Knowledge Retention After Blended Learning CPR First Aid Training

by

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ABSTRACT

Knowledge retention after cardiopulmonary resuscitation (CPR) first aid training delivered through blended learning is an area that has not been extensively researched. Previous research conducted has not been specific to blended learning, was limited to only CPR, and often the participants were healthcare professionals. This study employed a cross-sectional design to address this research gap by examining knowledge retention after blended learning CPR first aid training for non-healthcare professionals. Former students from two CPR first aid training companies were recruited to participate and all study data was collected using an online survey. Measures of central tendency were used to describe the data collected, while CPR first aid knowledge retention was analyzed using inferential statistics. The study findings have important implications for education delivered though blended learning, current policies for CPR first aid re-training intervals, and future research related to CPR first aid knowledge retention specifically when delivered through blended learning.

DEDICATION

I would like to dedicate this paper to my husband Evan, daughter Ella, and son Aaron. They have been with me through all the difficulties of a Masters program, encouraged me when I needed it most, listened to me talk about statistical analysis, and stress over deadlines. It has been a journey for everyone in my household, and I appreciate their support.

My mother started me on my love of nursing. She was a graduate of the Saint John School of Nursing. That was a different era of nursing from when I was enrolled in nursing education; however, other nurses have informed me that we have similar working styles. Her passion for the profession has always been apparent to me and her colleagues.

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List of Abbreviations

1. Master of Nursing …… MN
2. Cardiopulmonary Resuscitation ..... CPR
3. Coronavirus Disease of 2019 ..... COVID-19
4. Canadian Standards Association ..... CSA
5. Canadian Nurses Association ..... CNA
6. New Brunswick ..... NB
7. Cumulative Index to Nursing and Allied Health Literature ..... CINAHL
8. Medical Literature Analysis and Retrieval System Online ..... Medline
9. Education Resources Information Center ..... ERIC
10. Medical Subject Headings ..... MeSHs
11. Randomized Controlled Trial ..... RCT
12. Basic Cardiac Life Support ..... BLS
13. Advanced Cardiac Life Support ..... ACLS
14. Specific, Measurable, Attainable, Realistic, and Timely ..... SMART
15. University of New Brunswick ..... UNB
16. Research Ethics Board ..... REB
17. Canadian Institutes of Health Research ..... CIHR

Chapter One

Introduction

When I graduated from the Bachelor of Nursing program twenty-one years ago, I had spent countless hours in a classroom, skills lab, and the hospital. All of my learning was done in person, in a traditional classroom setting, with no online learning. I recognize the internet was invented when I enrolled in my undergraduate degree, however it was not used as extensively as it is today; teaching and learning has evolved significantly with the evolution of technology. For my current Master of Nursing (MN) degree, I have completed all coursework online over the past three years. Most academic institutions offer course delivery in person, online, or a blend of the two. Being a learner in an online environment comes with different advantages and challenges than a face-to-face classroom setting. For me, the adjustment to online learning when I began the MN program took a period of time as I had to figure out the technology, course expectations, and identify strategies for me to remain focused.

The use of online learning has been growing since I first attended university, however the Coronavirus Disease of 2019 (COVID-19) pandemic has made it a common delivery method of education worldwide (Martin et al., 2020). The Organization for Economic Co-operation and Development (2020) noted that the number of adults engaging in online learning was four times higher during the pandemic than before. Offering online learning, academic institutions can reach more students, thereby improving student enrollment (Martin et al., 2020; Raes et al., 2020). Online learning also eliminates the need for academic institutions to create physical environments that are

conducive to learning, which can be expensive and difficult to maintain. For students, online course delivery provides flexibility in teaching and learning schedules and can eliminate location and time restrictions often seen in face-to-face classroom settings (Chandrasiri & Weerakoon, 2022). Compared to traditional face-to-face classroom learning, key benefits of online learning identified are increased accessibility to learning and more flexible learning options where students can set their own pace or use their time more efficiently (Chandrasiri & Weerakoon, 2022; Estelami, 2016; Raes et al., 2020).

The benefits of online learning still apply to students accessing blended learning, which is a combination of online and face-to-face classroom learning. To qualify as blended learning, a course or instructional activity must have between 30% and 80% of the course content delivered online with the remaining done face-to-face in a classroom setting (Allen & Seaman, 2010; Smith & Brame, 2014). An advantage of blended learning is that the online portion is often done before the face-to-face classroom sessions which helps prepare the learner for the face-to-face learning component (Elgohary et al., 2022). One area where blended learning has the potential to make a significant impact is CPR and first aid training. In fact, Cason and Stiller (2011) report one of the most cited reasons for not obtaining CPR first aid training is the requirement to schedule or attend class. Blended learning delivery for CPR first aid training has not been researched extensively, specifically knowledge retention after course completion or participant's motivations for seeking training.

Study Goals

The primary goal of this study was to identify learners' knowledge retention after completing a blended learning course for CPR first aid training. The secondary goal was to identify the participants' motivations for seeking CPR first aid training through blended learning. The research question that guided this study was; How does time since course completion impact knowledge retention among non-healthcare professionals who have undergone blended learning CPR first aid training?

Blended Learning

Blended learning is often used interchangeably with hybrid learning; I will refer to it as blended learning throughout this thesis paper. When considering different ways of defining blended learning, I opted to use the definition formulated by Elgohary et al. (2022) from their systematic review. "Blended learning is defined as the integration of face-to-face and online instruction, with coherence between the online and face-to-face elements to ensure they complement each other" (p.1). This definition was chosen because of the use of the word's coherence and complement. It is important that the components of blended learning complement each other to enhance the learning experience.

Research Study Background Information

The use of a blended learning model for CPR first aid training first emerged approximately five years ago. For this study, I partnered with two NB CPR first aid companies certified to deliver CPR first aid training that offer courses through blended learning. Their courses include CPR and first aid training as one module, and for the final

course assessment, students are evaluated on both CPR and first aid together. The courses being evaluated for this research study are workplace standard intermediate CPR first aid with approximately 50% of the course being delivered online and then the remaining component in a face-face classroom with an instructor where students' CPR first aid skills and knowledge are applied and assessed.

The Canadian Standards Association (CSA) outlines the national standards for CPR first aid training in Canada and provides training companies the regulations to adhere to. Course components and length of time spent learning online versus in a face-to-face classroom are also specified. The current CSA guidelines dictate that workplace standard intermediate CPR first aid training is required every three years (CSA, 2017). In addition to the full training course that is required every three years, in New Brunswick (NB), WorkSafe NB stipulates that a six-hour re-training course must be taken annually to maintain certification in the two years between full course requirements (WorkSafe NB, 2021). WorkSafe NB is government organization that oversees the implementation of the Occupational Health and Safety Act in the Province of NB, Canada (WorkSafe NB, 2023).

The Importance of CPR First Aid Training to Nursing

The Canadian Nurses Association (CNA) outlines the essential principles of primary healthcare, which include active public participation, health promotion, and chronic disease prevention (2015). A large part of nursing education is focused on health promotion and health education. In an integrative review, Kemppainen et al. (2013) note health promotion by nurses can lead to many positive health outcomes, such as increasing

patients' adherence to medications, quality of life, knowledge of their illness, and self-management. Health education is described in the literature as imparting health-related information that can influence a person's values, beliefs, attitudes, and motivations; there is knowledge acquisition that can lead to skills development and lifestyle or behaviour modifications (Kemppainen et al., 2013). Health education is an activity that seeks to inform individuals about health-related information (Whitehead, 2004), whereas health promotion activities can empower patients (Kemppainen et al., 2013). Engaging in health education that is accessible is the foundation for health behaviour change and increasing access to effective health education can contribute to improved health outcomes (Adam et al., 2019).

According to the Heart and Stroke Foundation (2022), 35,000 Canadians experience cardiac arrest outside of hospital each year, either at home or in public places. Only one in ten survive, yet survival rates can double with immediate action (Heart and Stroke Foundation, 2022). A study by Kuramoto et al. (2008) surveyed non-healthcare professionals to examine their perceptions and willingness to perform CPR. Only 13% of participants responded that they were willing to attempt CPR in medical emergencies involving their families or friends, and that number dropped to 7% when it was a stranger that required help. According to the authors, the willingness of non-healthcare professionals to attempt CPR was shown to be associated with higher educational level, experience of the participant with CPR, and previous CPR training. The evidence supports that previous CPR training increases the likelihood of non-health care professionals to respond to situations that require CPR and that is an important measure

to increase survival rates among individuals who experience health emergencies in the community.

According to the nursing code of ethics, nurses are responsible for delivering health education and promoting health (CNA, 2017). This can be done in multiple settings such as community, medical clinics, schools, and through the media. In my current nursing role as a Clinical Nurse Specialist, I provide education and health promotion in a clinic setting and on an inpatient nursing unit to support patients and their family members. I review signs and symptoms of stroke as well as modifiable and non-modifiable risk factors. I attempt to empower patients to take control of their health and modify what they can. I have noted in my professional experience that in many cases, due to health education, specifically first aid training, the patient, family members, or bystanders recognized stroke symptoms, and it prepared them to react to the situation immediately. Quick recognition of signs and symptoms of stroke, heart attack, or other urgent health problems can save lives or prevent significant disability. I see the impact of training and education in my daily practice, and it is important.

In this chapter the concept of blended learning was defined, and the existing standards for CPR first aid training, as well as the intervals for recertification were explored. The study goals of examining knowledge retention after course completion and non-healthcare professionals' motivators for seeking training through blended learning were outlined. In addition, the importance of CPR first aid training for nurses was emphasized, and the impact of training on non-healthcare professionals was described.

Chapter Two

To understand the impact of a blended learning approach to CPR first aid and training, it is important to first appreciate the alternate approaches and their outcomes. While the focus of this study is on non-health care professionals and workplace standard intermediate CPR first aid training, there is value in examining the literature more broadly to include health care professionals. Furthermore, because of the increased reliance on online learning in recent years, and the separation of CPR and first aid training in some contexts, it is important to look at CPR and first aid training in both combination and separately. Literature pertaining to the CPR and first aid needs to be understood from a wide lens to appreciate how a specific teaching approach impacts learning outcomes. The literature review results are presented in five sections to summarize the results retrieved by topic.

Literature Review Search Strategy

To commence the literature review, I requested the assistance of the UNB health sciences librarian to develop a search strategy. Literature related to CPR and first aid training, knowledge retention after completing training, adult learners, non-healthcare professionals, online and blended learning were explored. A variety of search terms were used to search the databases in addition to Medical Subject Headings (MeSHs) and Boolean operators OR along with AND to combine search terms. Eight different combinations of search terms were used. Search one terms included "first aid" OR "CPR" OR "red cross" AND "online learning" OR "e-learning" OR "blended learning" OR "hybrid". Search two included "first aid" OR "CPR" OR "red cross" AND "online

learning" OR "e-learning" OR "blended learning" OR "hybrid" AND "design" OR "assess*" OR "evaluat*". Search three included "first aid" OR "CPR" OR "red cross" AND "online learning" OR "e-learning" OR "blended learning" OR "hybrid" combined with AND "knowledge retention" OR "knowledge retention strategies". Search four included "online learning" OR "blended learning" AND "course design". For search five, a MeSH was used, "online learning" versus "face to face". Search six included "blended learning" AND "benefits" AND "challenges". Search seven included "general public" OR "laypeople" AND "CPR training" AND "importance". The final search included the terms "health promotion" OR "health education" AND "nurs*".

Multiple databases were used to search the literature, including the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Medical Literature Analysis and Retrieval System Online (Medline), and Education Resources Information Center (ERIC). CINAHL and Medline usually provide quality health-related literature and most of the CPR literature is healthcare related. ERIC was used because it contains literature related to education research, including online and blended learning modes of education delivery. Google Scholar was also used to search the literature; it provides access to a wide range of literature. The search was conducted in 2022, limited to articles available in the English language and published in the last five years except for health promotion literature; the timeframe for this particular body of literature was extended further to twenty years. The timeframe for health promotion literature was extended as it is not a new concept for nursing, unlike blended or online learning. I focused on adult learners, blended learning or online learning, and non-healthcare professionals.

The search retrieved 386 articles from ERIC, 136 articles from CINAHL, 102 articles from Medline, and 36,290 from Google Scholar. Because of the volume of results retrieved from Google Scholar, I followed the advice of Ćurković & Košec, (2018) and screened only the first 50 titles from each search. Titles from all databases were screened, and duplicates were excluded. Articles that were identified as irrelevant based on the title, abstract, or both were immediately excluded. Seventy full text articles were reviewed, and 27 articles were chosen following the review of the 70 full articles. The reference lists from retrieved articles were examined to identify any relevant articles resulting in 15 of the 42 total articles used for this thesis paper. Most of the articles retrieved from the reference lists were older than five years, but they were included because of their relevancy. One article was included that examined CPR knowledge retention rates in high school students, as the literature related to the topic was limited. Articles were included where the population under study were healthcare professionals, as much of the CPR literature is healthcare related. There were many articles focusing on learning during the COVID-19 pandemic, psychological first aid, cost analysis, smartphone applications, and virtual simulation that were deemed irrelevant and therefore excluded. Studies including children were also excluded. In addition to database searching, I also conducted a Google search that resulted in eight useful websites on a variety of topics, such as course design, heart and stroke statistics, and the nursing code of ethics. Documents related to CPR first aid national guidelines and WorkSafe NB were obtained from the partnering CPR first aid companies.

Literature Review

Blended Learning for CPR First Aid Training

Blended course design for CPR first aid courses is a relatively new method of delivery. During this thesis paper I explore how this delivery method compares to other methods of course delivery. A search of the literature identified five articles related to blended learning for CPR training that were reviewed for this research. Two of these articles were systematic reviews; the others included randomized controlled trials (RCT) and a cluster-controlled study. Research conducted specifically on blended learning as a method of course delivery for CPR and first aid training has focused almost exclusively on CPR. Many of the studies identified compared blended course delivery to face-to-face classroom delivery and assessed student satisfaction, CPR skill acquisition, and knowledge retention at different time points after course completion. The studies chosen for review were related to the topic under study and helped guide the study.

In an RCT by Chien et al. (2020), CPR training for non-healthcare professionals delivered through blended learning was compared to face-to-face delivery in a classroom setting. Student knowledge retention and practical skills were examined at two time points, six and twelve months after course completion. Findings showed no statistically significant difference in retention of CPR knowledge or skills performance between the two groups at either assessment time point. Furthermore, there was no statistically significant difference in knowledge retention or skill performance when comparing theoretical knowledge and practical CPR skills from the six and twelve month

assessments. The authors concluded that CPR training delivered through blended learning was as effective as the face-to-face traditional classroom delivery.

A systematic review by Ali et al. (2021) included twenty studies related to CPR performance, quality, and knowledge retention for different course delivery methods of CPR training for non-healthcare professionals. Mixed results were reported after reviewing the studies on face-to-face classroom training versus alternate forms of learning, such as blended or online-only CPR training. When instructional methods were compared, three of the studies reported no significant differences in CPR knowledge retention between methods and four reported better knowledge retention. Overall, the authors concluded that alternative CPR training methods, including blended learning and online-only training are as effective as face-to-face classroom training in CPR performance and knowledge acquisition. However, they caution that learning "quality" CPR still largely depends on some in-person training. Overall, they concluded that alternate methods of CPR training provide an effective option to traditional face-to-face learning, especially during the COVID-19 pandemic. In an additional systematic review, Elgohary et al. (2022) reviewed the impact of blended learning for basic life support (BLS) and advanced cardiac life support (ACLS) courses for healthcare professionals. The studies included in the review examined knowledge acquisition and retention in addition to student satisfaction. Findings showed that blended learning is at least as effective as traditional face-to-face courses for student satisfaction, skills acquisition, and knowledge retention. It was also noted that blended learning is an efficient method of course delivery and can have long-term cost savings for the course provider despite the high start-up costs.

An RCT by Castillo et al. (2018) evaluated first-year nursing and medical students on basic life support skills by examining knowledge retention and skills performance. The control group consisted of a face-to-face classroom delivery method, and the experimental group was assigned to a blended delivery course. Students' performance was evaluated prior to training, at course completion, and at six months post-course. Data showed no statistically significant differences between the groups when examining knowledge levels; however, when practical skills were evaluated at course completion, the blended delivery group had higher scores than the face-to-face classroom group. Similar results were noted in favour of the blended delivery group six months post-course completion. Although test scores differed between groups for practical skills, both knowledge and practical skills were significantly reduced for both groups at six months post-course completion, indicating they had a similar rate of knowledge and skills decline. The authors concluded that knowledge retention is independent of the teaching method and expressed concern over how to reinforce CPR skills over time to prevent the decline.

A cluster-controlled study by Reder et al. (2006) evaluated high school students enrolled in three different CPR training programs. Knowledge was assessed at two time points with study findings indicating that students in the blended delivery method achieved the highest scores on knowledge acquisition immediately post-course and two months later. However, they did not test students later than two months due to the logistical challenges of high school semesters.

The literature provides evidence that blended learning is at least as effective as traditional face-to-face classroom learning, with some studies concluding that blended

learning may be the better learning approach in relation to knowledge gained and retention as well as skill acquisition.

CPR First Aid Re-Training Intervals

When reviewing the literature, there was discussion in five of the selected articles related to re-training intervals for CPR; however, a research gap was noted for first aid re-training intervals. Many articles (Anderson et al., 2019; Castillo et al., 2018; Chien et al., 2020; Nishiyama et al., 2015; Woollard et al., 2006) evaluated knowledge retention after CPR training at specific time points (e.g., six months after training), which could be used as evidence to support re-training intervals. Chien et al. (2020) assessed knowledge retention at six and twelve months after course completion and found retention of CPR knowledge was similar between groups at both time points. Results showed students had slightly reduced CPR knowledge at the six-month test but then retained that knowledge level when tested at the twelve-month time point. In their study, Chien et al. (2020) noted that CPR skills deteriorated faster than theoretical knowledge, similar to previous research studies conducted on the topic (Anderson et al., 2012; Hamilton, 2005; Mahony et al., 2008).

Multiple studies (Anderson et al., 2019; Castillo et al., 2018; Chien et al., 2020; Nishiyama et al., 2015; Woollard et al., 2006) made specific recommendations for re-training intervals for CPR skills; however, none examined first aid training. The participants in the studies varied from non-healthcare professionals to students enrolled in healthcare-related programs or nurses. An RCT by Anderson et al. (2019) examined different training intervals for CPR to determine the optimal training frequency. After

completion of a CPR training course, the authors randomized nurses from a Canadian hospital to one of four groups. Groups of nurses were allocated to complete brief CPR re-training practice sessions monthly, every three months, every six months, or at one-year post-completion of the original CPR training. When the nurses completed monthly re-training, they performed "excellent CPR" 58% of the time versus every three-month training group 26% of the time, every six-month training group 21%, with every twelve-month training group only performing "excellent CPR" 15% of the time. Based on their findings, the authors recommended monthly CPR re-training to ensure effective CPR performance. Similarly, Castillo et al. (2018) noted practical skills were significantly reduced at six months after CPR course completion, however, the blended learning students retained more knowledge compared to the face-to-face classroom group. An RCT by Woollard et al. (2006), sought to determine the optimal re-training interval for CPR. Their study findings supported CPR skills re-training not exceed seven months. Nishiyama et al. (2015) and Chien et al. (2020) both recommended a brief re-training course at six months after the initial course completion to help maintain CPR skills. Apart from Anderson et al. (2019), the recommended intervals of six to seven months for CPR re-training were consistent among the studies (Castillo et al., 2018; Chien et al., 2020; Nishiyama et al., 2015; Woollard et al., 2006). The workplace standard intermediate CPR first aid courses being evaluated for this study are for the general public, not healthcare professionals. The current Canadian regulations require CPR first aid recertification every three years with a six-hour re-training course annually in NB to maintain certification in the two years between full course requirements.

Instructor Challenges & Advantages of Online & Blended Course Delivery

Although the focus of this research is on learners' knowledge retention and motivations for seeking blended learning CPR first aid training, literature on instructors' challenges and advantages of delivering online and blended learning education were explored to provide context to students' experiences. According to Rasheed et al. (2020), blended learning is considered the most effective and popular mode of course delivery adopted by educational institutions. Blended learning is more complex than traditional face-to-face classroom delivery as it is a combination of in-person and online learning, which comes with many challenges and advantages. Seamlessly adding an online component to a course is not always easy; depending on the instructor, they may need training and technological support (Rasheed et al., 2020). A qualitative study by Kumar et al. (2019), described expert online instructors as being "experienced and comfortable in the online environment, using a wide range of strategies, being willing to learn, using data and analytics, and engaging in continuous improvement" (p.160). Expecting instructors who have no experience with online course delivery to develop and deliver effective courses could pose multiple challenges, such as difficulty with technology, course design, and teaching style. Not unlike their students, instructors need to be supported to be successful, it is easy for instructors to become overwhelmed trying to navigate technology (Martin et al., 2020; Rasheed et al., 2020).

Engaging the learner can be more difficult in the online portion of blended course delivery, but it is extremely important as the students are separated from their peers and the instructor (Martin et al., 2020). In addition, creating a sense of community in an online class can be more challenging than in-person course delivery. Interacting with

peers and instructors helps students build relationships and can help with a sense of community. This interaction can be done in a variety of ways, such as through discussion boards where students can post problems or challenges they are experiencing with assignments, and instructors can post changes in the curriculum or requirements (Cicco, 2016). Opportunities for communication in the online portion of blended learning are important for students and instructors, especially when teaching a course that is asynchronous. If students have social interaction with peers and instructors in the online portion of class, they may feel more comfortable interacting during the face-to-face class. Evidence suggests that blended learning can increase the interaction between instructors and students, and it is considered a valuable form of learning by different sorts of learners (Rasheed et al., 2020).

Student Challenges & Advantages of Online & Blended Learning

When considering student challenges and advantages with blended learning, most of the literature is focused on the online portion, not the traditional face-to-face classroom setting. The CPR first aid training examined in this study is a skills-based course delivered through blended learning. Because a portion of blended learning is done online, the challenges of online learning still apply but to a lesser degree. The online portion of blended learning is influenced by many factors that can create challenges for students. Potential challenges to online learning include the level of student academic skills, technological skills, students' academic motivation, instructor support, and the cost of technology (Pei & Wu, 2019). A systematic review by Rasheed et al. (2020) examined the online portion of blended learning from the perspective of students, instructors, and educational institutions

and multiple potential student challenges with online learning were noted. Similar to the potential difficulties noted by Pei and Wu (2019), these challenges include issues with student self-regulation, such as procrastination or time management skills, technological competency, and insufficiency challenges, such as lack of technology skills or equipment, as well as student isolation challenges (Rasheed et al., 2020). The authors identified solutions to overcome such challenges, including having a face-to-face class at the beginning of the blended delivery course to connect the students with peers and the instructor and for opportunities to set course and technology expectations. Alternatively, this class could be done online to promote social interaction and connection among students and the instructor prior to meeting in person.

When reviewing literature related specifically to online learning, studies note that online learning delivery offered an educational pathway that is flexible in relation to time or location, and some students claimed online class was more comfortable when communicating in class than face-to-face classroom learning (Chandrasiri & Weerakoon, 2022; Milz, 2020). Learning online can be less time-consuming than face-to-face classroom delivery and has the potential to allow students to complete a course faster than anticipated, and with some courses, they can set their own pace (Chandrasiri & Weerakoon, 2022). In their systematic review, Martin et al. (2020) noted that successful online learners had certain characteristics, such as strong academic motivation, good time management skills, and goal setting. With blended learning, during or after the course's online portion, students have a chance to be face-to-face with their peers and the instructor. A benefit of blended learning is the hands-on classroom portion at some point during the course, researchers have noted that students have difficulty learning clinical skills online in

comparison to a laboratory or clinical setting when enrolled in healthcare-based programs (Chandrasiri & Weerakoon, 2022). In a cross-sectional study, Bogossian et al. (2018) used simulation in a nursing program to teach clinical skills, and it was positively valued as an adjunct or substitute for clinical placement. Despite being viewed positively, the authors noted that online learning should not replace all hands-on clinical experience. The students reported that simulation enhanced their clinical placement learning and clinical competence. Blended learning can provide students with a rich learning experience due to the combination of face-to-face classroom learning and online components. Together, the two components support each other and lessen the student challenges associated with online learning (Rasheed et al., 2020).

Blended & Online Learning Course Design

There is evidence that online course development and design, specifically, how the content is delivered, the amount of information that can be presented during a single session, and methods used to engage students are critical to students achieving learning outcomes. Many institutions do not have processes in place for development or evaluation of online or blended learning courses (Martin et al., 2020). For example, an instructor should only use aspects of a learning platform if they contribute to student learning or evaluation (e.g. quizzes, discussion boards). Courses can be evaluated in several ways such a student surveys, analytics, etc., however Martin et al. (2020) note there is a need for further research on online course evaluation and quality.

As courses are changed to blended or online delivery, it is important to have flexibility and realistic and clear expectations for students and instructors (Carlton

University, 2021). Instructors often design courses based on their face-to-face classroom experience and incorporate the same strategies when teaching online courses; however, such an approach can be problematic as the effectiveness of teaching strategies can differ based on the mode of delivery (Baldwin et al., 2019). The online learning environment requires a different setup that highly influences the teaching and learning design. Although technology is a key element, its use should always be content driven. The curriculum should not be developed to fit the technology the technology should be developed to fit the curriculum (Driscoll et al., 2012; Raes et al., 2020).

A systematic review by Boelens et al. (2017) examined blended learning course designs and identified four key challenges associated with this design; they included how to incorporate flexibility, stimulate interaction, facilitate students' learning, and how to foster an effective learning climate. Findings showed that for the online portion, students do have some flexibility when studying the course material in terms of when they access content, the pace at which they complete the modules, and where they access it from. In relation to social interaction, the blended learning design often facilitates interaction due to the face-to-face aspect of the course and potential interaction among peers and the instructor in the online portion as well. During the review, the authors noted that facilitating students' learning and fostering an effective learning climate is more challenging as students' personal attributes can impact their academic motivation, ability to work autonomously, and required level of social interaction.

Before designing an online course, it is important to consider the audience, what knowledge they have related to the subject matter, and what instruction is needed to help them complete the course (University of Guelph, 2016). When considering course design

options, the University of Guelph (2016) recommends working backwards and thinking about the course learning outcomes, how students will demonstrate knowledge acquisition, and if there will be an opportunity for students to practice psychomotor skills learned to help prepare them for assessment. It is important to determine learning outcomes when designing any education and/or training activity as they are the foundation of the design phase, and all course components should be developed based on these (University of Guelph, 2016). Student progress toward achieving these outcomes can be assessed by multiple methods, including written tests, presentations, papers, discussions, and exams. Carlton University (2021) notes that course design is an iterative process and recommends using the SMART acronym when planning learning outcomes, they should be specific, measurable, attainable, realistic, and timely. If the blended delivery course is designed well, it combines the benefits offered by face-to-face instruction and online delivery (Rasheed et al., 2020).

When designing blended learning courses, it is also important to consider how the course delivery will impact the hosting provider or educational institution. According to Rasheed et al. (2020), a high cost can be associated with producing the content for online classes, providing the appropriate technology, and training the instructors. When discussing this study with the participating CPR first aid program delivery companies, it was noted that the cost, training, and time associated with upgrading course content created challenges. Having a quick turnaround time to meet changing regulations requires resources and up-to-date technology. These factors need to be considered when designing and upgrading blended delivery courses created by institutions or industry.

This chapter discussed the strategy employed for the literature review, along with the subsequent review and summation of results. The literature provides evidence that blended learning for CPR training is at least as effective as traditional face-to-face classroom learning, with some studies concluding that blended learning may be the better learning approach in relation to knowledge acquisition and retention. Blended learning has the potential to provide students with a rich learning experience that is flexible in relation to time and location. Notably, there is a research gap in the literature concerning blended learning's application in first aid training. When designing blended learning courses, it can pose challenges for both hosting providers and instructors, adapting course content must carefully factor in these challenges. In addition, recommended re-training intervals were discussed, there were consistent recommendations of re-training intervals for CPR in several studies however none were identified for first aid.

Chapter Three

Methods

This chapter describes the methodologies employed to conduct the study. The objectives and research questions are outlined, the study population, sample size, and participant recruitment process are described. Ethical considerations such as consent, privacy, and data security are discussed. The data collection and analysis techniques are explained, including the use of descriptive statistics and statistical tests applied to analyze the data.

Study Objectives & Research Question

Blended learning delivery for CPR first aid training in non-healthcare professionals has not been researched extensively, specifically knowledge retention after course completion or participants' motivations for seeking training. The main objective of this study was to identify learners' knowledge retention after completing a blended learning course for CPR first aid training. In addition, participants' motivations for seeking training through blended learning were examined. The research question that guided this study was; How does time since course completion impact knowledge retention among non-healthcare professional who have undergone blended learning CPR first aid training?

Study Design

This study employed a cross-sectional design to address this research gap by examining knowledge retention after blended learning CPR first aid training for non-healthcare professionals. Cross-sectional studies are observational and collect data from a

population at a single timepoint. They are useful for establishing preliminary evidence to potentially help with future research (Wang & Cheng, 2020). Former students from two CPR first aid training companies were recruited to participate. All study data was collected at one time point from each participant using an online survey. The length of time between CPR first aid course completion and data collection varied across participants.

Sample, Study Population & Recruitment

According to Creswell and Creswell (2018) when determining a desirable sample size for a study involving survey data, the sample size can be based on 10% of the population under study, or it can be based on sample sizes used in similar studies. The sample sizes of the five studies retrieved during the literature review that examined knowledge retention after CPR training ranged from n=57 to n=736, with a mean of n=231. All these studies utilized RCTs designs; however, only three of them were conducted with non-healthcare professionals. Nishiyama et al. (2015) sampled n=112 students and employees from a university in Japan, intentionally excluding students enrolled in a medical-related program. Woollard et al. (2006) sampled n=57 lay volunteer first responders at an international airport in the United Kingdom, while Chien et al. (2020) sampled n=736 non-healthcare professionals from the general public; this was the only study identified during the literature search that examined non-healthcare professionals taking CPR via blended learning with knowledge retention as one of the outcomes.

The population of interest for this study was composed of individuals 19 years of age and older who completed blended learning a CPR first aid training course between the years 2020 to 2023 at one of the two participating companies. The education and training offered by both companies target non-healthcare professionals in the community. The CPR first aid companies initially estimated that 2000 people had completed the blended learning training in both programs; however, contact information was only available for 1400 former students who met inclusion criteria, all of whom were emailed a letter of invitation. The invitation letter (Appendix A) explaining the nature of the study was sent via email directly from the CPR first aid companies. The email also included a survey link for easy access. The link to the consent form (Appendix B) and survey (Appendix C) were included in the invitation email. Only students who successfully completed CPR first aid training through blended learning in the years 2020 to 2023 were invited to participate. Of the 1400 former students who were emailed a letter of invitation, 134, or 10%, clicked on the link to complete the survey. This response rate is similar to that observed in other knowledge retention studies (Anderson et al., 2019; Castillo et al., 2018; Chien et al., 2020; Nishiyama et al., 2015; Woollard et al., 2006). After excluding participants with incomplete surveys, the final sample size included in the analysis was n=111.

Consent

Informed consent (Appendix B) to participate in the study was obtained once the participant selected the link to the survey. Potential participants could not proceed with the survey without providing consent. Potential participants who chose not to consent to

the survey and selected no were directed to a thank you message, they could not proceed to the survey.

Data Collection

A survey was developed to assess participants' knowledge retention after completing the CPR first aid training. The Qualtrics online survey platform was used to administer the survey (Appendix C), which was composed of key components from the CPR first aid course assessment requirements based on input from participating companies. The survey consisted of 22 items; the first eight were general information related to demographics, location of training, motivators for seeking CPR first aid education and training through blended learning, prior experience with training, and date of training. Three of the demographic questions had open-text options to allow responses not included in the provided list of answer options. The remaining 14 items assessed knowledge retention for CPR and first aid and were taken from the final course assessment from the participating companies. The 14 questions were a combination of multiple choice and dichotomized (e.g., yes, or no). The survey was pilot tested on a small sample (n=10) of non-healthcare professional volunteers to ensure clarity, content validity, and to seek feedback. Additionally, one individual from each of the two participating CPR first aid companies reviewed the survey for content and face validity. Feedback from the volunteers, CPR first aid companies, and the supervisors for this study was incorporated into the final survey version.

Privacy & Ethical Considerations

This study was reviewed and approved by the University of New Brunswick's (UNB) Research and Ethics Board (REB) and is on file as REB #2023-049. In addition to ethics approval, the tri-council policy statement on conducting research with humans and the CNA code of ethics guided every aspect of this study. The survey was administered through a secure online platform called Qualtrics, and study documents are stored on the researcher's UNB secure OneDrive account. Qualtrics is a secure platform and all communications to and from the servers are encrypted using transport layer security. Data at rest is also encrypted in Qualtrics. The Qualtrics servers are protected by web application firewalls, employ an Intrusion Detection System to prevent access by unauthorized users, and the servers are located in Canada. The survey did not include any identifiable information such as Internet Protocol addresses.

As a thank you for participating, the participants were given the option to share their email address at the end of the survey to be entered into a draw for one of five electronic gift cards. The five winners of the gift card draw were contacted by the researcher via email. The email addresses were used only to enter them into the draw, to contact them if they won, and they were destroyed once the draw was complete. Survey data, any study-related documents, and participants' email addresses were only accessible to the researcher. All study-related data and documents will be kept for five years to comply with UNB REB requirements and to allow for dissemination of findings. Study data could be used in the future for a secondary analysis, and this information was shared with the participants in the consent form. Participants were also made aware in the consent form that their information would be anonymized; no identifiable information

would be included in any research reports, presentations, or publication(s). Participants were also advised that they could contact the researcher via the email address included in the letter of invitation if they wished to receive a copy of the study findings.

Data Analysis

Survey data obtained from Qualtrics was exported to Excel and saved on the researcher's UNB secure Onedrive. After cleaning the data, it was exported into the statistical analysis program Jamovi Version 2.3.28 (The Jamovi Project, 2023). The data cleaning involved removing 23 incomplete surveys that only contained demographic data. The final sample included in the analysis was n=111. Descriptive statistics were used to examine demographics, location of training, motivators for seeking CPR first aid training through blended learning, prior experience with training, and date of training.

Chi-Square Test

CPR first aid knowledge retention test scores and time since course completion variables were analyzed using a Chi-square test to make inferences about the existence of a relationship between variables (Polit, 2010). The following null hypothesis was formed prior to analyzing the variables; There is no statistically significant association between the participants' knowledge retention test scores of 75% or greater and the time since blended learning course completion. A p-value of $<.05$ was considered statistically significant.

To meet the assumptions of the Chi-square test, the two variables, CPR first aid knowledge retention test scores and time since course completion, had to be re-coded. There were 14 questions on the knowledge retention test, and one point was allocated for

each correct answer. The test score results ranged from 7 to 14 correct answers. The CPR first aid test scores were re-coded from seven different scores to two groups, a score of 75% or greater or 75% or less. A test score of 75% or greater is equivalent to a score of 11 out of 14. Re-coding the variables was necessary to reduce the number of levels to ensure the expected frequencies cell count in the contingency table (Table 2) was at least five. The variable time since course completion had to be re-coded from six options to two. They were re-coded into two groups, training under one year ago or in the past one-three years. When the groups were combined, the under one year group amounted to 81 participants, and the remaining 30 were in the one-three years since course completion group.

Fisher's Exact Test

Although the variables CPR first aid knowledge retention test scores and time since course completion were re-coded, the assumptions of the Chi-square test statistic were not met. The expected frequencies cell count of at least five was only met in three out of four cells; therefore, a Fisher's Exact test was completed. A Fisher's Exact test is indicated when low expected frequencies are computed in the contingency table and a Chi-square test could be invalid (Polit, 2010).

Odds Ratio & Correlation Coefficients

In addition, an odds ratio was calculated, and the correlation coefficients were reviewed to examine the strength of association between variables, CPR first aid knowledge retention test scores, and time since course completion.

This chapter outlined the study goals and research questions. A cross-sectional framework was employed to gather information from a demographic of non-healthcare professionals who completed a blended learning CPR first aid training course. The participants were recruited through two CPR first aid training companies and provided with an internet survey link to gauge their knowledge retention after completing the CPR first aid course. The analysis included describing the data through descriptive statistics and completing a Chi-square test and Fisher's exact test.

Chapter Four

Findings

This chapter presents the findings from the online survey conducted to address the research question: How does time since course completion impact knowledge retention among non-healthcare professionals who have undergone blended learning CPR first aid training? In addition, the general information questions from the survey related to demographics, location of training, motivators for seeking CPR first aid training through blended learning, prior experience with training, and date of training were examined using descriptive statistics.

Descriptive Statistics

Sex & Age

Among the 1,400 individuals who had previously participated in blended CPR first aid training and received the survey invitation, a total of 134 respondents (10%) completed the survey. However, due to incomplete data from 23 participants, the final analysis included a sample size of 111 individuals (n=111). Of those participants, 80 or 72% were female, and 31 or 28% were male (Table 1). Ages ranged from 19-69 years, with the largest number of participants (32%) 19-29 years of age. When participants were stratified by age (19-29 yrs.; 30-39 yrs.; etc.), the mean knowledge retention test score was similar among the different groups ranging from 11.2-12.1. The highest mean score (12.1) was for the 40–49-year-old group of participants, and the lowest mean score (11.2) was for the 60–69-year-old group.

Location of Training

Participants reported where they completed CPR first aid training. The two companies where participants completed their CPR first aid training are hereafter referred to as Company A and Company B. The largest group of participants, 106 or 95%, completed training at Company A. Five or 5% of participants completed training at Company B. The mean knowledge retention test score from Company A was 11.7 and Company B was 12.0.

Motivators for Seeking Training

When asked about their motivators for seeking blended CPR first aid training, the majority of the respondents (n=88; 79%) identified that successful course completion was a requirement for their work. The mean knowledge retention test score for those seeking training for work was 11.6. Other reasons for seeking training included wanting to learn (n=11; 10%; mean test score 12.5), being a Girl Guide leader (n= 7; 6%; mean test score 11.4), a requirement for volunteering (n=3; 3%; mean test score 11.0), having a high-risk family member who may require CPR or first aid (n=1; 1%; test score 12.0), and a requirement for school (n=1; 1%; test score 13.0) (Table 1). The participant, n=1, who reported seeking training as a requirement for school achieved the highest test score of 13.0 and those who reported seeking training to learn, n=11, achieved the second highest mean test score at 12.5. The mean CPR first aid knowledge retention test score for those completing the training for work was 11.6, and the mean score for all other reasons combined was 11.4.

Time Since Course Completion

In response to the question pertaining to how long it had been since participants completed training, there were six timeframe options, zero-three months (n=28), three-six months (n=22), six-twelve months (n=31), twelve-eighteen months (n=20), eighteen months to two years (n=5), and two-three-years (n=5). The majority, 81 or 73% of participants, reported completing training under 1 year ago. The mean CPR first aid knowledge retention test score for participants that completed training under one year ago was 11.9, with a range of test scores from 8-14. The remaining participants, 30 or 27%, reported completing training in the past one to three years. The mean knowledge retention test score for participants who completed training in the past one to three years was 11.1, with a range of test scores from 7-14. The mean knowledge retention test scores for all six-time frames were similar (see Table 1), the highest scoring group being those who completed training within the past zero-three months (n= 28, mean test score 12.1).

Prior Experience with Training

Participants reported varying experiences with CPR first aid training. There were six answer options for this question, including no prior experience with training (n=16), having taken training one (n=20), two (n=17), three (n=10), four (n=10), five or more (n=38) times prior. The largest group, 38 or 34%, had completed training five or more times, and the second largest group, 20 or 18%, had only completed training once before. The largest group had a mean knowledge retention test score of 12.0 and second largest group had a mean test score of 11.9. The group with no prior experience with CPR first

aid training had the lowest mean knowledge retention test score of 11.1. The CPR first aid mean knowledge retention test scores were similar for all six groups, with the range being 11.1-12.0.

CPR First Aid Knowledge Retention Test Scores

The mean CPR first aid knowledge retention test scores, as measured by the 14 survey questions, were the same for each sex at 11.7 out of 14. Of the two participating companies that sent invitation emails to former students, 106 of the respondents were from Company A. Of those Company A students, 80% of them achieved a test score of 75% or greater. There were 5 participants from Company B, and 4 of them achieved a test score of 75% or greater. Overall, 84% of participants had a test score of 75% or greater. Table 1 displays the descriptive statistics of the sample.

Table 1

Descriptive Statistics n=111		n	Mean Test Scores
Sex	Female	80 (72%)	11.7
	Male	31 (28%)	11.7
Age	19-29yrs	36 (32%)	11.5
	30-39yrs	25 (23%)	11.9
	40-49yrs	21 (19%)	12.1
	50-59yrs	23 (21%)	11.6
	60-69yrs	6 (5%)	11.2
Location of training	Company A	106 (95%)	11.7
	Company B	5 (5%)	12.0
Motivators for completing training	For work	88 (79%)	11.6
	To learn	11 (10%)	12.5
	Girl Guides	7 (6%)	11.4
	Volunteering	3 (3%)	11.0
	High risk family	1 (1%)	12.0
	For school	1 (1%)	13.0
Number of months/years since completing training	0-3 months	28 (25%)	12.1
	3-6 months	22 (20%)	11.8
	6-12 months	31 (28%)	11.8
	1-1.5 years	20 (18%)	11.0
	1.5-2 years	5 (5%)	10.8
	2-3 years	5 (5%)	11.8
Number of times they completed training before	None	16 (14%)	11.1
	1	20 (18%)	11.9
	2	17 (15%)	11.4
	3	10 (9%)	11.8
	4	10 (9%)	11.8
	5 or more	38 (34%)	12.0

Chi-square & Fisher's Exact Test

The dependent variable, CPR first aid knowledge retention test scores, and the independent variable, time since course completion were examined using a Chi-square

and Fisher's Exact test. The contingency table (Table 2) includes details related to observed/expected frequency cell counts, in an additional table (Table 3) the Chi-square and Fisher's Exact test results are displayed.

Table 2

Contingency Table

Test Score		**Time since training completion**		
		Under 1 year	1-3 years	Total
≥75%	Observed	72	21	93
	Expected	67.9	25.14	93.0
	% within column	89%	70%	84%
< 75%	Observed	9	9	18
	Expected	13.1	4.86	18.0
	% within column	11%	30%	16%
Total	Observed	81	30	111
	Expected	81.0	30.0	111.0
	% within column	100%	100%	100%

The Chi-square results show that participants who completed CPR first aid training under one year ago were more likely to achieve a knowledge retention test score grade of 75% or greater, X^2 (N= 111, 1) = 5.75, p= .02 (Table 3). The critical Chi-square value is greater than 3.84 indicating the value is further out in the tail of the sampling distribution suggesting it is statistically significant. The p=.02 is less than pre-set alpha, indicating it is statistically significant. The Fisher's Exact test result of p=.02 is less than the pre-set alpha indicating it is statistically significant. There is a statistically significant association between time since course completion and knowledge retention test scores. These findings suggest it is appropriate to reject the null hypothesis.

Table 3

Chi-Square & Fisher's Exact Test Results

X^2 Tests

	Value	df	*p*
X^2	5.75	1	.02
Fisher's Exact			.02
N	111		

Odds Ratio & Correlation Coefficients

An odds ratio was performed to determine the association between knowledge retention and time lapse from CPR first aid training. When the odds ratio was reviewed results showed (Table 4) one does not fall within the 95th confidence interval indicating the odds of having a CPR first aid knowledge retention test score of 75% or greater is more than three times higher (OR = 3.43) for participants who completed their CPR first aid training under one year ago compared to those who completed the course greater than one year ago.

Table 4

Comparative Measures 95% Confidence Intervals

	Value	Lower	Upper
Odds ratio	3.43	1.21	9.74

The correlation coefficients (Table 5) were performed to examine the strength of association between the variables, CPR first aid knowledge retention test scores, and time since course completion. Findings suggest a weak association between the two variables.

Table 5

Correlation Coefficients

Nominal	Value
Phi-coefficient	0.23
Cramer's V	0.23

In this chapter descriptive statistics were used to characterize a sample of participants who completed a survey assessing knowledge retention after CPR first aid training. The study examined motivators for seeking CPR first aid training through blended learning, prior training experience, and the location of training. To answer the research question regarding the impact of time since course completion on knowledge retention in non-healthcare professionals who completed blended learning CPR first aid training, Chi-square and Fisher's Exact tests were conducted. The results revealed a statistically significant association between time since course completion and knowledge retention test scores.

Chapter Five

Discussion

This cross-sectional study sought to explore CPR first aid knowledge retention and motivating factors for seeking training. Findings from this study suggest that greater knowledge is retained from blended learning CPR first aid training for the first year after course completion.

Sex

Findings show that age and sex did not have a significant impact on CPR first aid knowledge retention test scores. Interestingly both males and females had the same mean knowledge retention test scores (11.7). A review of the literature could not locate any investigations that stratified knowledge retention rates by sex within the context of CPR and first aid training among non-healthcare professionals. However, there is evidence of sex-based differences of knowledge retention in other contexts such as exercise (Loprinzi, 2018), cognitive impairment (Brunet et al., 2020), and academic performance (Ogden et al., 2023). It is unclear if the consistency in retention scores between males and females seen in this study are unique. Given the heightened awareness of the importance of sex and gender analysis in research (CIHR, 2021), and the absence of sex-based analysis in research among non-healthcare professionals completing CPR and first aid training, further work in this area is required. Specifically, future studies should examine the impact of gender on knowledge retention in blended learning in general, and CPR first aid training specifically. While beyond the scope of this study, the impact of gender on knowledge retention also requires further exploration.

Motivators for Seeking Training

Participation in ongoing education and training is often necessary to maintain career requirements, for career advancement, or for personal growth and development (Choi et al., 2019). In previous studies, adult learners' report of their decision to pursue education and training is directly linked to their personal and professional responsibilities and/or goals (Hopstock, 2008; Hubackova & Semradova, 2014; Krismadinata et al., 2020; Van Rhijn et al., 2016). In this study, 88 (79%) participants identified that successful course completion was a requirement for their work and 11 (10%) participants reported completing CPR first aid training because they wanted to learn. Those seeking training because they wanted to learn had a higher mean CPR first aid knowledge retention test score than those seeking training as a requirement for work suggesting that motivators for completing training can impact knowledge retention. While several previous studies that examined CPR also described healthcare professionals' seeking training for work (Anderson et al., 2019; Castillo et al., 2018; Elgohary et al., 2022; Hamilton, 2005) none were located describing motivators for seeking CPR first aid training through blended learning specifically. Future studies should examine the impact of motivators, personal or professional for non-healthcare professionals seeking training on knowledge retention specific to CPR and first aid. In addition, the impact of participant motivators on knowledge retention should be explored for different forms of education and training, such as in-person, or virtual.

Knowledge Retention & Re-Training Intervals

Although this study focused exclusively on non-healthcare professionals who successfully completed blended CPR first aid training, previous studies report a range of people enroll in CPR training programs varying from non-healthcare professionals to students enrolled in healthcare-related programs, and nurses (Ali et al., 2021; Castillo et al., 2018; Chien et al., 2020; Elgohary et al., 2022; Nishiyama et al., 2015; Reder et al., 2006; Woollard et al., 2006). There is limited literature examining CPR knowledge retention after training in non-healthcare professionals when delivered through blended learning and to my knowledge, none that examined CPR and first aid training together delivered through blended learning. The findings from this study suggest that non-healthcare professionals retain 75% or more of their CPR first aid knowledge within the first year, and then it declines. This finding is similar to previous CPR knowledge retention studies (Castillo et al., 2018; Chien et al., 2020; Nishiyama et al., 2015; Woollard et al., 2006). Regulations require CPR first aid re-certification every three years with a brief re-training course annually to maintain certification in the two years between full course requirements (CSA, 2017; WorkSafe NB, 2021). Given the findings from this study, re-certification requirements for CPR first aid should be examined. It is possible that a re-certification requirement of every three years with a brief re-training course annually is inadequate to ensure ongoing competency in CPR and first aid. There may be benefit in replicating the current study with a larger and more diverse sample of non-healthcare professionals, such as targeted age groups, motivators for taking the course, or education level.

Challenges of Blended Learning

The challenges of delivering online and blended learning have been well documented and there are challenges for both instructors and students (Martin et al., 2020; Pei & Wu, 2019; Rasheed et al., 2020). Blended learning is considered by some to be the most effective and popular mode of course delivery adopted by educational institutions; however it is more complex than traditional face-to-face classroom delivery (Rasheed et al., 2020). Seamlessly adding an online component to a course can be difficult and expecting instructors who have no experience with online course delivery to develop and deliver effective courses could pose multiple challenges (Martin et al., 2020; Rasheed et al., 2020). While blended learning does offer flexibility to both students and instructors, the most effective way to do this needs to be explored as there is little known about the ideal balance between face-to-face and online instruction. When considering student challenges and advantages with blended learning, most of the previous studies have focused on the online portion, not the traditional face-to-face classroom setting (Chandrasiri & Weerakoon, 2022; Cason & Stiller, 2011; Estelami, 2016). It is possible the instructors teaching the online courses did not have the expertise or comfort required to maximize students' learning. Future studies should examine instructors' comfort with teaching online and/or students' perceptions of the effectiveness of the blended learning mode of delivery.

Knowledge Transfer

Data in this study was collected exclusively using an online survey that measured knowledge, not skill or ability to transfer the knowledge during a highly stressful

situation. It is important to acknowledge that having CPR first aid knowledge does not necessarily mean non-healthcare professional can transfer that knowledge to practice in an emergency situation, such as a seizure or cardiac arrest. Current understandings of what cognitive and psychomotor teaching and learning are best suited to face-to-face and online instruction is based primarily on anecdotal information, not research. A future study could assess the ability to transfer knowledge by using a skills demonstration in specific CPR and first aid scenarios. Further research is needed in this area to ensure the most appropriate balance between face-to-face and online instruction. Such studies could be beneficial to gather evidence to help guide training companies when developing blended learning versions of their courses. Ultimately this knowledge may help improve pre-hospital survival rates for those receiving CPR and first aid from non-health care professionals.

Blended Learning

To the best of my knowledge, this is the first study to investigate both CPR and first aid knowledge retention among non-healthcare professionals in Canada. It is noteworthy that this study focused on training provided through blended learning, a relatively new approach in delivering CPR and first aid education. It is important to acknowledge that retention rates might vary for participants who underwent training using different delivery methods. While there have been previous studies examining CPR knowledge retention among healthcare and non-healthcare professionals, there is a research gap in exploring the outcomes of CPR and first aid knowledge retention specifically for non-healthcare professionals who received training through blended

learning. Future research should compare the outcomes between blended courses and other delivery methods such as completely online or face-to-face for non-healthcare professionals taking CPR and first aid training.

Limitations

There were several limitations to this study. First the need to isolate students who participated in blended learning training from other training programs created challenges for the partnering companies. It is possible that some of the individuals who met the study's inclusion criteria were inadvertently excluded from the list of eligible students. Although the inclusion of only non-healthcare professionals in the study was discussed with the participating CPR first aid companies on multiple occasion it is possible that the letter of invitation was sent to ineligible students.

The use of a cross-sectional design with data collected at one point in time must be recognized as a potential limitation. It is possible that responses would have differed if data were collected at a different point, and/or if collected at different points with a mean score obtained. Also, the survey used for data collection relied on self-report. It is possible participants may recall certain content with more accuracy than others, such as when they completed the training or the signs and symptoms of a heart attack. The use of self-report data must be considered when interpreting study findings. Another limitation that must be considered is the use of multiple-choice questions to measure knowledge retention. In this study, multiple choice questions were used to measure knowledge retention, thus providing participants with a 25% chance of getting a correct response even when they did not know the answer. In addition, the survey measured knowledge,

not skill or ability to transfer the knowledge during a highly stressful situation.

Another potential limitation to consider is people under nineteen were ineligible to participate. It is possible that younger students would have different results. Future studies should target people under nineteen as this is the age group that may benefit from more diverse learning options and may be ideal candidates for blended learning as they are often familiar with technology.

Recommendations

Research

Further research is needed on CPR first aid courses completed through blended learning to assess knowledge retention. To date, there is little, if any, research examining training courses for both CPR and first aid through blended learning delivery. Blended learning has become more prevalent recently, and many companies offer courses in this format. Previous studies provide evidence that blended learning is at least as effective for CPR training (Ali et al., 2021; Chien et al., 2020), with some studies concluding that blended learning may be better for knowledge retention and skill acquisition (Castillo et al., 2018; Elgohary et al., 2022). Until more research is completed, it will be difficult to determine if blended learning for CPR first aid training in non-healthcare professionals' results in similar knowledge retention as face-to-face delivery. Future studies should include larger and more diverse samples (age ranges, different training companies, motivators), include open ended questions, and collect data at multiple and predetermined points between the initial training and refresher courses. Future research could also focus on knowledge transfer, including whether knowledge retained transfers into the ability to

perform CPR and first aid in a real life or simulated scenarios. Finally, research should explore the pre-hospital outcomes of CPR and first aid provided by non-healthcare professionals, including a comparison of outcomes by the training mode of delivery (e.g. face-to-face, online, blended).

Policy

The current guidelines require CPR first aid recertification every three years with an annual re-training course in the two years between full course requirements. Findings from this study and several prior studies (Castillo et al., 2018; Chien et al., 2020; Nishiyama et al., 2015; Woollard et al., 2006) suggest the current policy of recertification every three years may not be sufficient to ensure ongoing competency in CPR and first aid. It is difficult to determine if an annual re-training course that consists of a condensed version of the full CPR first aid course is sufficient to maintain knowledge and skills. Current policies on certification and re-certification should be re-examined to ensure they are evidenced informed and support ongoing competency in CPR first aid knowledge in non-healthcare professionals.

The results of this study suggest CPR first aid knowledge is maintained throughout the first year after training. Considering the high knowledge retention rates reported in this study, employers should consider exploring other learning opportunities that could adopt a blended learning approach.

Education

Blended learning is a viable option and should be considered when designing and delivering education and training programs. Given the numerous ways education and

training can be delivered, educational institutions should monitor, track, and compare participants' interest in and success with the various modes of delivery offered. Beyond the scope of this study, engaging the learner and creating a sense of community during online and/or blended learning can be more challenging. There is evidence that course development and design are critical to students achieving learning outcomes and educational institutions and/or training companies should ensure teachers and instructors have the necessary skills, resources, and supports when delivering online and/or blended programs.

Conclusion

This study aimed to fill the research gap concerning blended learning delivery for CPR first aid training, with a specific focus on knowledge retention after course completion. Several variables were analyzed to understand the factors that drive non-healthcare professionals to seek training and to investigate how factors such as the location, timing, and motivators for training influence knowledge retention. The preliminary evidence gathered from this study holds promise in providing valuable insights for guiding future research in this area.

CPR first aid training in non-healthcare professionals is important to nursing. It is a means to achieve more public awareness of health problems, common signs and symptoms of urgent health problems. More importantly, CPR first aid training facilitates a timely pre-hospital response to cardiac arrest and other emergencies that occur in the community. CPR first aid training prepares people in the workplace or community for

emergencies, and knowledge gained from training could potentially help them save the life or prevent serious disability in a loved one, a colleague, or a stranger.

Preparing non-health care professionals to respond to situations that require CPR and/or first aid is an important measure to increase survival rates among individuals who experience health emergencies in the community. Offering flexibility in how CPR and first aid training is offered to non-healthcare professionals is one strategy to increase public capacity to respond to emergencies. Blended course delivery can increase access to CPR and first aid training and has high knowledge retention rates up to one year post course completion. Future studies should explore the ideal time intervals for recertification post CPR first aid training.

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Appendix A

Letter of Invitation

Hi there,

I am a nurse studying how much knowledge people retain after they have taken a CPR first aid training course. I am also interested in what motivates people to take the training.

I am looking for volunteers to take a survey. If you are 19 years or older and have taken CPR first aid in the past 3 years you are being invited to take a 5–10-minute survey. If you choose to take the survey, you can enter your email address at the end to be entered into a draw for 1 of 5 $100 electronic visa gift cards to thank you for your time.

Please click this link if you are interested.

Thank you,

Shauna Sommerville RN

Appendix B

Consent Form

I am a nurse working on my Master of Nursing at the University of New Brunswick (UNB). I am studying how much knowledge people retain after they have taken a CPR first aid training course. I am also interested in what motivates people to take the training. I am looking for volunteers to take a survey.

If you are 19 years or older you are being asked to take part in this study because you have recently taken CPR first aid training. You are not required to take part. If you decide to take the survey, you will be helping me, other researchers, and CPR first aid companies understand how knowledge levels change over time especially when training is done partly online(computer) and the other part face-to-face in a classroom. You will also be helping us understand why people take the training.

If you agree to take part in the survey, you will be asked 22 questions and it will take about 5-10 minutes. The first 8 questions are about you, how many times you have taken CPR first aid training, why, when and where you took the training. Any information gathered about you will be kept confidential. The other questions are about what you learned during the training to see what you remember. You will not be graded or judged on your answers, and they will have no impact on your original course grade. Just do the best you can to remember what you learned without any help. You can skip any question you do not feel comfortable answering.

The survey is in a secure platform called Qualtrics. Qualtrics has built-in safeguards to protect the information you provide from loss, misuse, and unauthorized access. Qualtrics

stores data on servers in Canada, however because it is an internet-based service, we cannot guarantee it is fully secure or error free.

This study has been reviewed by the research ethics board at UNB and is on file as REB# 2023-049. All the information from your survey will be kept for five years for research purposes. The information gathered from you may be reviewed again after this study is finished. If results from this study are shared in a research journal or presented at a conference, you will not be named. If you would like a copy of the written report from this study or have questions about the research study, please contact me, Shauna Sommerville, by email at shauna.sommerville@unb.ca. If you want to talk about the research study with someone not directly involved, please contact Beth Keyes at UNB by email bkeyes@unb.ca or call 506-648-5994.

If you choose to take the survey, you can enter your email address at the end to be entered into a **draw for 1 of 5 $100 electronic visa gift cards** to thank you for your time. You will have a 1 in 40 chance of winning.

If you are willing to take the survey, please click yes below. Clicking yes will be considered as consent to take part in the study. If you do not want to take the survey, click no.

Thank you,

Shauna Sommerville BNRN, Master of Nursing Student UNB

Appendix C

CPR First Aid Survey

General Information

1. How old are you?
    a. 19-29
    b. 30-39
    c. 40-49
    d. 50-59
    e. 60-69
    f. 70+ years old

2. Gender: How do you identify?
    a. Female
    b. Male
    c. Non-binary
    d. Prefer to self-describe: _____
    e. Prefer not to say

3. Where did you take your most recent CPR/First Aid training?
    a. Company A
    b. Company B
    c. Other: _____

4. When did you take your most recent CPR/First Aid training?
    a. 0-3 months ago
    b. 3-6 months ago
    c. 6-12 months ago
    d. 1-1.5 years ago
    e. 1.5-2 years ago
    f. 2-3 years ago

5. Was the majority of the online (computer) portion of your training reading or video?
    a. Reading
    b. Video
    c. Equal portion

6. Not counting your most recent training, how many times have you taken CPR/First Aid training before?
    a. None
    b. 1

c. 2
d. 3
e. 4
f. 5 or more

7. Why did you take CPR/First Aid training?
    a. It was a requirement for work
    b. It was a requirement for school
    c. Because I wanted to learn
    d. Other: _____

8. In your most recent CPR/First Aid class were you able to practice with a manikin on how to apply and use an automated external defibrillator (AED)?
    a. Yes
    b. No

CPR/First Aid Knowledge Questions

Select 1 answer for each of the following questions

9. What does the Good Samaritan Act Cover?
    a. Reasonable acts and care to a person in need within your scope of practice
    b. Tracheotomies
    c. Giving any ill or injured person medications
    d. How to perform advanced medical interventions

10. The brain can die in as little as _____ minutes without oxygen?
    a. 10-15 minutes
    b. 15-20 minutes
    c. 4-6 minutes
    d. 1-3 minutes

11. Have breaths during CPR been taken out of CPR for adults?
    a. Yes
    b. No

12. During infant choking, should a finger sweep be performed?
    a. Yes
    b. No

13. What First Aid care should be provided for partial thickness (2nd degree) burns?
    a. Cool the area for 10-15 minutes and apply a non-stick dressing
    b. Apply burn gel
    c. Wrap the area tightly with a gauze wrap

d. Apply a cooling spray

14. First Aid for a nosebleed is?
    a. Tilt the head back pinching the bridge of the nose
    b. Tilt the head forwards pinching the bridge of the nose
    c. Insert packing into each nostril
    d. Apply an ice pack to the back of the neck

15. Is an amputated finger considered a deadly bleed?
    a. Yes
    b. No

16. Heartburn, cramping, lower back pain, flu like symptoms and nausea are signs and symptoms of what?
    a. Stroke
    b. Concussion
    c. Heart attack
    d. Arteriosclerosis

17. During a seizure what should be done?
    a. Put something in their mouth so they don't bite their tongue
    b. Try to hold the person still
    c. Keep them in a sitting position
    d. Move any objects away and keep the person safe

18. How many compressions to breaths should be given during infant CPR?
    a. 15:2
    b. 15:3
    c. 30:3
    d. 30:2

19. For an imbedded object in the eye what First Aid steps should be taken?
    a. Pull the object out and secure a bandage over the eye
    b. Stabilize the object and cover both eyes
    c. Wash the eye out then cover it
    d. Do not do anything

20. For a broken bone what should be done?
    a. Apply bandages over the break
    b. Let the person hold it in place until the ambulance arrives
    c. Find something to splint above and below each joint where the break is
    d. Elevate above the head

21. When entering a scene what should be done first?

a. Call for help
b. Ask someone to get an AED
c. Scene survey
d. Wait for the ambulance to arrive

22. How many compressions to breaths should be given during adult CPR?
    a. 15:2
    b. 30:2
    c. 20:3
    d. 15:3

If you provide your email address, you will be entered into a draw for a $100 visa gift card.

____ No thanks

Curriculum Vitae

Candidate's Full Name: Shauna Lee Sommerville

Universities Attended: University of New Brunswick, Saint John Campus. Bachelor of Nursing, graduated in 2002.

Publications: N/A

Conference Presentations: N/A