

ORIGINAL ARTICLE

Assessing Malaysian School Teachers' Readiness to Teach Cardiopulmonary Resuscitation and Automated External Defibrillators: Knowledge, Attitudes, Willingness and Barriers

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ABSTRAK

Pelaksanaan resusitasi kardiopulmonari (CPR) di sekolah disarankan bagi meningkatkan kadar kelangsungan hidup pesakit yang mengalami komplikasi jantung terhenti. Walau bagaimanapun, kurikulum sekolah di Malaysia kekurangan pendidikan mengenai CPR dan defibrilator luaran automatik (AED). Kajian ini bertujuan untuk menilai pengetahuan, sikap, kesediaan dan halangan kepada pendidikan CPR dan AED dalam kalangan guru di Malaysia. Kaedah pensampelan rawak berstrata dua peringkat digunakan untuk memilih 400 orang guru daripada 20 sekolah rendah dan menengah di negeri Selangor, Malaysia. Borang soal selidik digunakan yang merangkumi soalan tentang pengetahuan CPR dan AED, sikap dan kesediaan untuk mengajar CPR dan AED serta faktor pendorong dan halangan dalam pelaksanaan CPR dan AED di sekolah. Seramai 165 orang peserta (57.0% wanita) telah melengkapkan soal selidik. Hanya dua orang guru (1.2%) lulus ujian pengetahuan, manakala 74.5% melaporkan bahawa tiada latihan CPR dijalankan di sekolah mereka dalam tempoh dua tahun yang lepas. Walaupun 57.6% orang guru bersedia untuk mengajar CPR, sebanyak 61.8% menghadapi halangan seperti kurang pengetahuan, kekangan masa dan kekurangan sumber. Halangan lain dalam pelaksanaan kurikulum CPR termasuk tanggapan kekurangan sokongan daripada pihak kerajaan di peringkat pusat, negeri dan daerah, kekurangan dana serta persepsi bahawa minat pelajar yang rendah. Analisis Varians Multivariat menunjukkan keputusan yang tidak signifikan, di mana tahap sikap, kesediaan dan halangan yang dirasakan adalah konsisten dalam kalangan guru tanpa mengira latar belakang, seterusnya mempamerkan keperluan yang sama untuk memperbaiki pendidikan CPR. Kajian ini menunjukkan bahawa guru bersedia untuk mengajar CPR dan AED. Walau bagaimanapun, terdapat keperluan untuk meningkatkan pengetahuan CPR dalam kalangan guru serta mengatasi halangan struktur dan institusi yang menjadi penghalang dalam memastikan pelaksanaan kurikulum CPR yang berkesan dapat dicapai di seluruh sekolah di Malaysia.

Kata kunci: Guru sekolah; halangan; kerangka konseptual; pemudah cara; pendidikan CPR

ABSTRACT

Implementing cardiopulmonary resuscitation (CPR) in schools is recommended to improve cardiac arrest survival. However, Malaysian curricula lack CPR and automated external defibrillators (AED) education. This study assessed teachers' knowledge, attitudes, willingness and perceived barriers to teaching CPR and AED. A two-stage stratified random sampling method was employed to choose 400 school teachers from 20 primary and secondary schools across the Selangor state, Malaysia. A self-administered questionnaire was distributed, comprising questions on knowledge of CPR and AED, attitude and willingness towards teaching CPR and AED and perceived facilitators and barriers to implementing CPR and AED in schools. A total of 165 participants (57% female) completed the survey. Only two teachers (1.2%) passed the knowledge test, and 74.5% reported that no CPR training had been conducted in their school within the past two years. While 57.6% were willing to teach CPR, 61.8% faced barriers such as limited knowledge, lack of time and resources. Other barriers to implementing CPR curriculum included perceived lack of support from the government at the central, state and district levels, a lack of funding and perceived students' lack of interest. Results of the Multivariate Analysis of Variance showed non-significant results, indicating that levels of attitude, willingness and perceived barriers remained consistent across all teachers regardless of their background, underscoring a uniform need for improved CPR education. The study highlights a willingness to teach CPR and AED among school teachers. However, there is a need for improving teachers' CPR knowledge, and removing structural and institutional barriers which hinder the successful implementation of CPR curriculum in Malaysian schools.

Keywords: Barriers; CPR education; facilitators; framework; school teachers

INTRODUCTION

Recently, there has been an uptick in incidents of road traffic accidents, fractures, sudden cardiac arrest, seizures and physical injuries within school environments. Sports facilities and playing fields have been identified as the most common locations for cardiac arrests during school activities (Drezner et al. 2013; Lear et al. 2015; Sado et al. 2019). Additionally, schools are often the site of the highest rates of accidents that lead to serious injuries and fatalities (Mathew et al. 2016). A 12-year retrospective study on out-of-hospital cardiac arrests (OHCA) found that staff members and the general public are more frequently affected than students, who accounted for less than 25% of these cases. Although the occurrence of cardiac arrest among children is relatively rare, the emotional impact on families and friends when a child dies or sustains severe neurological damage is overwhelming (Haskins et al. 2021). In such emergencies, immediate action is crucial even before medical professionals arrive. To improve survival outcomes, schools should have a clear emergency medical response plan.

One essential intervention is cardiopulmonary resuscitation (CPR), which involves chest compressions and artificial ventilation to help restore heart function and ensure adequate blood flow to the brain and vital organs during cardiac or respiratory emergencies.

Currently, it is estimated that around 17.5 million people die each year from cardiovascular diseases (CVD), including strokes and heart attacks, making it the leading cause of death worldwide (Field et al. 2010). Cardiac arrest, a common emergency requiring immediate medical attention, can occur across all age groups, from infants to adults and accounts for about 70% of cases of high mortality risk outside hospital settings (Dwood et al. 2014; Rajeswaran et al. 2018). The Sustainable Development Goal (SDG) 3 aims to promote healthy lives and well-being for people of all ages. One specific target supports strengthening the capacity of countries worldwide to reduce and manage risks associated with out-of-hospital deaths. In Malaysia, efforts to decrease out-of-hospital cardiac arrest deaths involve several strategies. These include extensive

public education campaigns to raise awareness of cardiac arrest symptoms and promote prompt responses, along with CPR training programs to ensure community members have vital life-saving skills. Community engagement initiatives help foster a culture of preparedness and response, while improvements in emergency medical services aim to ensure rapid and effective care before reaching hospitals. Additionally, leveraging technology and conducting research play a crucial role in optimising interventions and assessing their effectiveness. Through these combined efforts, Malaysia strives to significantly increase survival rates for cardiac arrest victims outside healthcare facilities.

Increasing the baseline knowledge of CPR among school teachers and students can significantly improve how such emergencies are handled (Bharati et al. 2016). Since children spend a large part of their day at school, basic CPR knowledge among them is particularly important (Olympia et al. 2005). To prepare for on-campus cardiac emergencies, the American Heart Association developed the Cardiac Emergency Response Plan (CERP), which guides schools in responding effectively (Rose et al. 2016). This plan emphasises the need to assess and ensure the accessibility of automated external defibrillators (AEDs) and their proper placement (Aufderheide et al. 2006). CERP also requires both staff and students to be trained in CPR, enabling them to recognise cardiac events quickly and administer CPR and AED use when needed. Recently, teaching CPR has been extended to secondary school students worldwide, and many countries now include it as an optional part of the school curriculum in both primary and secondary education (Ghrayeb et al. 2017; Reder & Quan 2003). These initiatives align with guidelines from the American Heart Association (AHA), the American Academy of Pediatrics, and the International Liaison Committee on Resuscitation (ILCOR), which strongly recommend incorporating Basic Life Support (BLS) training into school programs (Adedamola & Chukwudi 2018; Jain et al. 2016). As a result, CPR training is now mandatory in

schools across most states in the United States (US) as well as in countries like Denmark, England and Norway (Bottiger & Van Aken 2015; Mpotos et al. 2013; Özbilgin et al. 2015; Stiehl et al. 2003). Since CPR is the second link in the chain of survival, teaching and practicing this vital lifesaving skill globally is crucial, as proper administration by trained individuals can greatly improve the chances of survival before medical help arrives (Hazinski et al. 2010; Richmond & Wyllie 2010).

A prompt response from a trained individual can greatly increase the chances of saving a life when performed accurately and effectively (Cuijpers et al. 2016; Plotnikoff & Moore 2009). The American Academy of Pediatrics and the AHA have emphasised the importance of school teachers being prepared with emergency response measures to handle life-threatening situations (Olympia et al. 2005). Training teachers not only equips them to respond effectively but also promotes a better learning environment for students. As key figures in our society, teachers play a crucial role in shaping the future generation. Increasing awareness and training among teachers can enhance students' knowledge, which they can then share with their families, creating a ripple effect that raises awareness throughout the community. Over time, this approach will significantly improve the likelihood of bystanders being able to perform CPR when needed (Adedamola & Chukwudi 2018; Jain et al. 2016).

Over the years, CPR training in schools has been delivered by professionals, such as physicians, firefighters, medical students and paramedics (Tanaka et al. 2011). However, the most suitable person to provide this training has yet to be clearly identified (Plant & Taylor 2013). Research suggests that school teachers are expected to play a crucial role in performing CPR on students during emergencies. Since they are often the first responders to recognise cardiac arrests, teachers need to acquire sufficient knowledge and skills to administer effective resuscitation (Zinckernagel et al. 2017). A study by Tanaka et al. (2011) indicated that teachers

are ideally suited to lead CPR training because they understand their students' characteristics, learning styles and environment, yet only about 20% of schools currently utilise teachers in this role. Additionally, some studies reveal that up to 50% of teachers are unwilling to teach CPR, mainly due to a lack of knowledge (Mpotos et al. 2013) and confidence in their teaching abilities (Tanaka et al. 2011). Discussions around CPR training for school children often focus on factors like the trainer's background, usually healthcare professionals or teachers. Several international studies have explored teachers' knowledge and attitudes regarding Basic Life Support (BLS) and CPR in the school setting (Tanaka et al. 2011). Using teachers as CPR instructors offers several advantages. For example, it can be a valuable long-term investment, as teachers can repeatedly instruct new student groups. Plant & Taylor (2013) also found that teachers are just as effective as physicians in teaching CPR to schoolchildren.

Over 90% of school teachers who conducted CPR training reported feeling confident in teaching their students. However, a Belgian study involving 4,000 teachers found that less than half were confident or willing to teach CPR in schools (Mpotos et al. 2013). The effectiveness of training delivered by different providers remains uncertain. Some studies reveal that 50% of teachers are unwilling to teach CPR due to a lack of knowledge and teaching skills (Stiell et al. 2003). In countries like Spain and Greece, schools prefer healthcare professionals to instruct students in CPR (Bottiger & Van Aken 2015; Özbilgin et al. 2015). A similar study involving 553 teachers in Hong Kong showed poor preparedness, with limited knowledge and a low level of support and willingness to teach CPR (Böttiger 2015). Malaysia has over 10,000 schools with about 5 million students and 420,000 teachers from preschool to high school (Krejcie & Morgan 1970). Yet, current Malaysian curricula still lack topics on CPR, and resources for implementing such training are scarce (Malaysians Must Know the TRUTH 2019). Teachers are expected to be adequately trained to educate students, but little has been documented about teachers' CPR knowledge and capacity in

Malaysia. So far, there has been no integration of CPR into the official Malaysian school syllabus. The only opportunity for students to learn CPR is during limited Physical Education classes, where it is briefly mentioned in the Form 4 textbook, specifically in pages 222 to 225 of the Form 4 Physical Education textbook. Other forms' textbooks do not include CPR or first aid topics. This falls short of the World Health Organisation's "Kids Save Lives" policy, which recommends that schools provide a minimum of two hours annually of comprehensive BLS training, including CPR and AED skills, involving both theoretical and practical components, something difficult to achieve within a standard Physical Education class. Incorporating CPR training into the school curriculum appears to be the most effective approach to teaching CPR within the community, preparing students to respond confidently in emergencies.

Currently, it is also unclear how many Malaysian secondary schools teach CPR through a complete syllabus that covers practical training and assessment. To address these gaps, this study aimed to: (i) assess school teachers' knowledge of CPR and AED; (ii) evaluate teachers' attitude and willingness (operationalised as readiness to teach CPR and AED); and (iii) identify perceived facilitators and barriers to integrating CPR and AED education into the school curriculum. The findings were intended to inform policy and curriculum development, ultimately empowering schools to equip students with vital life-saving skills and fostering a safer, more prepared community.

MATERIALS AND METHODS

Research Design and Population

This study used a descriptive cross-sectional design conducted from February 2025 to June 2025. Data were collected using a self-administered questionnaire involving a sample of primary and secondary schools' teachers from a public school in Selangor State, Malaysia. The Research Ethics Committee of Universiti Teknologi

MARA granted ethical approval (Approval no.: REC/10/2024 [ST/MR/232]). Additionally, the Department of Educational Planning and Policy Research, Ministry of Education (MOE), also granted ethical approval with approval number KPM.600-3/2/3-eras (22678).

Sampling Technique and Sample Size

The population of this study encompassed Malaysian primary and secondary school teachers in Selangor State. In total, there were 10 districts within Selangor, comprising 940 schools and 61,816 school teachers (as of 1 August 2024). The estimated sample size was determined using Krejcie and Morgan's (1970) sample size table for a population of approximately 75,000 school teachers, assuming a 95% confidence level, a 5% margin of error, and a population proportion of $P = 0.5$. A 5% dropout rate was also considered, resulting in a target sample size of 400 (MOE Malaysia 2019). Using a two-stage stratified random sampling method, two schools (one primary and one secondary) were randomly selected from each of the 10 districts in Selangor. This was achieved by assigning numbers to all schools within each district and selecting one primary and one secondary school from each district using a random number generator. The sample was evenly distributed across the 10 districts, with 20 school teachers randomly sampled from selected primary and secondary school. The study excluded individuals who did not provide consent to participate, as well as those teaching at international, private, or special education schools, and part-time teachers.

Instrumentation

A self-administered questionnaire, shown to be valid and reliable, was compiled based on multiple studies and consisted of five sections: (a) demographics; (b) knowledge of CPR & AED (comprising 11 multiple-choice questions) (Fariduddin et al. 2022); (c) attitude towards teaching CPR (10 items) (Mansour et al. 2019); (d) willingness to teach CPR and AED (7 items)

(Pivač et al. 2020); and (e) perceived barriers to implementing CPR and AED in schools (7 items) (Ravindra et al. 2024). In section (b), each correct response to the multiple-choice questions was assigned a score of 1 point, and each incorrect response received 0 points, resulting in a maximum possible score of 11. Passing criterion (10/11 correct) was set a priori to reflect a high competency threshold consistent with BLS competency expectations in AHA/ILCOR guidance (Field et al. 2010). Section (c) included a 4-point Likert scale and dichotomous Yes/No questions to assess participants' attitudes. Sections (d) and (e) utilised a 4-point Likert scale for all items. A higher score indicated greater attitude, willingness or perception of barriers.

Validity & Reliability of Instrumentation

The questionnaire was developed in English and first subjected to face validity assessment to ensure its clarity and relevance. This was followed by content validation conducted by public health physicians and health educationists. The Content Validity Index (CVI) achieved was 1.00, reflecting unanimous agreement. All sections of the instrument were pilot tested on a convenience sample of school students and teachers to assess clarity and internal consistency resulting in a KR-20 of 0.83 (section b) (Fariduddin et al. 2022; Fariduddin & Jaafar 2021; Fariduddin & Siau 2022; Fariduddin et al. 2025a), and an α value of 0.80-0.90 (sections c–e) (Fariduddin et al. 2025b).

Data Collection Procedures

The questionnaire was distributed using a Google Form (Google LLC, Mountain View, CA, USA) link. A representative from each district was appointed from both primary and secondary schools. These representatives then disseminated the questionnaires to the teachers within their school communities. To expedite the process, each completed questionnaire was rewarded with an e-wallet honorarium worth MYR 10.00. The front page of the questionnaire included a concise study overview, participant

information sheet and consent form, ensuring voluntary participation without any pressure or coercion. A period of 12 weeks was allocated for data collection. Reminders were sent once every 4 weeks to each representative to ensure all respondents completed the form. All collected information was kept anonymous and confidential by the researcher.

Data Analysis

The data collected were analysed using Statistical Package for Social Sciences (SPSS) for Windows, version 29 (IBM Corp. Armonk, NY, USA). Descriptive statistics were employed to evaluate frequency distribution, means and standard deviations for the knowledge score of CPR, attitude towards teaching CPR and AED, willingness to teach CPR and AED and perceived barriers to implementing CPR and AED in schools. To assess differences across demographic profiles regarding knowledge, attitude, willingness and perceived barriers, Multivariate Analysis of Variance (MANOVA) was utilised. Assumptions underlying the analyses were tested: the Shapiro-Wilk test confirmed univariate normality; no multivariate outliers were detected; the correlation between dependent variables was within acceptable limits; and Box's M test indicated homogeneity of variance-covariance matrices. Statistical significance was set at a probability value of 0.05 or lower, two-tailed.

RESULTS

A total of 165 participants responded to the survey (response rate of 41.3%). The majority of the participants were female (57.0%), with males comprising 43.0% of the sample. The age distribution skewed towards younger teachers, predominantly within the 25-30 years age group (49.1%), followed by smaller proportions in the 31-35 (13.9%), 36-40 (10.9%) and 41-45 (13.3%) brackets. The remaining age groups, especially those above 50 years, represented minimal proportions, with only 0.6% aged 56-60 years. Participants were geographically diverse, with the

largest representation from the district of Petaling (17%), followed by Hulu Langat (14.5%) and other districts collectively accounting for 38.2%. The districts of Gombak, Hulu Selangor, Kuala Langat and Kuala Selangor had smaller shares. In terms of educational qualifications, a significant majority held a bachelor's degree (73.3%), with smaller proportions possessing a master's degree (22.4%) and minimal representation with a professional or diploma (2.4%) or PhD (1.8%). Most teachers had extensive teaching experience, with 62.4% having between 5 and 10 years of experience, followed by smaller groups with 11-15 (13.3%), 16-20 (16.4%) and over 20 years of experience. Regarding the context of their teaching roles, participants were predominantly from secondary schools (58.8%), with the remainder teaching in primary schools (41.2%). The educational focus areas were varied, with the most common subjects being Languages (29.1%) and Sciences (15.8%). Other areas included Islamic Education (15.2%), Physical and Health Education (13.9%), Mathematics (10.3%) and a small distribution across arts, design, business, economics and other disciplines. Among those who reported prior CPR training ($n = 67$), timing was: 0-6 months 7 (9.7%), 6-12 months 5 (6.9%), 1-2 years 8 (11.1%) and over 2 years 52 (72.2%), indicating that most training sessions were not recent. Conversely, 59.4% had not participated, citing reasons such as the courses not being offered yet (49.1%), lack of time (10.7%), unawareness of where to train (26.8%), and other logistical or personal barriers. Regarding self-efficacy, only 35.4% felt capable of performing CPR now, with a minority feeling highly confident (18.4%). The majority reported low confidence levels (46.9%), indicating a general need for capacity-building. Furthermore, only about a third of teachers (35.4%) reported being physically able to perform CPR, highlighting potential physical limitations or a lack of recent practice (Table 1).

Knowledge of Cardiopulmonary Resuscitation and Automated External Defibrillators

The assessment of Malaysian school teachers'

TABLE 1: Demographics of school teachers

Demographics	Frequency, n (%)
Gender	
Male	71 (43.0)
Female	94 (57.0)
Age Group (years)	
25–30	81 (49.1)
31–35	23 (13.9)
36–40	18 (10.9)
41–45	22 (13.3)
46–50	10 (6.1)
51–55	10 (6.1)
56–60	1 (0.6)
District	
Gombak	6 (3.6)
Hulu Langat	24 (14.5)
Hulu Selangor	1 (0.6)
Klang	11 (6.7)
Kuala Langat	3 (1.8)
Kuala Selangor	11 (6.7)
Petaling	28 (17)
Sabak Bernam	8 (4.8)
Sepang	10 (6.1)
Others	63 (38.2)
School Type	
Primary School	68 (41.2)
Secondary School	97 (58.8)
Highest Qualification	
Professional or Diploma	4 (2.4)
Bachelor's Degree	121 (73.3)
Master's Degree	37 (22.4)
Doctor of Philosophy	3 (1.8)
Teaching Experience (years)	
5–10	103 (62.4)
11–15	22 (13.3)
16–20	27 (16.4)
21–25	8 (4.8)
26+	5 (3.0)
Main Area of Teaching	
Mathematics	17 (10.3)
Sciences	26 (15.8)
Languages	48 (29.1)
History	3 (1.8)
Geography	3 (1.8)
Moral Education	1 (0.6)
Islamic Education	25 (15.2)
Physical and Health Education	23 (13.9)
Art and Design	8 (4.8)
Design and Technology	4 (2.4)
Business Studies and Accounting	2 (1.2)
Economics	1 (0.6)

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Demographics	Frequency, n (%)
Participation in CPR courses	
Yes	67 (40.6)
No	98 (59.4)
If yes, when participated?	
0–6 months ago	7 (9.7)
6–12 months ago	5 (6.9)
1–2 years ago	8 (11.1)
Over 2 years ago	52 (72.2)
If no, why?	
Not offered yet	55 (49.1)
No time	12 (10.7)
Not interested	4 (3.6)
Don't know where	30 (26.8)
Too expensive	4 (3.6)
Physically limited	1 (0.9)
Other	6 (5.3)
Can you perform CPR now?	
Yes	58 (35.4)
No	106 (64.6)
How confident?	
Highly confident	18 (18.4)
Moderately confident	34 (34.7)
Low confidence	46 (46.9)

*One missing response for 'Can you perform CPR now?' (n = 164 valid responses). Confidence items were answered by respondents to that specific item. Percentages were calculated from the valid responses to each item

knowledge about basic life support revealed significant variations in understanding essential emergency response procedures. While some participants demonstrated solid awareness, many gaps still exist. For example, only 58.2% correctly identified scene safety as the very first action when encountering someone in need of CPR. When asked about assessing breathing, over half (53.3%) answered incorrectly, with nearly 22% confused the proper method as the latest guidelines is to scan for breathing (5.5%). Knowledge of specific CPR details was notably limited, only 30.3% knew the correct compression rate of at least 100 to 120 compressions per minute, and just 23% were aware that adult chest compressions should be around 2 inches deep. Responses about the compression-to-breath ratio

were also concerning; only 29.1% selected the correct ratio of 30:2, indicating many might not be familiar with standard protocols. As for AEDs, while 54.5% understood that AED stands for Automated External Defibrillator, fewer (47.9%) knew that its main purpose was to analyse the heart and deliver shocks if needed. When asked about operating an AED, only 22.4% could identify the correct sequence: power on, attach pads, analyse then shock, highlighting another area needing reinforcement. Additionally, many respondents were unsure about who can safely use an AED; only 20% correctly responded that it was safe for anyone, not just trained authorised or medical personnel. Recognition of when to use an AED was also limited, with less than half (46.7%) understanding that it should be used on unresponsive victims with no pulse and no breathing. Overall, only two teachers (1.2%) passed the knowledge test, with a total mean score of 3.52 (Table 2).

Attitude toward Teaching Cardiopulmonary Resuscitation

The responses indicated overwhelmingly strong support among educators for the importance of CPR education for students, with 90.3% affirming that CPR courses were important, and a staggering 97.6% expressing the belief that students should participate in such training more frequently. This consensus highlighted a shared understanding of CPR's vital role in saving lives and the importance of integrating it into the school experience. However, despite this enthusiasm, the current integration of CPR courses into the Malaysian educational curriculum appeared limited, with 74.5% reporting that no recent organised courses had taken place at their schools, and only 13.9% indicating that such courses were held within the past year. Most respondents believed that CPR education should be mandated across the board, with 69.7% supporting compulsory courses before high school graduation. When asked who should teach these courses, a clear majority (68.5%) felt that teachers should be responsible, although a notable minority (32.7%) endorsed

the idea of involving external experts or other school staff. Interestingly, more than half of the teachers (57.6%) indicated willingness to teach CPR themselves, yet 61.8% cited barriers such as limited knowledge, lack of time, or insufficient resources as reasons for hesitating or declining the role. Regarding alternative methods, digital self-learning received strong backing, with 57% supporting this approach, though concern remained about whether schools were sufficiently equipped to support such platforms, with only 27.3% felt their schools were well-resourced for digital self-learning, while around 20–28% expressed doubts. The total mean score of the teachers' attitudes was 7.81 (Table 3).

Willingness toward Teaching Cardiopulmonary Resuscitation and Automated External Defibrillators

The data revealed a high level of willingness among Malaysian educators to engage in various aspects of CPR education and related activities. An impressive 77.6% of teachers were open to collaborating with external organisations such as the Civil Defence Force, the Red Crescent Society or the Ministry of Health (MOH) Malaysia to organise CPR courses for students, reflecting a strong desire to partner with credible agencies to enhance emergency training in schools. Additionally, a significant proportion (63.6%) expressed eagerness to implement CPR courses within their own schools, indicating a proactive attitude towards integrating life-saving skills into the school curriculum. The enthusiasm extended to instructor development; 65.5% showed willingness to attend CPR instructor certification courses if given the opportunity, demonstrating a willingness to develop locally qualified trainers who can effectively teach students. Moreover, the majority (60.6%) would be willing to teach CPR if proper equipment such as AEDs and Ambu bags were provided through funding, emphasising the importance of resource support in enabling active participation. Teachers also showed a receptive attitude towards innovative teaching methods; 56.4% agreed to allocate time

TABLE 2: Knowledge of CPR and AED among school teachers

Questions	Response Options	Frequency, n (%)
If you are alone and come upon a person who may need CPR, the FIRST thing you should do is	A. Activate the emergency response system B. Begin CPR C. Go for an AED D. Make sure the scene is safe E. I do not know	30 (18.2) 8 (4.8) 7 (4.2) 96 (58.2) 24 (14.5)
When assessing the victim for breathing, you should:	A. Look, listen & feel the breathing B. Scan for breathing C. Touch the victim's chest to feel the chest rise D. Place your cheek near to victim's nose to listen for breathing E. I do not know	88 (53.3) 9 (5.5) 13 (7.9) 36 (21.8) 19 (11.5)
For any victim, the correct compression rate is:	A. At least 120 per minute B. At least 80 per minute C. At least 90 per minute D. At least 100 to 120 per minute E. I do not know	12 (7.3) 17 (10.3) 24 (14.5) 50 (30.3) 62 (37.6)
The recommended compression depth for an adult is:	A. 1.0 inch B. 1.5 inch C. 2.0 inch D. 2.5 inch E. I do not know	2 (1.2) 25 (15.2) 38 (23) 8 (4.8) 92 (55.8)
What is the compression to breathe ratio in two-person CPR for an adult?	A. 20:2 B. 30:2 C. 40:2 D. 25:2 E. I do not know	10 (6.1) 48 (29.1) 7 (4.2) 2 (1.2) 98 (59.4)
What does AED stand for?	A. Automated Extension Defibrillator B. Automated External Defibrillator C. Auto External Decompression D. Automatic External Defibrilid E. I do not know	13 (7.9) 90 (54.5) 7 (4.2) 3 (1.8) 52 (31.5)
What is the purpose of an AED?	A. To deliver CPR (perform chest compressions) B. To analyse the heart rhythm C. To deliver an electric shock to normalise the heart rhythm D. To provide ventilation to a patient E. I do not know	17 (10.3) 15 (9.1) 79 (47.9) 9 (5.5) 45 (27.3)
Who is allowed to use an AED?	A. A doctor, a nurse, or EMS personnel B. Someone with special training C. School children D. Everyone E. I do not know	39 (23.6) 54 (32.7) 2 (1.2) 33 (20) 37 (22.4)
Which of the following best describes how a defibrillator works?	A. It delivers an electrical shock to the heart to start the heart beating again B. It delivers an electrical shock to the heart to clear excessive electrical activity and allow the heart to regain its normal rhythm C. It delivers an electrical shock to the heart, which burns damaged heart tissue D. It delivers an electrical shock to the chest, which dislodges blood clots E. I do not know	85 (51.5) 23 (13.9) 4 (2.4) 4 (2.4) 49 (29.7)

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Questions	Response Options	Frequency, n (%)
The proper steps for operating an AED are:	A. Power on the AED, attach electrode pads, shock the patient, and analyse the rhythm	39 (23.6)
	B. Power on the AED, attach electrode pads, analyse the rhythm, shock the patient	37 (22.4)
	C. Power on the AED, analyse the rhythm, attach electrode pads, shock the patient	3 (1.8)
	D. Power on the AED, shock the patient, attach electrode pads, and analyse the rhythm	78 (47.3)
	E. I do not know	8 (4.8)
You should attach an AED only to a victim who is:	A. Unresponsive with shallow, rapid breathing, and has a pulse	25 (15.2)
	B. Unresponsive, not breathing, and has no pulse	77 (46.7)
	C. Conscious, complaining of severe, crushing chest pain	2 (1.2)
	D. Conscious and has a history of a heart attack	2 (1.2)
	E. I do not know	59 (35.8)
Total Score (Pass)	2 (1.2)	
Total Score (Fail)	163 (98.8)	
Mean Score (Pass)	3.52 (2.6)	

AED: Automated external defibrillators; CPR: Cardiopulmonary resuscitation

TABLE 3: Attitude toward teaching CPR among school teachers

Questions	Response Options	Frequency, n (%)
Do you agree that students should be required to participate in CPR courses more frequently?	Yes	161 (97.6)
	No	4 (2.4)
Do you believe that CPR courses are important for students?	Yes	149 (90.3)
	Probably yes	14 (8.5)
	Probably no	1 (0.6)
	No	1 (0.6)
Do you agree that a teacher without any qualified certifications or experience should be allowed to teach CPR to students?	Yes	30 (18.2)
	Probably yes	22 (13.3)
	Probably no	36 (21.8)
	No	77 (46.7)
Do you agree that CPR courses are mandatory for all students before they graduate from high school?	Yes	115 (69.7)
	Probably yes	44 (26.7)
	Probably no	3 (1.8)
	No	3 (1.8)
CPR courses are not integrated into the Malaysian educational curriculum. Have there been any CPR courses organised at school recently?	No	123 (74.5)
	Yes, in the past year	23 (13.9)
	Yes, in the past two years	7 (4.2)
	Yes, three years or longer ago	12 (7.3)
In your opinion, if CPR courses were made mandatory and included in the national school curriculum, who should teach these courses?	A. A teacher	113 (68.5)
	B. Someone from the school board (example: _____)	46 (27.9)
	C. Someone else working at school (example: _____)	30 (18.2)
	D. Someone who does not work at school (example: _____)	54 (32.7)

Continued...

...continuing

Questions	Response Options	Frequency, n (%)
Would you be willing to teach CPR courses?	Yes	95 (57.6)
	No	70 (42.4)
If no, why would you not be willing to teach CPR courses?	I have too little knowledge.	102 (61.8)
	I don't have time.	11 (6.7)
	I don't have the resources at school.	15 (9.1)
	I don't know.	37 (22.4)
Besides teaching CPR through instructors, there are other methods such as digital self-learning. Do you support this approach?	Yes	94 (57)
	Probably yes	37 (22.4)
	Probably no	20 (12.1)
	No	14 (8.5)
Do you think your school is well-equipped with resources for a self-digital learning platform?	Yes	45 (27.3)
	Probably yes	47 (28.5)
	Probably no	40 (24.2)
	No	33 (20.0)
Total Mean (S.D)	7.81 (1.64)	

AED: Automated external defibrillators; CPR: Cardiopulmonary resuscitation; SD: Standard deviation

and resources for students to use digital self-learning platforms, acknowledging the potential of technology in skill acquisition. Assistance in obtaining necessary training tools received similar support, with 32.1% willing to contribute funds for mannequins and other teaching equipment. Lastly, a strong majority (63.6%) were willing to undertake qualified CPR certification themselves, setting a positive example for their colleagues and fostering a culture of preparedness. The teachers exhibited an overall mean score of 9.79 for willingness (Table 4).

Perceived Barriers to Implementing Cardiopulmonary Resuscitation and Automated External Defibrillators in Schools

The responses clearly highlighted several key barriers perceived by educators in integrating CPR and AED training into the school setting. A substantial majority (70.3%) agreed that lack of funding was the main obstacle to launching widespread CPR and AED education, underscoring financial constraints as a significant hurdle. Regarding student engagement, only about a third (32.7%) believed that students were uninterested in learning about these life-saving skills, implying that students lack of interest was

not viewed as the most critical barrier, but still warranted attention. Interestingly, most teachers (60%) were confident that even those without a background in science or health education can support the implementation of CPR and AED training, indicating a belief in the potential for effective peer or teacher-led education if proper resources and training were provided. Parental consent, a vital component for school-based programs, appeared feasible, with 61.8% of teachers believing that parents would generally agree to CPR and AED lessons for their children. However, significant concerns remained around teachers’ own confidence; nearly half (48.5%) agreed that teachers felt insecure about their technical skills, and over half (51.5%) believed teachers lack confidence in their knowledge of CPR and AED. These insecurities could undermine the quality and effectiveness of training if not adequately addressed. Lastly, nearly half of the respondents (46.7%) were concerned that teachers might face difficulties obtaining necessary support from the school administration or the education ministry, reflecting apprehensions about structural and institutional barriers. The perceived barriers were recorded with a mean score of 11.7 (Table 5).

TABLE 4: Willingness toward teaching CPR and AED among school teachers

Question	Response Options	Frequency, n (%)
Would you be willing to collaborate with external organisations, such as Angkatan Pertahanan Awam, Red Crescent Society or Kementerian Kesihatan Malaysia, to organise CPR courses for students?	Yes	128 (77.6)
	Probably yes	33 (20.0)
	Probably no	3 (1.8)
	No	1 (0.6)
Would you be willing to implement CPR courses in your school?	Yes	105 (63.6)
	Probably yes	51 (30.9)
	Probably no	5 (3.0)
	No	4 (2.4)
If given the opportunity to receive certification, would you be willing to attend a CPR instructor course to become qualified and effectively teach students CPR?	Yes	108 (65.5)
	Probably yes	43 (26.1)
	Probably no	9 (5.5)
	No	5 (3.0)
If the necessary equipment for performing CPR, such as an AED and Ambu bag, were provided through funding, would you be willing to teach CPR to the students?	Yes	100 (60.6)
	Probably yes	43 (26.1)
	Probably no	12 (7.3)
	No	10 (6.1)
Do you agree to provide time and resources to let children use a digital self-learning platform?	Yes	93 (56.4)
	Probably yes	51 (30.9)
	Probably no	13 (7.9)
	No	8 (4.8)
Would you be willing to provide funds for the school to have proper equipment for teaching CPR, such as mannequins?	Yes	53 (32.1)
	Probably yes	50 (30.3)
	Probably no	34 (20.6)
	No	28 (17.0)
Would you be willing to learn and take qualified CPR certification courses to set an example for other teachers?	Yes	105 (63.6)
	Probably yes	48 (29.1)
	Probably no	5 (3.0)
	No	7 (4.2)
Total Mean (S.D)	9.79(3.38)	
AED: Automated external defibrillators; CPR: Cardiopulmonary resuscitation; SD: Standard deviation		

TABLE 5: Perceived barriers to implementing CPR and AED in schools

Question	Response Options	Frequency, n (%)
Do you agree that funding is the main barrier to implementing CPR and AED teaching in schools?	Yes	116 (70.3)
	Probably yes	41 (24.8)
	Probably no	5 (3.0)
	No	3 (1.8)
Do you think that school students are not interested in learning about CPR and AED?	Yes	54 (32.7)
	Probably yes	25 (15.2)
	Probably no	47 (28.5)
	No	39 (23.6)
Do you agree that teachers without a background in science or health education will be able to support the implementation of CPR and AED teaching in schools?	Yes	99 (60.0)
	Probably yes	48 (29.1)
	Probably no	11 (6.7)
	No	7 (4.2)

Continued...

...continuing

Question	Response Options	Frequency, n (%)
Do you think parents would consent to teaching CPR and AED to their children in a school setting?	Yes	102 (61.8)
	Probably yes	53 (32.1)
	Probably no	8 (4.8)
	No	2 (1.2)
Do you agree that teachers feel insecure about their CPR and AED technical skills?	Yes	80 (48.5)
	Probably yes	64 (38.8)
	Probably no	16 (9.7)
	No	5 (3.0)
Do you agree that teachers feel insecure about their knowledge of CPR and AED?	Yes	85 (51.5)
	Probably yes	67 (40.6)
	Probably no	8 (4.8)
	No	5 (3.0)
Do you think that teachers may encounter difficulties in obtaining necessary support from the school or ministry if CPR and AED teaching were to be implemented?	Yes	77 (46.7)
	Probably yes	64 (38.8)
	Probably no	15 (9.1)
	No	9 (5.5)
Total Mean (S.D)	11.7(2.14)	

AED: Automated external defibrillators; CPR: Cardiopulmonary resuscitation; SD: Standard deviation

MANOVA using Roy’s Largest Root indicated significant multivariate effects for age ($p = 0.016$), qualifications ($p = 0.009$), teaching experience ($p = 0.040$), area of teaching ($p = 0.029$) and last date of CPR participation ($p = 0.012$) (Table 6).

However, follow-up between subjects tests for individual dependent variables (knowledge, attitude, willingness, perceived barriers) did not reach the Bonferroni adjusted significance level ($\alpha = 0.005$) (Table 7). Therefore, while multivariate

signals were observed, univariate differences for single outcomes were not robust after correction for multiple comparisons.

DISCUSSION

This study examines the readiness and perceived barriers among school teachers across Malaysia, with a particular focus on districts in Selangor, regarding the training of CPR and AED to school

TABLE 6: Multivariate test of knowledge, attitude, willingness and perceived barriers towards CPR and AED teaching among school teachers from selected demographics profile

Demographics	Source	Value	F	Hypothesis df	Error df	Sig	Partial Eta Squared
Gender	Roy’s Largest Root	0.057	0.440	4	31	0.779	0.054
Age		0.546	3.09	6	34	0.016*	0.353
District		0.464	1.97	8	34	0.81	0.317
School type		0.044	0.341	4	31	0.848	0.042
Qualifications		0.492	4.05	4	33	0.009*	0.330
Teaching experience		0.331	2.81	4	34	0.040*	0.249
Area of Teaching		0.701	2.38	10	34	0.029*	0.412
Participation in CPR course		0.047	0.364	4	31	0.832	0.045
Last date of participation		0.459	3.78	4	33	0.012*	0.315

AED: Automated external defibrillators; CPR: Cardiopulmonary resuscitation

*Significant value of $p < 0.005$

TABLE 7: Test of between subjects

Demographics	Dependent Variables	df	Mean Square	F	Sig	Partial Eta Squared
Age	Knowledge	6	7.389	1.350	0.263	0.192
	Attitude	6	6.332	2.001	0.093	0.261
	Willingness	6	14.743	1.008	0.463	0.151
	Barriers	6	5.368	1.180	0.340	0.172
Qualifications	Knowledge	3	15.48	2.829	0.053	0.200
	Attitude	3	1.733	0.548	0.653	0.046
	Willingness	3	43.226	2.956	0.046	0.207
	Barriers	3	6.371	1.401	0.259	0.110
Teaching experience	Knowledge	4	14.895	2.72	0.460	0.243
	Attitude	4	1.207	0.404	0.805	0.045
	Willingness	4	3.145	0.215	0.928	0.025
	Barriers	4	4.845	1.065	0.389	0.111
Area of teaching	Knowledge	10	9.568	1.749	0.110	0.340
	Attitude	10	1.494	0.472	0.896	0.122
	Willingness	10	10.05	0.687	0.729	0.168
	Barriers	10	2.095	0.461	0.903	0.119
Last date of participation	Knowledge	3	12.03	2.199	0.106	0.163
	Attitude	3	1.520	0.480	0.698	0.041
	Willingness	3	30.741	2.102	0.118	0.156
	Barriers	3	10.987	2.416	0.083	0.176

*Bonferroni adjusted level of significant value at $p < 0.005$

students. While existing literature has extensively investigated teachers' readiness and barriers at multiple levels, this research concentrates specifically on the current context in Malaysia. The study highlights key aspects, including teachers' levels of knowledge, attitudes towards teaching CPR and AED, willingness to do so and perceived obstacles. Overall, most teachers demonstrated inadequate knowledge, with the majority failing to pass the test according to AHA standards, despite having attended training courses in the past two years or more. These findings align with numerous studies that report insufficient CPR knowledge among teachers (Alharbi et al. 2016; Yang & Kwon 2014). Additionally, the study shows that lack of exposure to cardiac arrest emergencies or situations requiring emergency CPR may impact knowledge levels and retention (Lockey et al. 2016). Knowledge retention is often critical; various professions have demonstrated that declarative knowledge tends to decline over time. For example, research indicates that healthcare

practitioners' skills and knowledge diminish three months after training. Even in the face of genuine medical emergencies, this loss becomes evident (Bukiran et al. 2014; Ouseph et al. 2015). In Malaysia and Pakistan, surveys among student teachers revealed low knowledge retention just two months after CPR training (Naqvi et al. 2011). In this study, most teachers are unable to correctly identify key CPR protocols, such as initial scene assessment, breathing evaluation, compression rate and depth or the purpose and use of AED. This deficiency is likely due to limited initial knowledge, as these questions focus heavily on theoretical aspects that are not easily answered without prior familiarity. Additionally, the lack of access to ongoing training or opportunities to learn these skills may contribute to the knowledge gap, as such training is often unavailable or not sufficiently emphasised.

Regarding teachers' attitudes towards teaching CPR and AED in Malaysian schools, most teachers believe that CPR education is important and that students should actively participate without

hesitation. This view is also supported by local non-governmental organisations (DayakDaily 2021). Given the high prevalence of obesity in Southeast Asia, the Malaysian government recognises this as a significant risk factor for OHCA, making the promotion of bystander CPR essential (Chia et al. 2023). To achieve this, integrating mandatory CPR courses at the school level, especially before students graduate from high school is considered a strategic approach. However, retrospective studies from countries with mandatory CPR curricula, such as Canada, the US and Denmark, show considerable variation in implementation. In Canada, only about 50% of responding schools reported teaching CPR, while Denmark's rate is around 60%. In the US, a national survey revealed a 77% implementation rate, despite CPR training being mandated in all schools (Brown et al. 2017; Zamzami et al. 2023). These findings indicate that even in systems with compulsory CPR education, actual implementation remains inconsistent and moderate. Most teachers support the idea that they are well-suited to teach CPR in schools, as they spend the majority of their time in the classroom. They believe they should be primarily responsible for administering effective CPR during emergencies and for teaching students the necessary skills and knowledge (Al Enizi et al. 2016). Nevertheless, many teachers perceive several barriers that hinder their ability to do so. These include limited knowledge, insufficient time allocated for training and a lack of resources, including digital platforms and infrastructure that support proper CPR instruction. These infrastructural challenges restrict teachers' capacity to deliver effective training and dampen their overall enthusiasm for the initiative.

The willingness of school teachers to perform CPR indicates strong support for the integration of CPR training within school environments. A majority of educators advocate for collaborative efforts involving local community engagement and partnerships with healthcare sectors, such as the MOH and non-governmental organisations like St. John Ambulance. Such collaborations are seen as foundational to the successful

implementation of CPR programs and could potentially inform future legislation (DayakDaily 2021). Furthermore, many teachers expressed their willingness to serve as CPR instructors, provided they are given the opportunity, and demonstrated their readiness to contribute financially toward training courses within schools. Since the majority had suggested teachers would be the best instructors for CPR courses, and some studies have shown that lack of willingness and perceived incompetence could hamper effective CPR training, these issues require immediate attention. One such solution is to provide opportunities for the teachers to be trained by certified instructors (Hoyme & Atkins 2017). Thus, specialised training is inevitable to increase the knowledge and CPR proficiency among teachers (Bakke et al. 2017). Teachers will also need special training to develop and assess teaching methods for CPR education in order to provide high-quality CPR education to school students (Fariduddin et al. 2022). In addition, despite not having related science or physical health backgrounds among the teachers, the majority would agree to the implementation of CPR teaching at Malaysian schools since they are aware of the importance of this course (Fariduddin & Siau 2022). This is also supported by Saudi Arabian teachers, with 78% willing to take free CPR courses, 40% agreeing that it should be mandatory in schools and 54% agreeing that certification is required before teaching CPR (Al Enizi et al. 2016). They also emphasised the importance of having sufficient resources, including digital tools, to effectively teach CPR to students. Overall, teachers are enthusiastic about participating in and supporting the development of comprehensive CPR education in schools, recognising its critical role in fostering a prepared and resilient student body.

The perceived barriers identified by school teachers can be categorised into several key areas, primarily arranged from the most to the least perceived challenges. At the forefront, support from the MOE remains the most significant obstacle, followed by the backing from higher authorities at the state and district

levels, and ultimately, school principals. From another perspective, parental support plays a crucial role and can also pose an obstacle if not sufficiently engaged (Brown et al. 2017). Among these, funding emerges as a primary concern. Adequate funding is crucial as this ensures the availability of external instructors and training materials such as CPR manikin and AED devices. Moreover, local engagement from the healthcare sector, such as the MOH and other non-governmental bodies such as St John is also required in supporting the CPR course in school (DayakDaily 2021). In addition to financial constraints, a lack of allocated time and comprehensive planning for CPR training persists among teachers. Many teachers have not been exposed to, nor instructed in, internationally recognised guidelines for effective CPR teaching, which hampers their ability to deliver quality instruction. This deficiency may contribute to a lack of student interest in learning CPR, despite the recognition by teachers that such skills are vital for lifelong safety and health awareness. On a secondary level, teachers' preparedness is frequently cited as a barrier. The majority express concerns about the quality of their CPR teaching, primarily due to insufficient knowledge and limited skills in demonstrating and instructing CPR techniques. Therefore, teachers believe that overcoming these barriers through targeted training and resources would enable educators from diverse backgrounds, not solely those in Physical Education or health sciences, to become effective CPR instructors.

Lastly, an assessment of the differences in knowledge, attitude, willingness and perceived barriers regarding CPR and AED training revealed significant variations across several demographic factors, including age, highest qualification level, teaching experience, area of specialisation and recency of CPR certification. Despite these differences, no notable variations were observed across other variables. Most teachers demonstrated very limited knowledge of CPR and AED, with low passing rates despite having attended training courses. Interestingly, levels of attitude, willingness and perceived barriers

remained consistent across all teachers regardless of their background, underscoring a uniform need for improved CPR education. These findings highlight a critical gap and emphasise the urgent necessity to integrate effective and sustainable CPR training into the curriculum to enhance preparedness across diverse teachers' profiles.

The Roots and Growth Framework

The findings of this study suggest that facilitators and barriers are key factors influencing the successful development and implementation of CPR programs at the national level in Malaysia. Currently, the CPR curriculum is taught at the secondary school level within a limited subject scope, with minimal guidance on how it should be delivered according to internationally accepted standards or in comparison with countries where CPR education has been successfully integrated into the national curriculum, including legislation and mandatory inclusion. The existing literature on the effectiveness of the current Malaysian approach remains sparse, indicating that CPR is primarily taught within classroom settings with inadequate assessment and training methods. Merely embedding CPR as a topic within certain subjects does not guarantee successful implementation or improved outcomes. Therefore, a framework such as "*Roots and Growth*" can serve as an exemplary model. This framework emphasises the importance of establishing strong foundational policies, comprehensive teacher training, and resource allocation, (*as the roots*) necessary to cultivate a resilient and effective CPR education system. By fostering collaboration among stakeholders and continuously evaluating progress (*representing growth*), the framework aims to nurture a culture of preparedness and life-saving skills among students and educators alike, ensuring long-term sustainability and impact (Figure 1).

To begin with, policies and legislation must be developed, or existing ones be modified and strengthened. In Malaysia, the MOE, specifically the Curriculum Development Unit should take responsibility for designing how best to integrate

CPR and AED programs as a stand-alone subject rather than as small topics within other subjects. A stand-alone subject would be an excellent starting point and is feasible given current global health needs (Reveruzzi et al. 2020). The MOE should also seek help and advice from stakeholders capable of providing a curriculum outline and recommending effective teaching methods. Collaboration and support, particularly from the MOH and university researchers, are crucial in designing the subject content to ensure sustainability and continued support from all angles. This should include a clear pathway with objectives for students at all levels, taking account of their cognitive and physical development and limitations, together with training requirements, resource allocation, and an implementation timeline (Andrews et al. 2018). With this initial step in place, the MOE can proceed to ensure successful implementation.

Moving on to the next steps, capacity building and teacher training are imperative to ensure the curriculum's applicability. With the Ministry's support to make CPR teaching mandatory, developing a standardised training module is essential for largescale teacher training. Train the trainer programme should be the priority; this requires close collaboration between the MOH

and the MOE. Appointing certified CPR trainers, for example paramedics, nurses or doctors is crucial, as these trainers will prepare selected teachers to deliver instruction in their school settings. It is important that selected teachers are trained using a nationally approved, standardised programme that is simple and practicable for teachers from varied backgrounds. Training should emphasise both theory and hands-on practice. Once fully certified by the MOH led programme, these teachers can be formally assigned responsibility for delivering CPR instruction in their schools and should attend periodic refresher courses to maintain knowledge and skills. Overall, this approach creates a domino effect: certified teachertrainers multiply capacity, lower per teacher costs, and facilitate wide dissemination of CPR knowledge and skills while enabling regular updates to keep pace with international changes in resuscitation guidelines (Lockey et al. 2016; Pivač et al. 2022; Zinckernagel et al. 2016a; Zinckernagel et al. 2016b). Now that the curriculum is established and teachers are prepared to deliver it, it is important to ensure preimplementation preparations align with teacher development, including resource allocation and infrastructure.

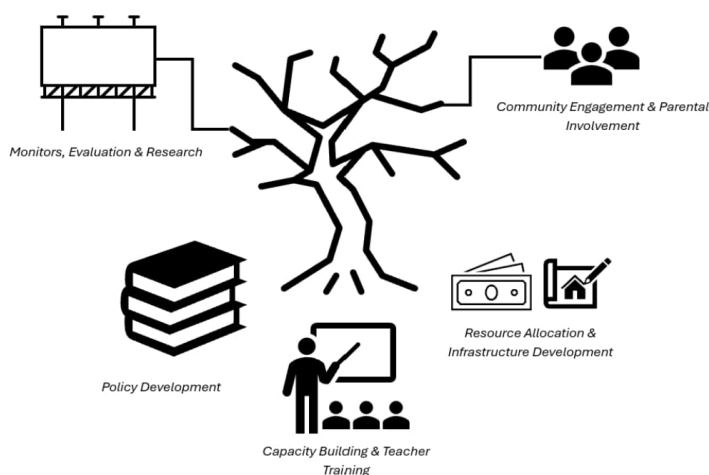


FIGURE 1: Roots and growth framework. Drawn using Mirosoft Word (Microsoft Corporation, Redmond, WA, USA)

The government should allocate funding to support this large scale programme, covering three main items: a budget for teacher preparation and training; costs to purchase training equipment, such as manikins and AEDs; and funds to prepare a designated room for CPR and AED training within school grounds. It is also crucial to fund the advancement of training through digital platforms and simulation tools to supplement hands-on practice and support active learning. These digital resources facilitate large-scale preparation, save time and improve skills accuracy through digital assessment. Teaching materials should conform to standard guidelines while remaining simple, clear and age-appropriate, considering students' cognitive and psychomotor development. (Bakke et al. 2017; Hoyme & Atkins 2017). Ensuring successful, sustainable implementation requires active involvement from school leadership, parents and the wider community. School leaders, particularly the principal are ultimately responsible for ensuring the subject is delivered effectively. Principals should provide foundational support by prioritising and permitting teacher training, which prepares staff to teach the subject. Leadership can also relieve curriculum pressure by allocating timetable space, so CPR and AED programs is treated as equal in importance to other subjects. Parental and community engagement, including the parent-teacher association (PTA), can provide networking and additional instructors; parents with healthcare backgrounds could serve as volunteer instructors to reinforce CPR education. These approaches promote shared responsibility and ownership, help sustain the subject long term, and increase support and interest among students and families (Fan et al. 2018; Yim et al. 2020).

Monitoring and evaluation are essential to ensure the sustainability of school-based CPR education. Although CPR instruction should be mandated within the curriculum, the Ministry must conduct continuous oversight, including review of the legislative framework. Monitoring systems need to be established because they are crucial for assessing training outcomes

against the approved curriculum. These systems should measure success in knowledge and skill acquisition, annual retention rates among students, and fidelity of implementation across schools. This will help to prevent variability in student outcomes arising from nonstandardised delivery. In addition, longitudinal studies should be conducted through collaboration between universities and the MOE, to evaluate the long-term impact of CPR education on bystander CPR rates in Malaysia. Finally, routine feedback and tailored approaches are required to improve engagement and acceptance of the subject among teachers, students and parents (Calicchia et al. 2024). In summary, implementing a standalone CPR and AED subject underpinned by robust policy, standardised teacher training, adequate resources, community engagement and rigorous monitoring offers a viable route to embedding lifesaving skills in Malaysian schools and sustaining impact at the national level.

The proposed "Roots and Growth" framework aligns closely with WHO's HealthPromoting Schools approach: the "roots"-strong policies, teacher capacity building and resource allocation - provide the structural foundation, while the "growth" - continuous evaluation, community and parental engagement, and ongoing skills practice - fosters a supportive social and learning environment. Operationalising both frameworks entails curriculum integration, adaptation of the physical environment (e.g. accessible AEDs, designated training and simulation spaces) and strengthening the school's social environment (clear policies, leadership, peer mentoring and routine practice). Crucially, it extends beyond the school gates by actively engaging families, local health services and community organisations as partners in training, advocacy and evaluation, thereby reinforcing learning, expanding capacity and enhancing sustainability. Together, these complementary frameworks offer a coherent, evidence-based strategy to mainstream CPR education across Malaysia and to improve bystander response and public health outcomes over the long term (Langford et al. 2014).

This study has limitations, and therefore, all

findings should be interpreted with caution. Firstly, the number of teachers participating in this study falls below the minimum sample size required for generalisability to Malaysian school teachers. To address this limitation, future research should aim to meet or exceed appropriate sample sizes, ideally encompassing larger, nationally representative groups across all states. Doing so would enhance the robustness of the findings and provide greater confidence in their applicability. While this study provides self-reported perceptions of Malaysian school teachers CPR and AED education, its reliance on a survey approach, which limit the depth understanding. Therefore, further research should incorporate a mixed-method design which would involve complementing the quantitative data on knowledge, attitudes, willingness and perceived barriers with qualitative inquiries to capture richer contextual details and teacher experiences. In addition, integrating direct observation of CPR/AED implementation with larger scale quantitative data collection would enable a more robust statistical analysis of various training methodologies and their impact, which improving the generalisability of findings and offering a more comprehensive view of the identified facilitators and barriers.

CONCLUSION

The results of this study highlight a gap between Malaysian school teachers' willingness to teach CPR and AED and their actual readiness to do so. Although more than half of the participants expressed interest in providing CPR education, only a few demonstrated adequate knowledge or reported receiving recent training. Structural and institutional barriers including lack of funding, insufficient institutional support, and perceived disinterest among students were some reported barriers. The lack of significant differences in the teachers' demographic background across their knowledge and attitudes towards teaching BLS indicates that the challenges are systemic rather than individual. Therefore, more effort should be done to improve teachers' knowledge and skills

through structured training programs, providing adequate resources, and securing stronger support from educational authorities from the central, state and district levels. Developing policy frameworks and sustainable funding will be crucial to overcoming the stated barriers to enable the integration of CPR and AED education within Malaysian schools.

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