

4. Discussion

This brief, single session, introductory non-resuscitative first aid course for junior secondary students was associated with increased students' knowledge scores, attitudes and self-confidence levels in performing first aid. Students were fully engaged with learning new practical skills for treating knee abrasions, ankle sprain, choking and scald injury, with a good level of competency achieved in the game-based formative assessments. Using uReply in the game-based formative assessments was associated with higher team scores than the paper-based format.

The baseline level of first aid knowledge in our students was poor, with two-thirds of students answering 4 of 8 questions correctly. Similar to a previous UK study in a similar age group of school children,[13] the correct responses to the appropriate management of choking and minor burns were the lowest before

Table 3

Team proportion of correct response (n, %) to game-based formative assessment by mode of format delivery.

Questions	uReply group (n=12)	Paper-based group (n=12)	P value
Q1. Which of the following is not an objective for first aid?	11 (91.7)	9 (75.0)	.47
Q2. What is the most important first step when performing first aid treatment?	10 (83.3)	9 (75.0)	.82
Q3. Which of the following injuries has the top priority to receive treatment?	12 (100)	12 (100)	NA
Q4. What is the most effective way to stop bleeding?	9 (75.0)	6 (50.0)	.45
Q5. Cyanosis refers to the mouth and mucosa of patients turning into what colour?	12 (100)	12 (100)	NA
Q6. Which of the following is not an ideal improvised dressing?	12 (100)	12 (100)	NA
Q7. Which of the following is not a correct management for ankle sprain?	9 (75.0)	10 (83.3)	>.99
Q8. Which of the following is an appropriate management for scald wound?	12 (100)	10 (83.3)	.34
Q9. Correct treatment of minor abrasions to knees*	12 (100)	12 (100)	NA
Q10. Correct treatment of ankle sprain*	11 (91.7)	6 (50.0)	.07
Q11. Correct treatment of choking*	12 (100)	10 (83.3)	.48
Q12. Correct treatment of scald injury*	11 (91.7)	12 (100)	>.99

* Skills assessed by instructor; NA = not applicable.

training. We found common misconceptions of applying topical cream to a scald wound (70%) and inducing vomiting in choking victims (24%), which was consistent with findings from a local adult laymen survey on first aid knowledge (47% and 29% respectively).[3] This suggests that students without first aid training may have had misconceptions from exposure to different sources of information, such as from their parents and mass media.[14] However, the level of knowledge and skills related to the appropriate management of scalding and choking substantially improved after the training. These results were consistent with the knowledge gains related to these 2 types of injuries in an injury minimization program for schools.[13] Overall, we found a valuable and noticeable gain in knowledge scores associated with training. This is consistent with findings from 8 of 10 studies involving children or young participants included in a systematic review where significantly greater first aid knowledge occurred in the intervention groups than in the control groups.[15]

The effect of non-resuscitative first aid training on the attitudes, behavioral intent and confidence in performing first aid was mixed in several studies included in a systematic review.[15] In our study, over 75% of students were aware of the importance of learning first aid and the essential need for public education. Despite this, only one in 7 students had prior first aid training before our course, possibly reflecting the limited opportunities and availability of first aid courses for teenagers in Hong Kong. After training, students were moderately confident in performing first aid and most were willing to provide first aid to people in need. Engeland and colleagues identified self-efficacy, attitudes towards learning and giving first aid, and positive emotions connected with first aid situations as factors predictive of intended first aid behavior.[16]

Small group competitive educational games can foster active cooperative learning, teamwork, communication and problem solving abilities.[17] Our case scenario required students to work collaboratively with each other to recall, distinguish and demonstrate appropriate treatments to simulated knee abrasions, ankle sprain, choking and a scald injury, as well as to prioritize which injuries to treat first. These respective features in the formative assessment were designed to measure the first 4 of 6 increasing learning complexity domains; "knowledge," "comprehension," "application," and "analysis" using Bloom's Taxonomy framework.[18] Although we found higher team scores using the uReply cloud-based format than the paper format, we did not directly measure students' motivation, engagement and learning satisfaction levels associated with the degree of interactivity between students and instructors.[19] The results suggest that the mode of delivery format may affect the reliability of the formative assessment. Nonetheless, we are unaware of other studies reporting non-resuscitative first-aid courses incorporating a game-based formative assessment (using a student response system) to promote a positive, safe and dynamic learning environment for skill competency evaluation. To enable more flexibility for teams to work at their own pace, further developments to the activity ranking in a multiple-item session component in the uReply cloud-based platform has been planned.

The study has implications for promoting first aid knowledge, attitudes and skills in secondary school students. First, evidence-based age-appropriate non-resuscitative first aid courses that incorporates a game-based formative assessment are feasible for adaptation into local secondary school curriculum. Second, game-based learning in small groups of students can foster active

and experiential learning, teamwork, problem solving and critical thinking skills but is rarely used in formative or summative first aid training assessments in schools. Finally, we did not examine the cost-effectiveness and sustainability of physician instructors-led non-resuscitative course. If non-resuscitative first aid courses are included in the local school curriculum, teachers with recent first aid certificates may be willing to be trained as instructors in the long-term.

There are several limitations to the study. First, as this was a single-centre study, the generalizability of the results to other junior secondary schools is uncertain as our training was led by Emergency Medicine physicians. Students may have performed better than expected as they were aware that parental informed consent was obtained before the study. As the knowledge and skill assessments were carried out on the same day after completing the first aid course, it is unclear how much students' knowledge and skills will be retained in the long-term. As there was no control group for comparison, the change in attitudes may not be directly associated with first aid training with certainty. In contrast to our previous study of assessing the efficacy of a 2-hour compression-only cardiopulmonary resuscitation and automated external defibrillator course in secondary school students,[20] we did not change instructors for the game-based formative assessment component or use a standardized checklist for assessing the 4 simulated injuries. Thus, misclassification bias may be present in this study and future studies need to take this possible bias into account.

In conclusion, this brief non-resuscitative first aid course was associated with noticeable and valuable changes in knowledge score and self-confidence level in performing first aid. The game-based formative assessment facilitated a positive and dynamic learning environment for students to demonstrated good skill competency in treating simulated knee abrasions, ankle sprain, choking and a scald injury. Given these encouraging results, we believe that evidence-based courses, containing age-appropriate non-resuscitative first aid contents that incorporates an interactive formative assessment, are feasible to be adopted in the Hong Kong junior secondary school curriculum.

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