Developing a first principles approach to educating water skills for life to children

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Executive Summary

In New Zealand, despite the fact that the majority of drownings occur in open water, most swimming teaching occurs in public swimming pools. It is possible that learning to swim in a public swimming pool does not sufficiently prepare people to develop water competence when exposed to open water environments. This aim of this study was to address whether it is effective to teach children water safety knowledge and skills in open water environments. Based on existing research the following predictions were tested:

1) The water safety skill competency of NZ primary school children will be varied but overall quite low
2) The water safety skill competency of children will improve following a one week intervention program taught in open water environments
3) Following an intervention program taught in open water environments, the improvement in water safety skill competency of children will be retained for at least three months

Ninety-eight primary school-aged children (7-11 years old) volunteered to participate and provided informed consent. Their water safety knowledge and skills were tested in a swimming pool before, immediately after, and three months after receiving a three-day education program delivered in open water environments (harbour, surf, river). The education program was conducted by teams of 'expert providers' with comprehensive experience and appropriate education qualifications. For each of the three test phases, participants were asked to attempt six tasks (i.e., Quiz, Buoyancy, Submersion, Obstacle Course, Simulated Rescue and Propulsion). The participant's relative competency to perform the tasks unaided was assessed by observers on a 4-point scale.

At pre-test, the percentage of children achieving a high level of competence on the six water safety tasks was typically less than 50%. In support of previous research, the water safety competencies of children were spread across a wide continuum of skilled behaviour and was quite low relative to those recommended in the Water Skills for Life program. It is concerning that approximately 60% of participants failed to complete a 5 minute continuous swim or an unsupported floating exercise without receiving additional help. Encouragingly there was strong support for the efficacy of the open water education program. Children improved their competency in each of the six tasks assessed. Furthermore, children demonstrated a good level of retention of these skills when assessed three months after the program had concluded. Caregivers offered very positive support for the education program and most felt that their child/children were definitely more aware of the dangers associated with open water environments and how to behave safely.

Previous work had shown that 10 weeks of one hour lessons taught in swimming pools was effective in improving water safety knowledge and competency (Button et al., 2017). The current study indicates that similar levels of improvement can be obtained from an education program conducted within three days. A key challenge for future research will be to determine the transferability of water safety skills learnt in open water environments. It is recommended that New Zealand's water safety sector work collaboratively to inform policy and strategies by:

- Exploring and promoting opportunities to teach water safety knowledge and skills to New Zealanders in open water environments
- Identifying and supporting 'expert' organisations best placed to provide education in different open water environments
- Liaising with and lobbying the Ministry of Education and NZ schools to consider how best to integrate open water safety education with swimming pool based skill acquisition programs

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- Participants and caregivers (for their time and willingness to volunteer for the study)

Introduction

According to the World Health Organisation, we are in the midst of a global drowning pandemic with an estimated 372,000 fatalities per year, and that figure is almost certainly an underestimate. In 2017, there were 104 drownings in New Zealand and Water Safety New Zealand reported that 92 of these drownings were preventable (WSNZ, 2018). Immersion incidents, where the victims had no intention of being in the water, are typically the most common types of drowning incident, followed by those where people simply went for a swim. In 2017, over 80% (n=75) of the preventable drownings were in open water environments (rivers, sea, lakes, ponds etc.). In Australia and NZ, young people seem to be particularly vulnerable to drowning, as children are over-represented in statistics relative to other age groups (Croft & Button, 2015). In such countries with abundant and varied natural water bodies and swimming pools, renewed emphasis has been placed on aquatic education and skills development.

In New Zealand, despite the fact that the majority of drownings seem to occur in open water, most swimming teaching occurs in public swimming pools (Stevens, 2016). It is possible that learning to swim in a public swimming pool does not sufficiently prepare people to develop water competence in open water environments. As we explain below there are a variety of reasons (safety, economic and logistical) why learning to swim in a pool has been preferred historically.

Differences between swimming pools and open water environments

For several reasons, learning to swim in open water environments (e.g., harbour, river, surf, lake, etc.) is different than learning in an enclosed environment such as a pool. The water in a swimming pool is treated and maintained at a comfortable temperature. As the water is clean it allows swimmers to see the bottom of the pool and determine (above and below the water) the approximate distance to exit points. Furthermore, lifeguards or instructors typically monitor the pool environment and there are warning signs to prevent dangerous situations arising (e.g., children going out of their depth). In contrast most open water environments are not patrolled, with the exception of some beaches, and they may have limited information about potential dangers. Additional differentiating factors may include colder and varying water temperatures, less confined spaces (depth and area), sudden changes in depth, waves, currents, eddies and strainers (e.g., submerged objects that may trap or injure someone).

Although some public pools have the capacity to simulate some of these factors (e.g., with a wave pool or a lazy river) the large majority of pools do not have such expensive facilities. Hence, people typically learn to swim in an environment that is quite different and much more predictable than open water. It is quite likely that the differences between a controlled indoor environment and an outdoor swimming environment can contribute to the panic often associated with an unplanned and sudden immersion into cold water (Potdevin et al., 2017). Hence, pools certainly offer a ‘controlled and safer’ environment to learn to swim than open water but they are not necessarily the only option. Indeed, learning to swim within the sheltered confines of a swimming pool may create a misplaced confidence in aquatic ability that may not transfer well to other aquatic environments (Stallman et al., 2008).

In the developed world, humans are typically taught to swim in comfortable, clear and calm water environments that are absent of features such as currents or waves. Enclosed aquatic environments like swimming pool are different in many respects to open water environments. A clear depiction of this fact was observed by Kjendlie et al. (2013) who compared 66 children of 11 years old performing identical tests in two different environments: a calm swimming pool and a simulated wavy environment (30–40 cm amplitude). The tests consisted of a 200 m swimming time trial, a 3 min floating test, a diving entry test, and a rolling entry test. The results highlighted that only 59% of the sample was able to perform the wavy water course (80% in calm conditions). More precisely, the tests in the waves clearly showed a performance decrement (14% longer time to complete the swimming test and 21%, 16% and 24% lower scores for rolling entry, diving and floating tests, respectively). It highlighted that children "*should not be expected to reproduce swimming skills they have performed in calm water with the same proficiency in unsteady conditions during an emergency*" (Kjendlie et al., 2013; p.303).

Most New Zealanders have relatively easy access to open water environments and consequently engage in a wide range of different aquatic activites (e.g., swimming, fishing, snorkelling, scuba diving, jet boating, kayaking, water-skiing, windsurfing, etc.). However, research suggests that many New Zealand residents are ill-prepared to recreate in these environments and underestimate the level of risk inherent in such activities (Moran et al., 2008). The safety organization 'Safe Kids Worldwide' suggest that the assumption that a child that is able to swim in a pool will be safe in open water may be one factor contributing to drowning statistics (Safe Kids Worldwide, 2018).

Water Skills for Life

Langendorfer and Bruya (1995) proposed that a basic level of water competence is required for humans to show mastery of aquatic environments. In their work, water competence emerges as a consequence of the interaction between three types of constraint (i.e.; personal - e.g., age, confidence, and fitness; environment - e.g., temperature, currents and waves; and task - e.g., clothing, flotation aids and the desired goal of the activity). However, as such constraints can change rapidly on a moment-to-moment basis in open water, an apparently competent individual may find themselves in difficulties if they lack awareness or knowledge of their environment. Even the strongest swimmers are vulnerable to factors such as cold water, strainers, waves and currents (Button et al., 2015). Therefore, it seems important that a basic level of water competence must account for the different types of aquatic environment that humans are exposed to (Stallman et al., 2017).

In 2015, the New Zealand Water Safety Sector Strategy 2020 was launched. This strategy includes a goal that every New Zealander receives the opportunity to develop water safety knowledge and skills. Water Safety New Zealand (WSNZ) commissioned a review into the way basic water safety skills are taught to children aged five to thirteen (Stevens, 2016). The review looked at national and international water safety, swimming and drowning prevention research to find out whether the current teaching of aquatic skills in New Zealand provided kids with adequate water safety skills. Most schools provide at least some water-based aquatic education (94% of those surveyed), and most also offered some classroom-based aquatic education (88%). Primary schools were most likely to offer water-based aquatic education with around 97% indicating that they offered a water-based program. Slightly fewer offered a water-based program at intermediate level (79%) and secondary level (77%). Just over a quarter of the schools surveyed (27%) achieved the Water Safety New Zealand's suggested minimum of 8 or more lessons of at least 30 minutes. A further 40 percent managed 8 or more lessons of 26–30 minutes. Most, but not all (93%) of those offering water-based sessions, indicated that their programs include: swimming lessons; some survival skills; beach and water safety. Those schools that offered classroom-based activities most often covered: general water environment rules hazards and risks; beach and river education. Overall less than four percent of schools surveyed did not offer any water-based aquatic education (Stevens, 2016). In the review, Stevens cited research papers, surveys, practical evidence from other parts of the world (e.g., Bangladesh), and advice from New Zealand water safety sector experts indicating that the acquisition of a combination of water safety and swimming skills results in a reduced incidence of drowning in young children.

Based on this review, WSNZ have since concluded that there is a need for a greater emphasis on teaching water safety skills alongside stroke and distance focused swimming skills, and that offering exposure to a range of aquatic environments (such as rivers and cold open water where most New Zealand drownings occur) is a crucial part of water safety skills learning. WSNZ also identified that there is a need to establish a more consistent national approach to the teaching of water safety skills. The national "Water Skills for Life" (WSFL) program launched by WSNZ in 2016 resulted from a wide consultation amongst the water safety sector in New Zealand. WSFL includes a range of swimming skills and water safety competencies that children are expected to have achieved by the time they are 13 (see Appendix). These skills are deemed as crucial for the safe enjoyment of aquatic activities in a range of environments. WSFL also provides the essential basis for participating in most water-based sports.

A recent study by Button et al. (2017) has provided early data about the current WSFL competencies of NZ children. The study also assessed the impact of integrating safety skill into a typical 'learn-to-swim' education programs on the ability of children to evaluate risk and behave appropriately in and around water. It was expected that teaching children a range of survival skills (including how to swim) would improve their performance from pre-test to the post- and retention tests. Whilst the findings from this study were generally encouraging, the levels of improvement were fairly modest and less than 50% of children exhibited high competency in each of the tasks at post-test. However, whilst children's knowledge of risks and emergency response increased at post-test, this knowledge was not retained by children after 3 months (Button et al., 2017). As was discussed in that study, it might be more effective to teach such knowledge in a relevant open water context rather than within the sheltered confines of a swimming pool. Furthermore, only 48 children participated in this initial study and it was suggested that a larger sample size would be required in future work.

Foundational Water Competencies Underpinning WSFL

In recent years, a radical shift has been proposed in the teaching of aquatic skills, to be based upon learning a range of water safety skills rather than certain classical swimming strokes (Stallman et al., 2008). This shift in emphasis seems appropriate, as safety skills are typically absent, or at least downplayed, in many learn-to-swim programs (Button, 2016). Stallman et al. (2017) proposed a list of fifteen water competencies (see Figure 1) that should be considered as essential or required to reduce the risk of drowning. Core skills, such as how the child enters the water and then subsequently reorients their body into a streamline position, form the building blocks from which more sophisticated ways to move through the water can later be developed. Water competency also relies upon knowledge and awareness of the environment and the potentially hidden factors (e.g., depth, current, temperature) that can play an influential role in drowning. Additional knowledge and practical skills around water safety and emergency situations (e.g., how to correctly fit a lifejacket, what to do if caught in a rip, etc.) should also form a foundational part of education to develop water competency. Education of water competency also needs to be supported by improved awareness of the learner's ability to move in different aquatic environments (Kjendlie et al., 2013).

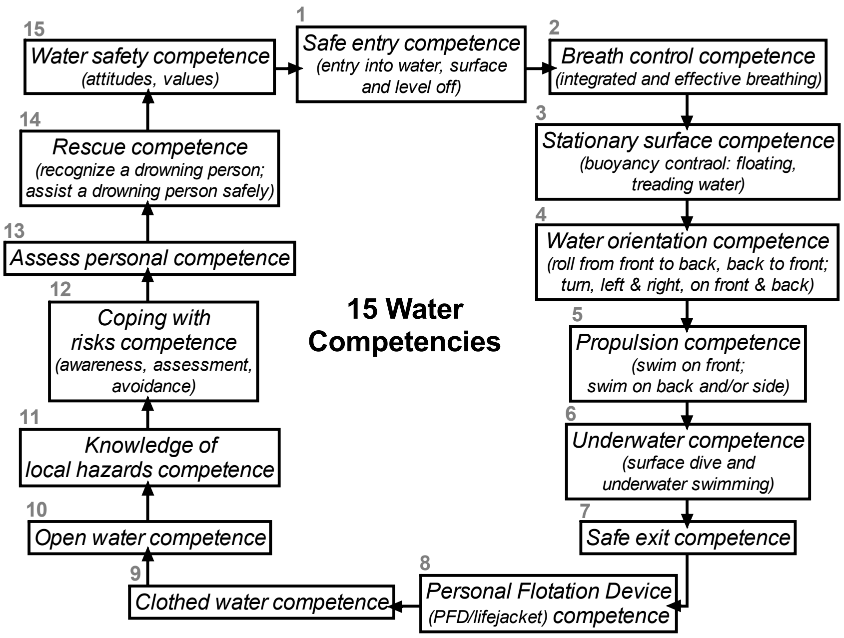


Figure 1: An adapted depiction of the fifteen water competencies identified by Stallman et al., (2017) to prevent drowning.

Retention of Water Safety Skills

The 'first principle model' depicted in Figure 1 is closely aligned with the WSFL competencies proposed by Water Safety New Zealand. However, whilst there is now general agreement about what information and skills should be taught to children, there are few data on the current level of competencies that New Zealand children possess (Button et al., 2017). There is also a lack of research surrounding how to optimise the retention of water safety skills and knowledge in children. Existing efforts to better understand the impact of water safety education have focused almost exclusively on the immediate effect of education on knowledge (e.g., McCool et al., 2009). Similar fields of investigation that pertain to educating children in safety awareness and risk identification also lack investigative insight into how best to consolidate such competencies over the lifespan

(Hillier et al., 1998). When learning any new knowledge or skill one should assess the extent to which the skill has been learnt relatively permanently (or robustly). Motor learning researchers strongly advocate that researchers and practitioners must include consideration of skill retention when assessing the effectiveness of education programs (Davids, Button & Bennett, 2008). As such for the present study it was important to include an assessment of skill and knowledge retention following a phase of learning.

Aims and hypotheses

This aim of this study is to address whether it is effective to teach children the water skills for life competencies in open water environments. This report describes an independent research study undertaken by the University of Otago from January to April, 2018. The study was part funded by a Water Safety New Zealand research grant and also by the University of Otago. A secondary aim was to examine the level of water skill competency amongst a sample of NZ primary school age children (from 6 -11 years old). Addressing the following three hypotheses formed the focus of the experimental design:

H_1: The water safety skill competency of NZ primary school children will be varied but overall quite low i.e., less than 50% children would exhibit competency in core tasks (e.g., Button et al., 2017; Moran et al., 2008)

H_2: The water safety skill competency of children will improve following a one week intervention program taught in open water environments, i.e., significant increase in competency after the program.

H_3: Following an intervention program taught in open water environments, the improvement in water safety skill competency of children will be retained for at least three months, i.e., no significant decrease in competency after 3 months.

Methodology

Participants

Children between the ages of 7 and 11 years on the 1st of January 2018 were invited to attend a water safety program provided over the summer holiday period. The lower limit of 7 years of age was necessary as pilot testing showed that younger children often struggled to verbalise answers to questions (a requirement of the testing protocol). Primary schools within and surrounding Dunedin were contacted in term 4 of 2017 and asked to advertise the program in their weekly newsletters. Posters (see Appendix 1) advertising the program were also displayed at various sporting and retail venues around Dunedin and suburbs. Interested parents and care-givers (hereby termed caregivers for brevity) were directed to a website that provided full details of the program and a weblink to sign up their child/children[1].

A three-day intensive water safety education program was run in January 2018 during the school summer holidays. Two repetitions of the program were run for up to 60 children which provided an overall capacity of 120 children. Recruitment was conducted in December 2017 and was extremely successful with all spaces allocated by the end of the month. However, only data from 98 participants who attended all four phases of the study (pre-test, intervention, post-test, retention test) were included in the subsequent data analysis (see Table 1 for participant characteristics)

Table 1. Participant characteristics at pre-test (mean and standard deviation)

Sex	Number	Age (years) *(mean)*	Height (m) *(mean)*	Weight (kg) *(mean)*	Estimated Swimming Pool Visits *(N / year)*	Estimated Open Water Visits *(N / year)*	Self-reported swimming ability (N of children)		
							Fair	Good	Advanced
F	44	9.25 *(1.28)*	1.39 *(0.10)*	34.26 *(9.08)*	55.89 *(37.83)*	40.48 *(65.39)*	5	26	12
M	54	8.79 *(1.34)*	1.36 *(0.10)*	32.58 *(9.96)*	54.72 *(45.49)*	39.29 *(66.52)*	7	36	9
Total	**98**	**9** ***(1.32)***	**1.37** ***(0.10)***	**33.34** ***(9.56)***	**55.27** ***(41.76)***	**39.85** ***(65.48)***	**12**	**62**	**21**

[1] Although there is no data available to test for selection bias it is possible that either low or high competent performers were over-represented in the data due to contrasting opinions about the relative benefits of participating from children and caregivers.

Testing facilities and equipment

The three testing sessions that took place before or after the education program were conducted in one of two indoor swimming pools (Table 2). It was deemed appropriate to test in swimming pools rather than in open water environments to control for environmental factors that could change unpredictably. Two pools were required for convenience of sampling and transport for families from different areas of Dunedin. Both swimming pools had private, secure changing rooms located next to them. Participants were advised to bring their own set of cotton pyjamas, typical swimwear, towel, and if desired, a pair of goggles.

Table 2. Characteristics of swimming pools used for testing

	Pool 1	Pool 2
Temperature	28 degrees Celsius	25-28 degrees Celsius
Depth	0.85m - 1.63m	1.04m – 1.38m
Dimensions	Length = 30.48m Width = 10m	Length = 25m Width = 13m

Various items of equipment were necessary for the testing and also for health and safety purposes. These items included: 3 life jackets (small, medium and large child size), buoyancy aid on a leash, floats, 6 brightly coloured buoys, 12 bunches of artificial seaweed (strips of plastic and matting material, each weighted at one end), a coloured diving ring attached by a hook and weighted string to an empty plastic bottle, range of 5kg plastic dumb-bells to anchor buoys, a plastic kayak (3 m), a hose and water-spray attachment, a stopwatch, and laminated A4 size posters. Additionally, a stopwatch, stadiometer, 10-m tape measure and digital balance were used for various measurements taken during testing. Depicted as a modified traffic light, a board displaying a 4-point Likert scale was presented to the participant to ascertain confidence before and after each task. Data were transcribed from written form into Microsoft Excel, and analysed using SPSS (Version 23.0).

Procedure

The following procedure was approved by the participating institution's human ethics committee (16/033). All children and caregivers provided written informed consent and health information before participating. The water safety program was free to attend (no cost) other than providing transport for the children to and from the open water environments. Caregivers were sent instructions about how to schedule their child for testing via an online registration system. Participants were typically tested in small groups of between 2-6 children, although occasionally one child was tested alone (with assistance from a lifeguard). Children were quasi-randomly allocated to testing groups of variable size depending upon the preference of the caregivers in terms of the time slot that they chose. Furthermore depending upon the number of participants allocated to each testing session, there were between 1 and 4 qualified lifeguards present in the water to provide supervision where necessary.

Participants and their caregivers attended the swimming pool on three separate occasions (i.e., pre-test, post-test, and then 3 months later on a retention test). The day after the pre-test each participant began a 3-day water safety program, and was then tested again back in the same swimming pool on the final day of the week (see Table 3).

Before each testing session, the children were instructed to refrain from heavy exercise or a large meal for at least one hour. Upon arrival participants went straight to the changing rooms to change into their typical swimming costumes underneath a pair of their own light cotton pyjamas; meanwhile the experimenters explained the experimental procedure to their caregiver. Once the participant was ready to begin testing the caregiver was asked to leave the swimming pool and return to collect their child in one hour. The purpose of requiring the caregiver to absent themselves during testing was to prevent them from intentionally (or unintentionally) influencing their child's responses to the tasks.

Table 3: The structure and duration of testing sessions and the water safety program.

Monday	Tuesday	Wednesday	Thursday	Friday	3 Months
1. PRE-TEST	2. WATER SAFETY PROGRAM			3. POST-TEST	4. RETENTION TEST
Pool assessments	Harbour	Beach	River	Pool assessments	Pool assessments

N.B. on the 2nd repetition of the program, the order of the Beach and River days was reversed (i.e., River Wednesday, Beach Thursday) due to limited availability of the water safety organization delivering the River day.

For the pre-test session, a number of anthropometric and self-reported variables were measured (see Table 1). Experimenters measured the participant's standing height and mass. Participants were then asked whether they had received, or were currently receiving swimming lessons outside of those delivered by their school. Finally, participants were asked how often they visited a swimming pool and any natural waterways (e.g., beach, lake, rivers) for recreational purposes.

For each of the three test phases, participants were asked to attempt six tasks (Table 4). The order of the tasks was randomised except for the quiz (first) and propulsion task (last), which were ordered consistently for logistical reasons. Before each task was attempted, verbal instructions were given to the participant until they confirmed they understood what was required. Immediately before each task was attempted and then again immediately afterwards the participants were asked to rate their confidence/competence on a 4-point Likert scale (where 1 indicates a high level of confidence/competence and 4 was low). Once all six tasks had been completed the participants were collected by their caregiver (approximately 45-60 minutes after drop off).

Task	Description	Assessment (grade 1-4)
Quiz / knowledge	A series of 4 multi-part questions prompted by pictures of various aquatic environments scenes (e.g., ocean, river, lake, harbour: see examples in Appendix 1). The knowledge tested in the quiz included: 1. Understands how various open water conditions (e.g., temperature, current, waves, obstructions) influence risk 2. Knowledge, understanding and attitude towards water safety rules, hazards and risks 3. Recognise an emergency for yourself or others and know how/who to call for help	Participants could provide up to 13 correct answers: Grade 1 = 13-12 correct Grade 2 = 11-8 correct Grade 3 = 7-4 correct Grade 4 = 3-0 correct
Safe entry/exit and buoyancy	This task took place in the deep end of the pool (Pool 1 = 1.63, Pool 2 = 1.38 m). Participants wore just their swimming costume for this task. They were first asked to check the pool for a safe place to enter, and then get into the water without using the ladders. The participants were then required to float on their back for one minute. If they accomplished this, they then had to tread water for four further minutes. After two minutes treading water, a hose with a spray attachment was switched on to simulate rain. Then after three minutes treading water, the lifeguard simulated waves using a paddleboard. Once five minutes was completed, the participants had to call for help with one hand in the air before swimming to the side and climbing out of the pool.	Grade 1: Completes all tasks correctly without assistance. Grade 2: Stays afloat for one minute and treaded water for up to one minute Grade 3: Stays afloat on back for up to one minute. Grade 4: Cannot complete any aspects of task without assistance
Submersion	Wearing just their swimming costume, participants climbed into the water (swimming goggles were optional but the experimenters recommended that they were not worn). Participants were then asked to submerge completely underwater and swim to a brightly coloured ring situated 6m away from them and retrieve it whilst holding their breath. They gave the ring to a lifeguard and then swam back to the side of the pool and exited.	Grade 1: Successfully retrieved the ring. Grade 2: Successfully retrieved the ring but an additional breath was required. Grade 3: Successfully retrieved ring with multiple breaths required. Grade 4: Unable to retrieve the ring
Obstacle course	The children were asked to complete an obstacle course whilst wearing their swimming costume beneath a pair of full-length pyjamas. The obstacles were located in the shallow end of the pool (pool 1 = 0.85m, pool 2 = 1.04 m). The course consisted of 3 'bushes' of artificial seaweed placed 2m apart, 3 brightly coloured buoys configured in a zigzag, and a plastic kayak. The children climbed into the pool using a ladder, then waded (or swam if they chose to) through the seaweed. They then had to swim around the buoys, without touching the bottom of the pool. Finally, they were asked to climb over the kayak, and then grab a buoyancy aid before exiting at the side of the pool (see Figure 2).	Grade 1: Completes all tasks successfully without assistance. Grade 2: Completes all tasks but requires assistance or touches sides or bottom. Grade 3: Cannot complete all tasks and requires assistance often, but finishes the course. Grade 4: Cannot complete the course.

Simulated rescue	At the side of the pool the children were asked to choose one of three different lifejackets appropriate to their size (small, medium, large). They then had to put the lifejacket on and secure two plastic buckles. The instructions were to secure the jacket tightly so that it would not slip over their head if pulled up by the experimenter. Once the life jacket was put on, the child had to pick up a leashed buoyancy aid and throw the aid to their partner in the water (see Obstacle course above). They then pulled their partner to the side and helped them to exit the pool (Figure 2).	Grade 1: Chooses correct life jacket, secures it tightly and throws buoyancy aid to partner successfully Grade 2: Completes all tasks with advice from experimenter Grade 3: Completes all tasks with physical help from experimenter Grade 4: Unable to complete all tasks successfully.
Propulsion	Brightly coloured buoys were placed at either end of the pool (pool 1 = 30.48m/ pool 2 = 25 m). The children were asked to enter the pool and then swim continuously up and down the pool around the buoys for 5 minutes. The instructions were not to touch the sides of the pool or floor if at all possible. The children were told they could use whichever stroke they preferred. They wore their normal swimming costumes and, if they chose to, their goggles. Participants performed this activity in groups of 2-6 other children with a lifeguard in close proximity at all times.	Grade 1: Able to swim continuously for 5 minutes without assistance Grade 2: Able to swim at least 100m but stops once or twice Grade 3: Unable to complete 100m or 5 minutes, requiring multiple rests Grade 4: Unable to complete 50m or 2 ½ minutes, requires multiple rests

Table 4. Overview of six water safety skills and assessed competencies

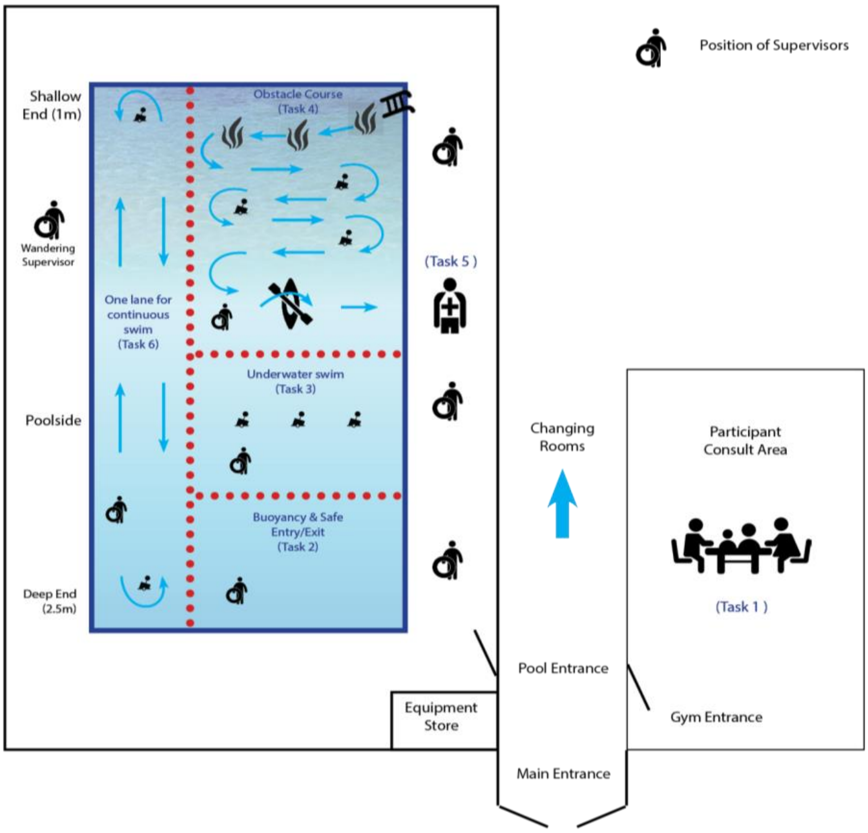


Figure 2. Diagram of the typical pool facility set-up to accommodate all six tasks, and the placement of supervisors. N.B the typical ratio of lifeguards to participants was 4:6.

Phase 2: Water Safety Program

The water safety education program was delivered over three consecutive days in different open water environments (i.e., Harbour, Surf, River). The education program was conducted by teams of 'expert providers' with comprehensive experience of the environments and appropriate education qualifications (see Acknowledgements). For the Harbour and Surf days, children were divided into learning groups of 20 and a 2.5 hour session was delivered for each group (9:30am-12:00pm; 12:30-3:00pm; 3:30-5:00pm). Caregivers chose which group to sign their child/children into when enrolling the children into the program. The river session was delivered to all 60 children at the same time and was ran between 10am and 3pm. Children were subdivided into five groups and rotated around 5 stations. A brief summary of the activities completed by participants on each of the intervention days is provided below. A summary of activities for each of the intervention days is provided in Tables 5a-c.

At the conclusion of the Water Safety program caregivers were surveyed about their perceptions of the program and how beneficial they felt it had been for their child/children. The survey was conducted by paper and pen and took approximately 5-10 minutes to complete. The survey is included in the appendix. Sixty-three caregivers completed the survey.

Table 5a: Summary of Harbour Activities

Club House. Walk to Swim Area	*Water Activities*
• W.E.T – Weather, Equipment, Tell someone	• Demonstration of what happens when life-jacket in fitted incorrectly
• Sorting Box (useful vs non useful items for taking on boat trip)	• Rescue with a throw bag
• Choosing and fitting life-jackets correctly	• Entering and exiting water safety
• Huddle and help positions • Group moving backwards in water as a train to retrieve isolated individuals	• Huddle and help positions - All individuals to show the help position - Group adopt a huddle position - Group picking up isolated individuals using train
	• IRB rescue and boat activities - Balancing boat - Dropping backwards of boat - Swim to shore
	• Overturned IRB - Explanation of air pockets - Temperature under boat vs on top of overturned boat

Table 5b: Summary of River Activities

Station	Water Activities
Station 1	Create a stream in the riverbank and discuss current, eddies, strainers etc. - Float objects down the stream - Relate observations to discussion of potential dangers in river environments
Station 2	Feet first float downstream (Entry and Exit, Floating, Breathing, Moving Left or Right Whilst in Back Survival Swim Position)
Station 3	Strainers and how to deal with them - Aggressive swim to avoid the strainer - Going over the strainer
Station 4	Knowledge and awareness of hazards in a river environment and potential changes - Deciding if river is safe to cross - How to safely wade across river (individual and group)
Station 5	Rope rescue - Coiling a weighted rope and throwing it to rescue someone - Adopting and maintaining feet first back survival swim position whilst being rescued - Safe Exiting of River

Table 5c: Summary of Surf Activities

Club House/ Walk to Swim Area	Water Activities
Surf safety rules - Flags - Adult Supervisor - Listen to Lifeguards - Never Swim Alone - If in Doubt, Stay Out	Rip Sculpture Activity - Make own mini working rip using sand by water edge - Watch for Rip Features as Water Recedes - Children name the different Features of the Rip
Rips - What are Rips - How to Spot Rips - Where Rips Form - How to Escape a Rip	Tube rescue relays - Mock Rescues using tubes - Person being rescued to raise hand to signal for help - Discuss what else can be used to help stay afloat
Radios - How VHF Radio Works - Marine Distress Channel = 16 - "Mayday, Mayday, Mayday"	Water Activities 1 - Wading - Beached hales (beginners) / dolphin diving (advanced) - Floating (with and without body board)
Preparation for Water Activities - Huddle and Help Positions - Moving Backwards in Water as a Train to Retrieve Isolated Individuals	Water Activities 2 - Over, Under, Run (Beginner)/ Body Surfing (advanced) - Body Boarding

Data Analysis

A range of different types of data were collected. For the pre-test, post and retention tests each participant's water competencies were assessed and recorded manually by an assessor. One of a team of four trained assessors carried out this duty and were typically assessing participants in small groups of up to four participants at a time. The training was conducted during pilot work and involved explanations of the different tasks and scoring system, followed by shared observation and deliberation of children with a range of competencies undertaking the 6 tasks. The assessors marked competency scores (i.e., 1-4 as described earlier) on an assessment sheet following the completion of each task (see appendix). On the same sheet the assessors also recorded the participant's perceived confidence before and after each task had been undertaken. Anthropometric data and perceived general swimming competency were collected at the pre-test. A caregiver's survey was used to collect both quantitative and qualitative feedback after the completion of the retention test.

For ease of interpretation much of the data are summarized descriptively in pie-charts or bar-charts. As the majority of the data were of an ordinal nature (i.e., 4 point scale for competency or confidence) non-parametric statistics were deemed appropriate for comparisons. Friedman's N related samples tests were used to compare for a main effect of time with 3 levels. Post hoc analysis with Wilcox signed-rank tests was conducted with a Bonferroni correction for multiple comparisons ($p < 0.017$).

Results

The results are presented in the following order: 1) Competencies for the six tasks; 2) Physical competency and perceived confidence; 3) Caregivers survey.

Quiz Competency

The pre-test data indicate that nearly 90% of the children gave correct answers to at least 8 out of 13 questions in the **quiz**. The children improved their overall quiz competency from pre to post-test and retained this improvement in the retention test (Figure 3). At pre-test only 30% of children achieved a high competency score in the quiz (at least 12 from 13 answers correct). At post-test the proportion of children had increased to 83% and this level was maintained in the retention test (82%).

THE QUIZ

Presented with pictures and illustrations of various aquatic environments, children were asked

1. How they perceived various open water conditions (e.g., temperature, current, waves, obstructions) might influence risk
2. Their knowledge, understanding and attitude towards water safety rules, hazards and risks
3. How to recognise an emergency for yourself or others and know how/who to call for help

1 — 13-12 correct

2 — 11-8 correct

3 — 7-4 correct

4 — 3-0 correct

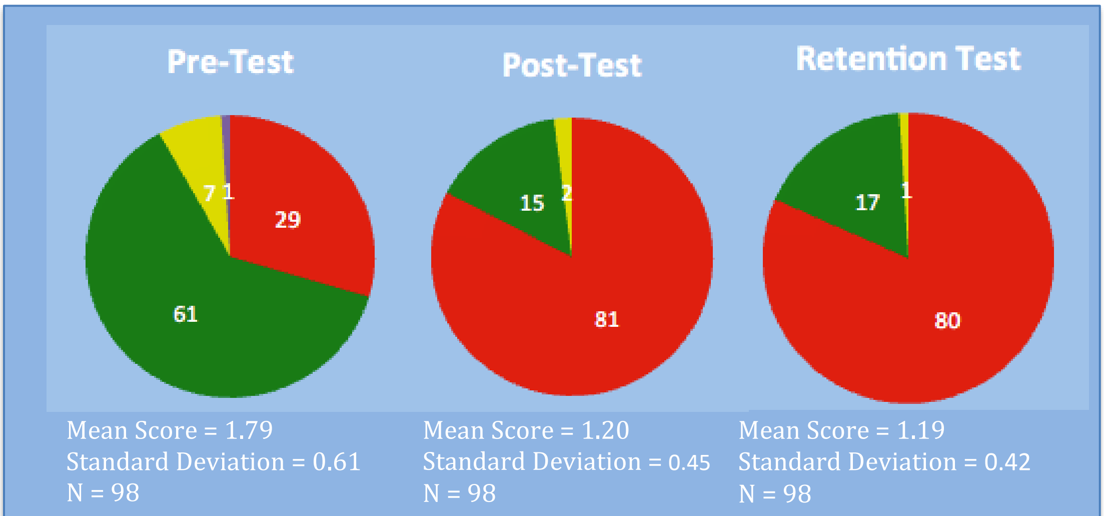


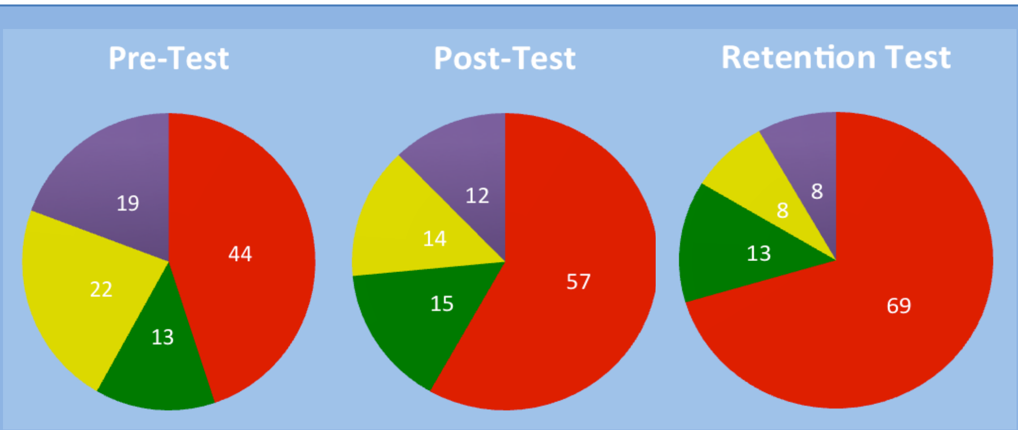
Figure 3: Pie Charts of Quiz Competency

Bouyancy Competency
Pre-test competency was varied for the buoyancy task (Figure 4). Nearly half the group could complete 5 minutes of continuous floating and treading water (44), however nearly a third of participants could not manage up to 60 seconds unsupported in deep water (31). By post-test competency had improved with 57 children now attaining a grade 1. A further significant improvement in competency was found at the retention test with 69 participants successfully completing the task and only 16 children unable to float for 60 seconds.

BUOYANCY

1. Completes all tasks correctly without assistance
2. Stays afloat for one minute and treaded water for up to one minute
3. Stays afloat on back for up to 60 seconds
4. Cannot complete any aspects of task without assistance

Participants wore just their swimming costume for this task. They were first asked to check the pool for a safe place to enter, and then get into the water without using the ladders. The participants were then required to float on their back for 60s. If they accomplished this, they then had to tread water for four further minutes. After two minutes treading water, a hose with a spray attachment was switched on to simulate rain. Then after three minutes treading water, the lifeguard simulated waves using a paddleboard. Once five minutes was completed, the participants had call for help with one hand in the air before swimming to the side and climb out of the pool.



Pre-Test	Post-Test	Retention Test
Mean Score = 2.13	Mean Score = 1.77	Mean Score = 1.54
Standard Deviation = 1.19	Standard Deviation = 0.11	Standard Deviation = 0.95
N = 98	N = 98	N = 98

Figure 4: Pie Charts of Buoyancy Competency

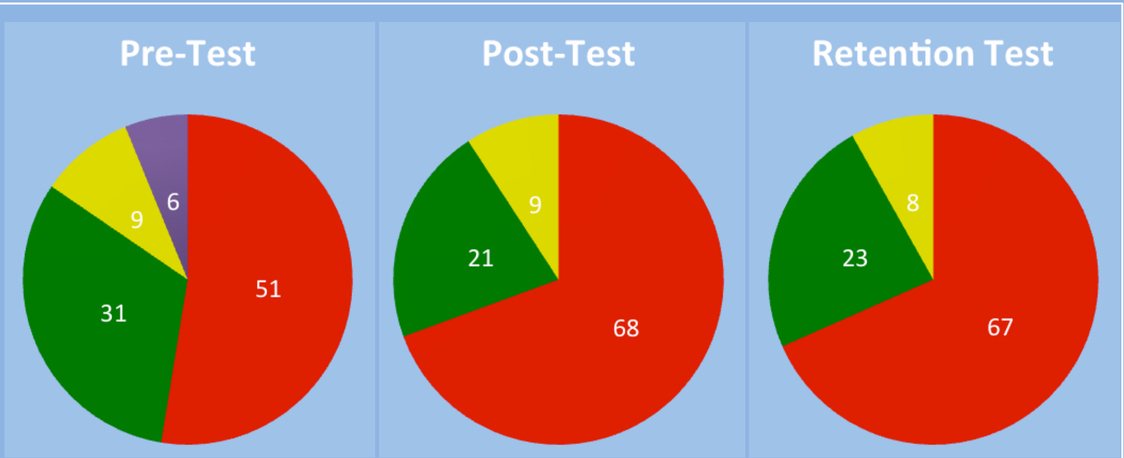
Obstacle Course Competency

Approximately half of the children could complete the **obstacle course** successfully without assistance at the pre-test. The children improved their overall competency from pre to post-test (51 to 68) and retained this performance level without further improvement in the retention test (Figure 5). There were 6 children at pre-test who refused to complete the course but by post-test and retention there no children who were graded at level 4.

OBSTACLE COURSE

Participants completed an obstacle course whilst wearing their swimming costume beneath a pair of full-length pyjamas. The obstacles were located in the shallow end of the pool (1.2 m). The course consisted of 3 'bushes' of artificial seaweed placed 2 m apart, 3 brightly coloured buoys configured in a zigzag, and a plastic kayak. The children climbed into the pool, then waded (or swam if they chose to) through the seaweed. They then had to swim around the buoys, without touching the bottom of the pool. Finally, they were asked to climb over the kayak, and then grab a buoyancy aid before exiting at the side of the pool

1. Completes all tasks successfully without assistance
2. Completes all tasks but requires assistance or touches sides or bottom
3. Cannot complete all tasks and requires assistance often, but finishes the course.
4. Cannot complete the course



Pre-Test	Post-Test	Retention Test
Mean Score = 1.68	Mean Score = 1.37	Mean Score = 1.40
Standard Deviation = 0.88	Standard Deviation = 0.63	Standard Deviation = 0.64
N = 98	N = 98	N = 98

Figure 5: Pie Charts of Obstacle Course Competency

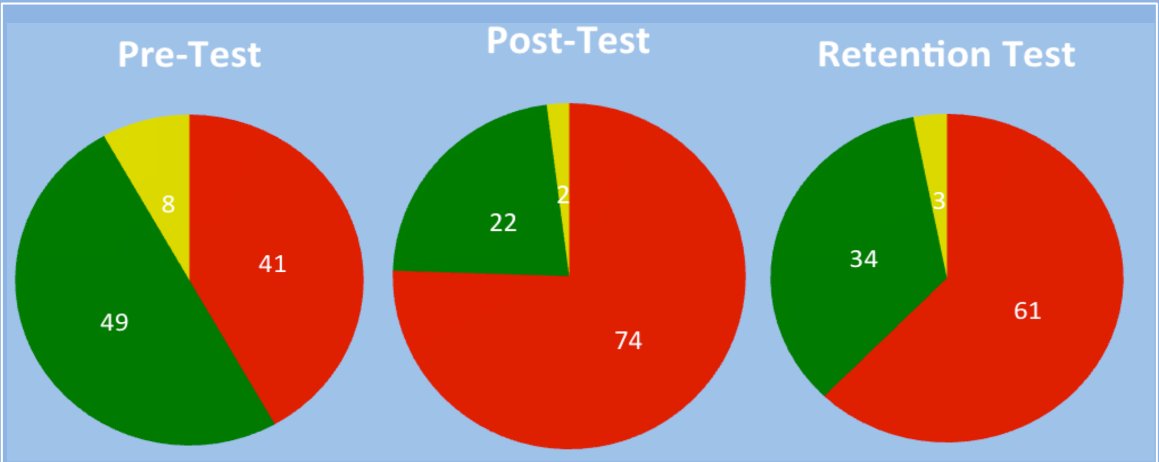
Simulated Rescue Competency

Participants were mostly able to complete the **simulated rescue** at pre-test (90 out of 98) although 49 participants needed advice about how to secure their lifejackets or throw the buoyancy aid. By the post-test, 74 participants scored a grade 1 which was a significant improvement. The performance level at the retention test was still significantly better than the pre-test indicating the improvement had been retained after 3 months.

SIMULATED RESCUE

At the side of the pool the children were asked to choose one of three different lifejackets appropriate to their size (small, medium, large). They then had to put the lifejacket on and secure two plastic buckles. The instructions were to secure the jacket tightly so that it would not slip over their head if pulled up by the experimenter. Once the life jacket was put on, the child had to pick up a leashed buoyancy aid and throw the aid to their partner in the water. They then assisted their partner to the side and helped them to exit the pool

1. Chooses correct life jacket, secures it tightly and throws buoyancy aid to partner successfully
2. Completes all tasks with advice from experimenter
3. Completes all tasks with physical help from experimenter
4. Unable to complete all tasks successfully



Pre-Test	Post-Test	Retention Test
Mean Score = 1.66	Mean Score = 1.24	Mean Score = 1.41
Standard Deviation = 0.63	Standard Deviation = 0.45	Standard Deviation = 0.55
N = 98	N = 98	N = 98

Figure 6: Pie Charts of Simulated Rescue Competency

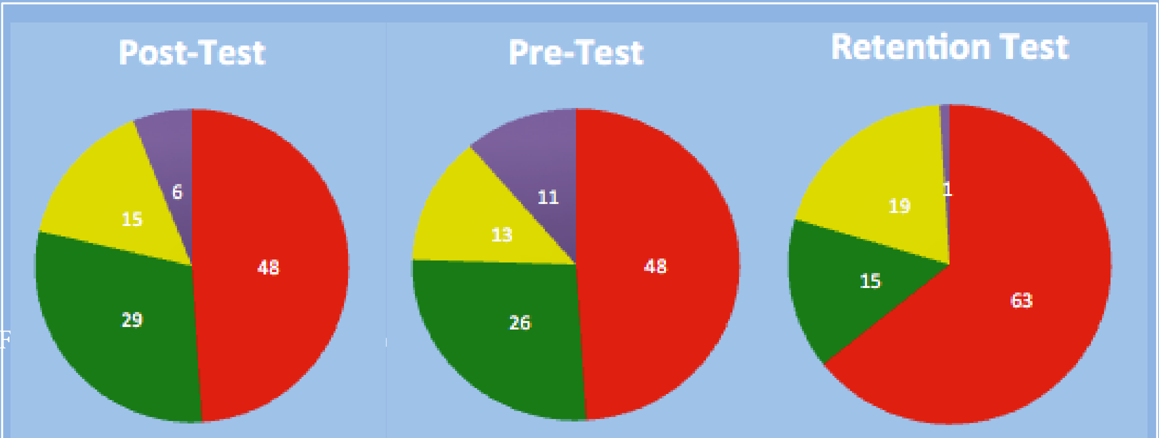
Submersion Competency

There was no significant improvement in submersion competency from pre to post-test (Figure 7). However, submersion competency did significantly improve in the retention test compared to the pre-test. By the retention test approximately two thirds of participants could swim along the bottom of the pool floor to retrieve a coloured ring from a floating hook. Furthermore by this test only one participant was unable/unwilling to complete a surface dive and retrieve the ring.

SUBMERSION

Wearing just their swimming costume, participants climbed into the water (swimming goggles were optional but the experimenters recommended that they were not worn). Participants were then asked to submerge completely underwater and swim to a brightly coloured ring situated 6m away from them and retrieve it whilst holding their breath. They gave the ring to a lifeguard and then swam back to the side of the pool and exited.

1. Successfully retrieves the ring.
2. Successfully retrieves the ring but an additional breath was required.
3. Successfully retrieves ring with multiple breaths required.
4. Unable to retrieve the ring.



Mean Score = 1.86
Standard Deviation = 1.03
N = 98

Mean Score = 1.76
Standard Deviation = 0.92
N = 98

Mean Score = 1.57
Standard Deviation = 0.84
N = 98

Figure 7: Pie Charts of Submersion

Propulsion Competency

There was a significant improvement in propulsion competency from pre to post-test which was retained 3 months later (Figure 8). At pre-test, 47 children could swim continuously without assistance for 5 minutes increasing to 62 children by the post test, and 67 by the retention test.

PROPULSION

Brightly coloured buoys were placed at either end of the pool (25m). The children were asked to enter the pool and then swim continuously up and down the pool around the buoys for 5 minutes. The instructions were not to touch the sides of the pool or floor if at all possible.

The children were told they could use whichever stroke they preferred. They wore their normal swimming costumes and, if they chose to, their goggles.

Participants performed this activity in groups of 2-6 other children with a lifeguard in close proximity at all times.

1. Able to swim continuously for 5 minutes without assistance
2. Able to swim at least 4 lengths but stops once or twice
3. Unable to complete 4 lengths or 5 minutes, requiring multiple rests
4. Unable to complete 2 lengths or 2 ½ minutes, requires multiple rests

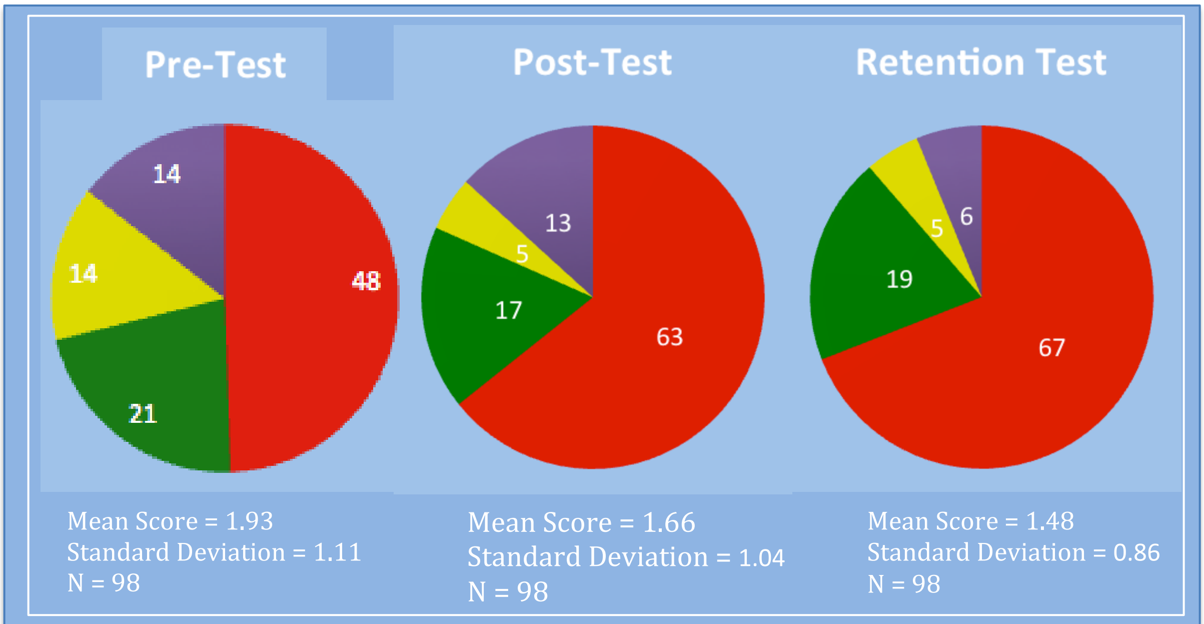
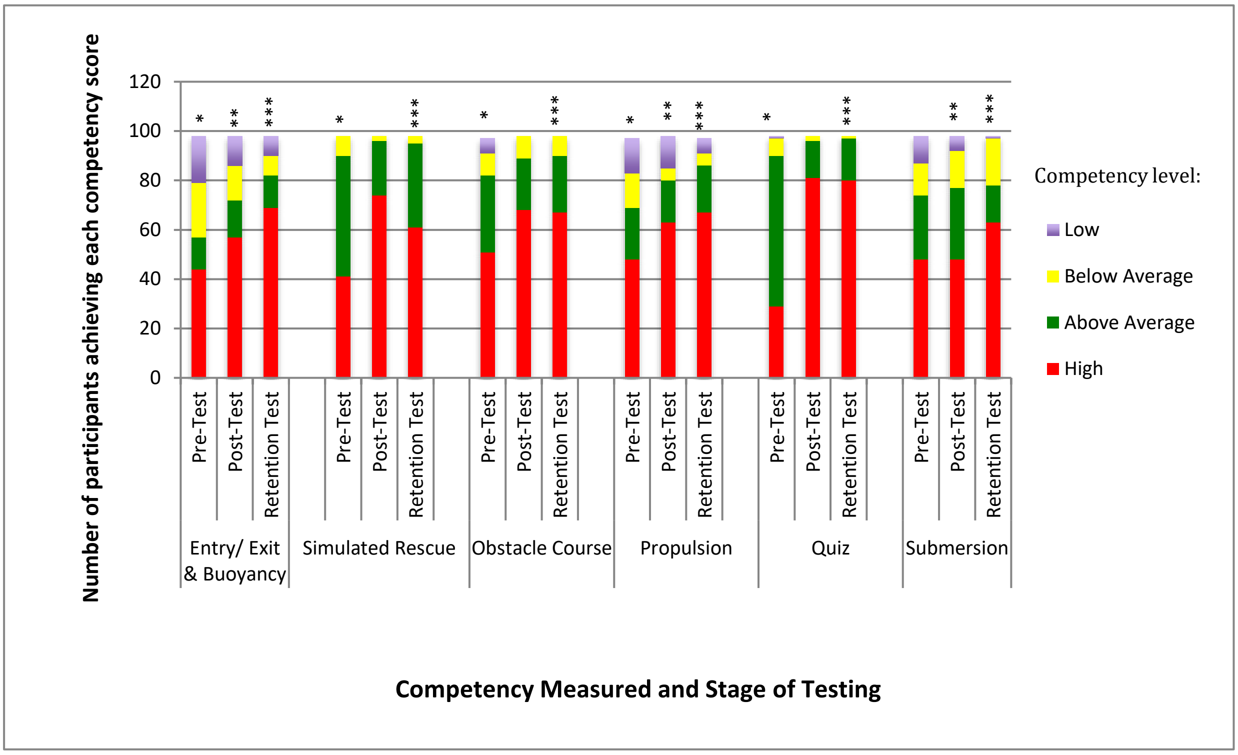


Figure 8: Pie Charts of Propulsion Scores

Figure 9 summarizes the competency data for all six tasks. The number of participants that achieved each of the four competency scores on each of the challenges during the pre-test, post-test and retention test clearly highlights an increased number of participants achieving the higher competence levels between the pre- and post-tests and retaining that performance at the retention test. Statistically significant improvements (p<.017) annotated by stars in Figure 9 were found for all six tasks typically from pre to post test and/or from pre to retention.



* Significant difference between pre-test and post-test
** Significant difference between post-test and retention test
*** Significant difference between pre-test and retention test

Figure 9: Competence achieved by all participants on the challenges during the three stages of the program (pre-test, post-test and retention test)

When the overall competency data are presented by gender (Table 6) there appears no consistent trends for either boys or girls to benefit more from the education program. It is notable that the post-test to retention test changes were typically positive (further improvements) or relatively small decreases in competency. These data indicate that the level of retention of knowledge and skills 3 months after the program was completed was generally good. The only task with a noticeable decrease from post-test to retention was the lifejacket and simulated rescue (-14%) indicating that further consideration of the retention of these important skills is required.

Challenge	Gender	Pre to Post Percentage Change (%)	Pre to Retention Percentage Change (%)	Post to Retention Percentage Change (%)
Quiz	Female	36.59	38.89	3.63
	Males	30.04	28.42	-2.31
	Mean	**33.11**	**33.22**	**0.167**
Buoyancy	Female	23.91	35.52	15.26
	Males	11.14	21.98	12.20
	Mean	**16.85**	**27.75**	**13.11**
Submersion	Female	1.41	15.01	13.80
	Males	7.18	15.93	9.42
	Mean	**5.15**	**15.45**	**10.86**
Obstacle Course	Female	17.65	11.26	-7.75
	Males	19.09	21.08	2.45
	Mean	**18.56**	**16.97**	**-1.96**
Lifejacket and Rescue	Female	29.73	17.08	-18.01
	Males	21.54	13.3333	-10.46
	Mean	**25.32**	**15.00**	**-13.83**
Propulsion	Female	19.44	20.45	1.25
	Males	10.29	24.79	16.16
	Mean	**14.12**	**23.02**	**10.37**

Table 6: Changes in competency expressed as percentage of participants increasing (+) or decreasing (-) between tests.

The extent of the competency changes between data collection phases are displayed in more detail in Tables 7a and 7b. They indicate that typically children changed their competency grade by one level (i.e., from level 2 to level 1) as opposed to 2 or more levels.

Table 7a: Summary table of children's scores changed from pre to post test. N.B: Green cells represent improvements in competency, red cells are decreases in competency.

Task:	Change in Achievement Score From Pre-Test to Post-Test						
	+3	+2	+1	No Change	-1	-2	-3
Quiz	1	6	53	30	7	1	0
Buoyancy	1	6	24	63	4	0	0
Obstacle Course	0	3	31	55	8	0	0
Life-Jacket	0	5	36	41	5	1	0
Propulsion	0	10	18	59	10	0	0
Submersion	0	2	22	57	16	1	0

Table 7b: Summary table of children's scores changed from pre to retention test

Task:	Change in Achievement Score From Pre-Test to Retention-Test						
	+3	+2	+1	No Change	-1	-2	-3
Quiz	0	7	55	27	8	1	0
Buoyancy	12	17	17	36	9	4	3
Obstacle Course	4	7	23	47	11	5	0
Life-Jacket	0	6	34	40	17	2	0
Propulsion	10	13	20	37	9	4	4
Submersion	6	9	21	42	12	8	0

Further analysis of these competence changes, demonstrates how those children that scored, 1, 2 3 or 4 in the initial assessment were impacted by the program (see Appendix). For example, 61 children initially achieved a competency level of '2' on the quiz challenge during the pre-test phase. Of these 61 children, 52 achieved an improved competency level of '1' in the post-test and 54 of the 61 achieved an improved competency level of '1' in the retention test. Seven children were initially graded as a '3' and six of these achieved a '1' during the post and retention test.

Physical competency and perceived confidence

Prior to and following each pool assessment activity, participants were asked to indicate on a four point scale how confident they felt that they would do well (i.e., where 1 was extremely confident and 4 was not at all confident). The Figures below show how well the perceived and actual confidence of the children were aligned during each stage of the study. A score of 1 indicates high confidence or competence and a score of 4 low confidence or competence.

Buoyancy

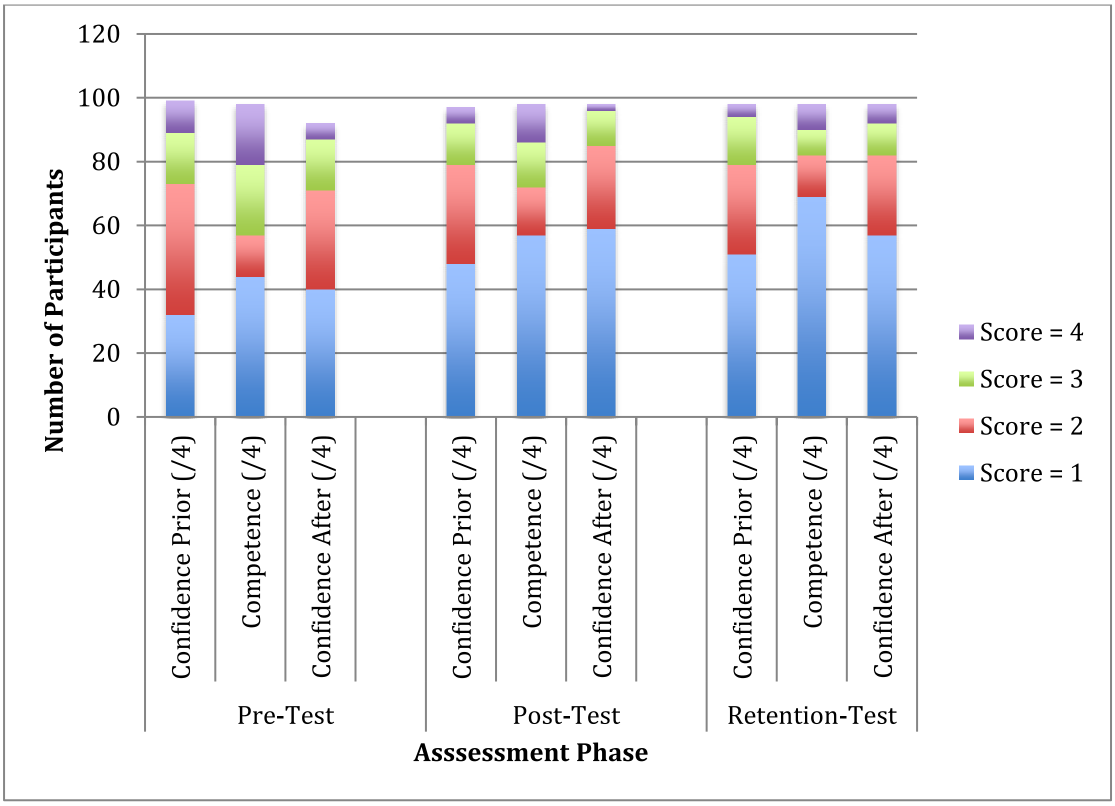


Figure 10. Self-rated perceived confidence before and after buoyancy task

Not surprisingly, participants were typically a little less confident before attempting the task than they felt after completing the task (Figure 10). It is interesting that the children were reasonably accurate at matching their perceived confidence with their actual competence. A similar number of children with below average or low confidence were actually rated in the corresponding categories by the assessors.

Similar trends to the buoyancy task are repeated in the other assessments as revealed in the following bar-charts (Figures 11-14)

Simulated Rescue

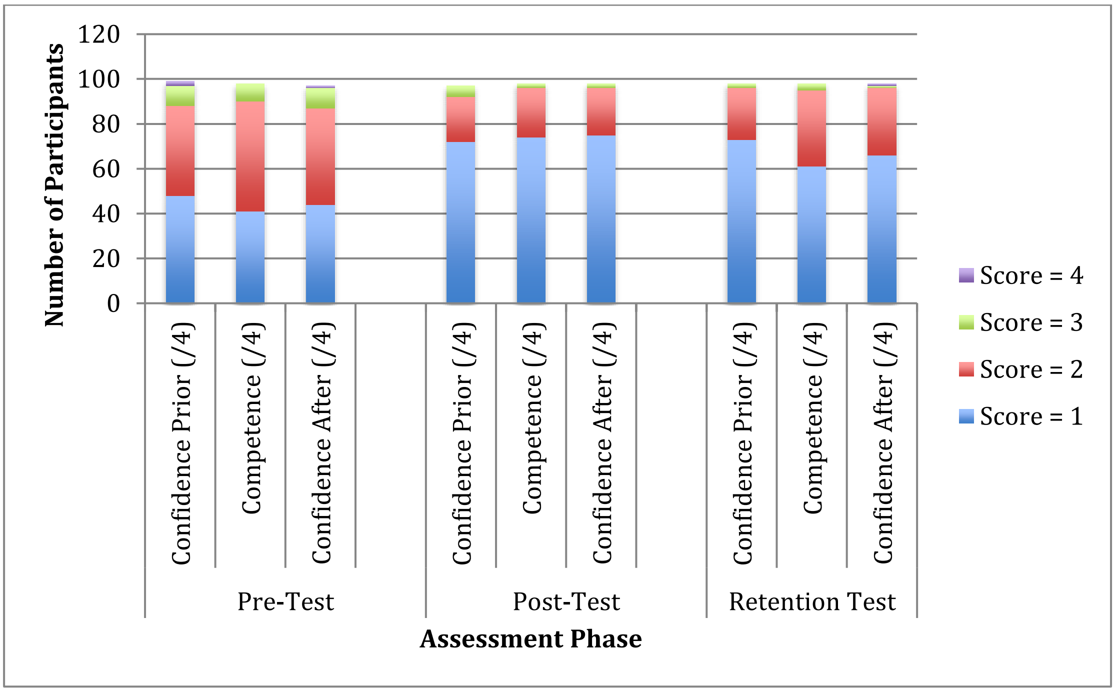


Figure 11. Self-rated perceived confidence before and after simulated rescue task

Obstacle Course

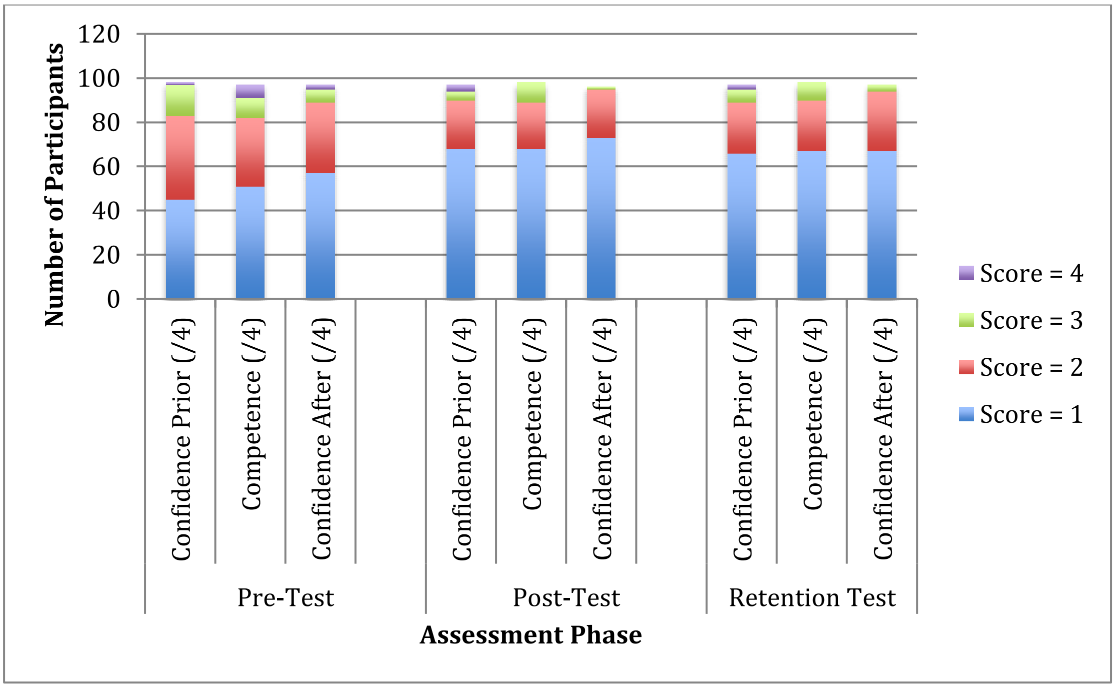


Figure 12. Self-rated perceived confidence before and after obstacle course task

Propulsion

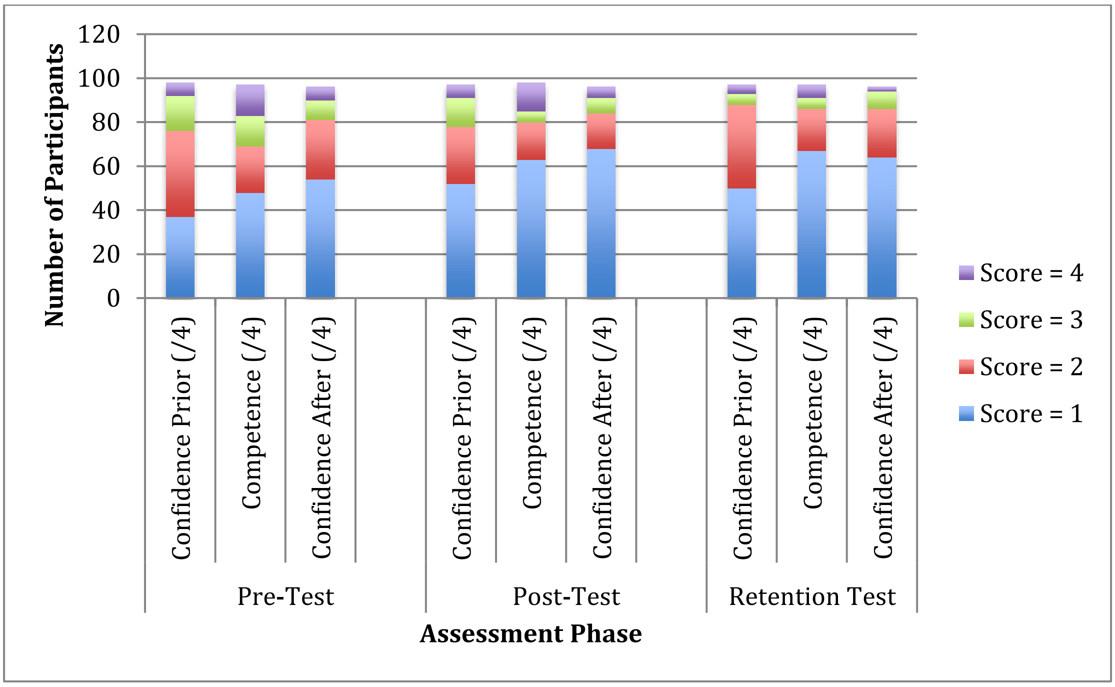


Figure 13. Self-rated perceived confidence before and after propulsion task

Submersion

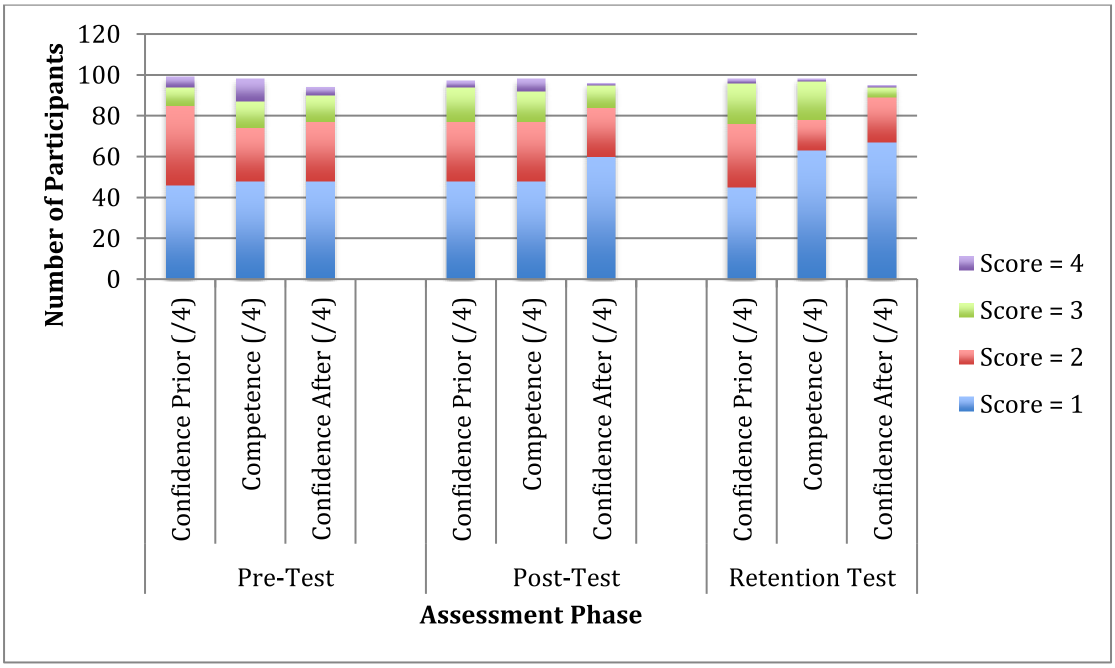


Figure 14. Self-rated perceived confidence before and after submersion task

The children ranked the Obstacle Course (followed by the Simulated Rescue task) as the easiest of the 6 tasks to complete (Table 8). At Pre-test, the Propulsion task was ranked 'most difficult' followed by the Bouyancy task. By Post-test and Retention, these two tasks were still ranked as most difficult albeit with the Bouyancy task adopting the most difficult ranking.

Table 8: Perceived difficulty of the six tasks during pre-test, post-test and retention-test

Task:	Pretest		Posttest		Retention Test	
	(Mean)	(Ranking)	(Mean)	(Ranking)	(Mean)	(Ranking)
Quiz	3.34	4	3.55	4	3.62	4
Buoyancy	4.34	5	4.46	6	4.49	6
Submersion	3.17	3	3.40	3	3.11	3
Obstacle	2.35	1	2.38	1	2.51	1
Simulated Rescue	2.80	2	2.77	2	2.76	2
Propulsion	4.71	6	4.45	5	4.41	5

Caregivers Survey

Sixty-three caregivers completed a program evaluation form whilst children took part in the 3 month retention-test (see questionnaire in Appendix). A summary of the key data that emerged from this questionnaire data is presented below.

Sign-Up Process

Caregivers were directed to a scheduling App (Schedulista) to sign up their child/ children for the water skills program. This program, allowed caregivers to choose the session times for the children. Once a child was signed up for the program, Schedulista automatically sent a reminder emails/ text 24 hours in advance of each of the sessions the child was taking part. Whilst many caregivers commented on how easy the automated sign up process was and how useful they found the reminders. It was noted that the system proved awkward for those wanting to sign up more than one child as they had to repeat the sign up process for each of their children.

Information about the Program

Although one caregiver highlighted they would have liked more information on the content of the program, the general consensus was that the program was well run and caregivers were well informed. Sample free-text comments from the questionnaire include:

"Everything was well organised and all the instructions were easy to follow"

"Parents well informed as to what to expect"

"Sessions were well planned and parents well informed as to what to expect"

Caregivers appreciated that the program provided opportunities for children to learn about dangers and safety skills across different environments and overall were pleased with the experiences their child/children had on the program (Figure 15).

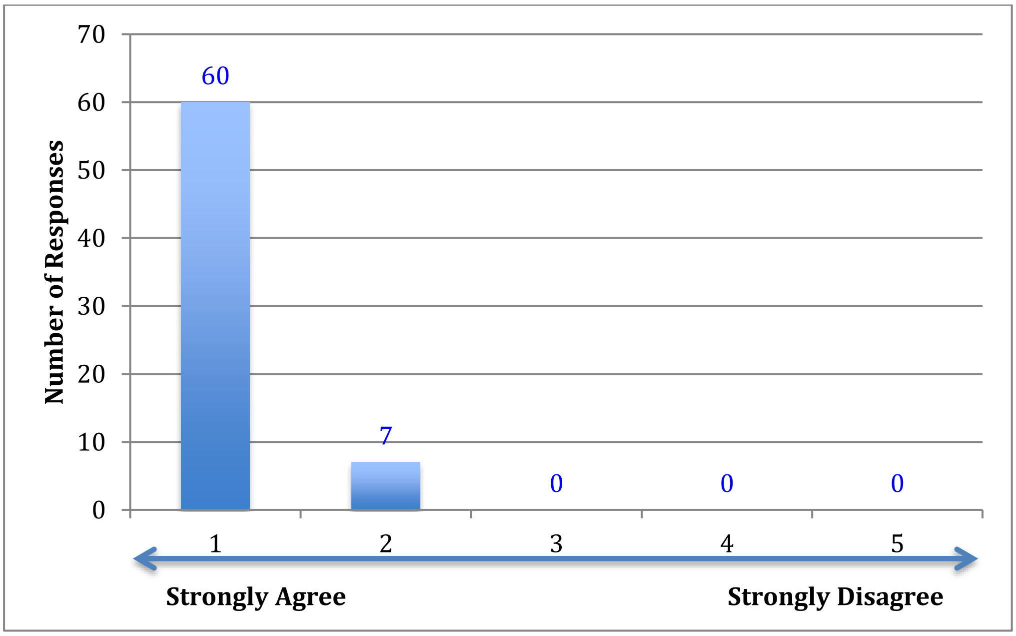


Figure 15: Likert responses (1-5) to the statement: Overall, I am very pleased with the experiences my child/children had on the water safety program

"It was great to have learning sessions in different water environments such as river, ocean, harbour etc."

"Great that they learn specific skills for each location - the beach, sea, river"

"Variety of skills taught in a variety of locations"

"Teaching them in different environments instead of in a classroom"

"Awesome program. All children should have the opportunity to experience the program. Outdoor swimming is very different to swimming in a pool"

"The program is so DIFFERENT from "swimming lessons" and much more applicable to our lifestyle"

"The overall structure of the course was well thought out and my kids enjoyed the experience, especially the beach and river day"

"A great program. Good to see the children experience real life situations"

Caregivers also highlighted how the sessions were also fun and how children were fully engaged:

“Fabulous program. Children were engaged throughout all sessions and felt more confident as a result. It was fun for them too.”

“It’s great to know kids can get such experience and have fun.”

Two caregivers highlighted that they felt the better swimmers could have been challenged a bit more in some of the activities and one caregiver felt that the subgroups children were taught in could have been smaller. However, the general consensus was that the needs of the various children were well catered for and that children learnt lots of valuable water skills (even those who were already strong swimmers) (see Figure 16).

Our son really enjoyed it! If the groups were in ages and abilities I think he could of even got more out of it

“This has been a fantastic opportunity, and not only has my child learned a lot, so have I”

“This course has improved our child's general swimming confidence. She has swum in deep water, which she would never have attempted before the course”

“[My child has] gone from being wary of waves to begging to go boogie boarding. Would recommend this program.”

“The program has encouraged our child into aquatic environments which she was previously frightened of.”

“What an awesome program this is. My son loved it even though it took him out of his comfort zone.”

“Both [my children] came home saying they had learnt a lot and feeling more confident in water that wasn't just in a pool.”

“[My child] experienced a number of experiences that he hadn't before this program, however he was well supported during these new experiences and came home looking forward to the next day's program”

“We are not a water sports family, and our child is not confident in the water. This allowed her to learn skills that we don't have the knowledge to teach her.”

“All those children! Wow, well done. This was a very valuable experience; even though "_" is a strong swimmer.”

“The boys had a great time. Their confidence in the water has improved greatly”

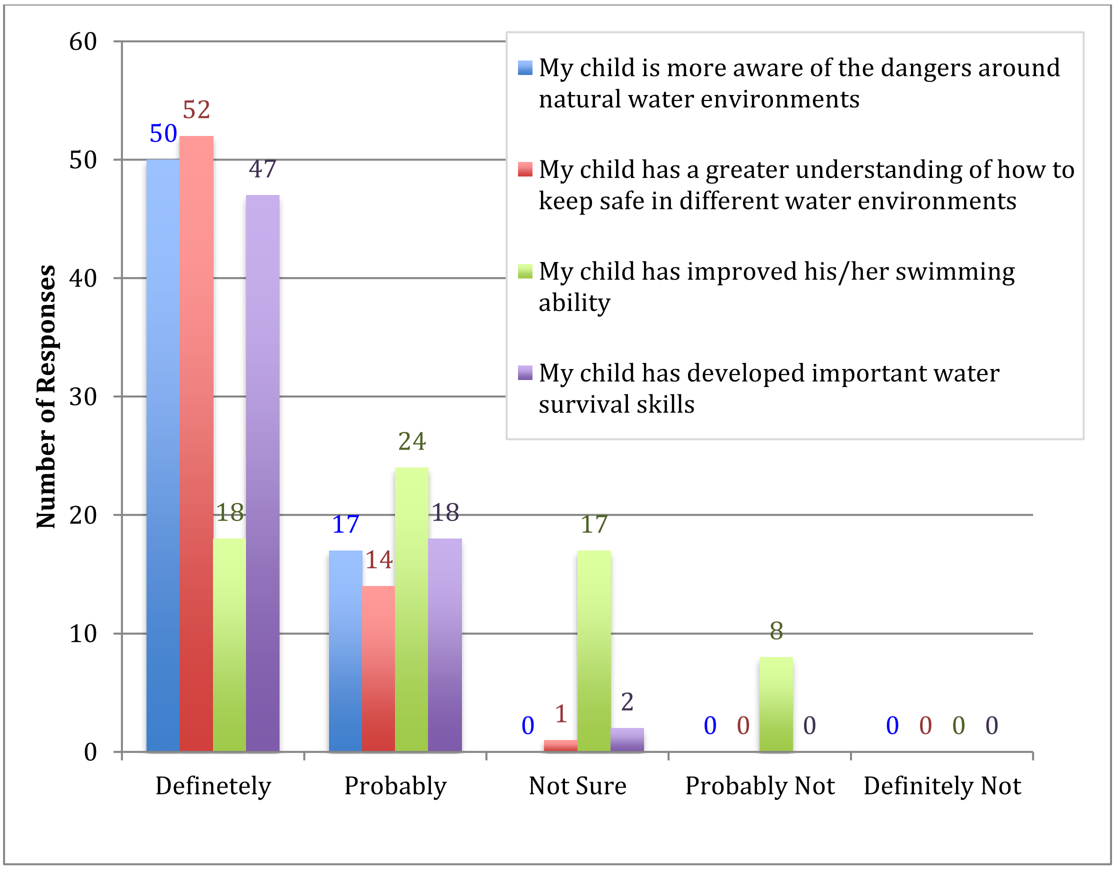


Figure 16: Likert responses (1-5) to the statements: As a result of being involved in the program, I feel … (see legend for specific comments)

Program Delivery

Many caregivers highlighted how happy they were with not only the content of the program but also how well the program was delivered and how friendly and engaging the deliverers and researchers were during the whole program. Only one caregiver commented that some of the deliverers could have established a better rapport with the children.

“Very happy with the program. Great patient and kind instructors!”

“Excellent with the kids.”

“Fantastic team working with the children.”

“Made it kids focussed and lots of fun.”

Suggested Improvements

An issue that was highlighted by a number of caregivers whose children attended the first block of the course was the need to provide more information on the specifics of the river day. The river day involved approximately a 20 minute walk along a path to where the water activities took place and many caregivers who wanted to attend the session felt ill prepared for this walk. Further details were provided to all participants in the second block of the program which overcame this issue. In addition, many children got very cold during the river activities during the first block as the wind was strong and unseasonably cold. Whilst the deliverers of this session took extra tops in case of children feeling cold, additional warm clothing would have been desirable. During the second week, a number of additional fleece blankets were taken along to this session and any children that felt too cold were able to use these.

An additional concern raised regarding the river session was the safety of children as they walked along the river bank as there were a number of drop offs. Children were instructed to walk in single file and keep away from the river side of the track. Adults were positioned at the front of the group, dispersed along the line of the group and at the back of the group. Nevertheless, it was still difficult to monitor all 60 children and ensure that they kept to the correct side of the path. During the final session, sub groups of 10 were formed and two adults were assigned with each group. Individuals were instructed to remain with their group at all times. This system was found to be much easier to monitor and we would recommend a similar system in future for any large groups of children walking the track.

One caregiver also highlighted that they felt that groups needed to be smaller during the beach day with better supervision. However, the general consensus was that that activities were run safely and that the “supervision was more than adequate”.

“[The deliverers] recognised and acknowledged child's fear of water”

“[The deliverers] provided support and encouragement”

“[The deliverers] were good at engaging reluctant starters”

“Most wonderful program! Well organised. Thoroughly planned”

Future Delivery of such a Water Skills Program

Overall, the program was considered to be very successful in terms of feedback received by both the participants and the deliverers. Sixty-two of the sixty-three caregivers that completed an evaluation questionnaire highlighted that they definitely would recommend the program to others (see Figure 17).

“I have enthusiastically and wholeheartedly encouraged friends to keep an eye open for opportunities to do this course if offered in future”

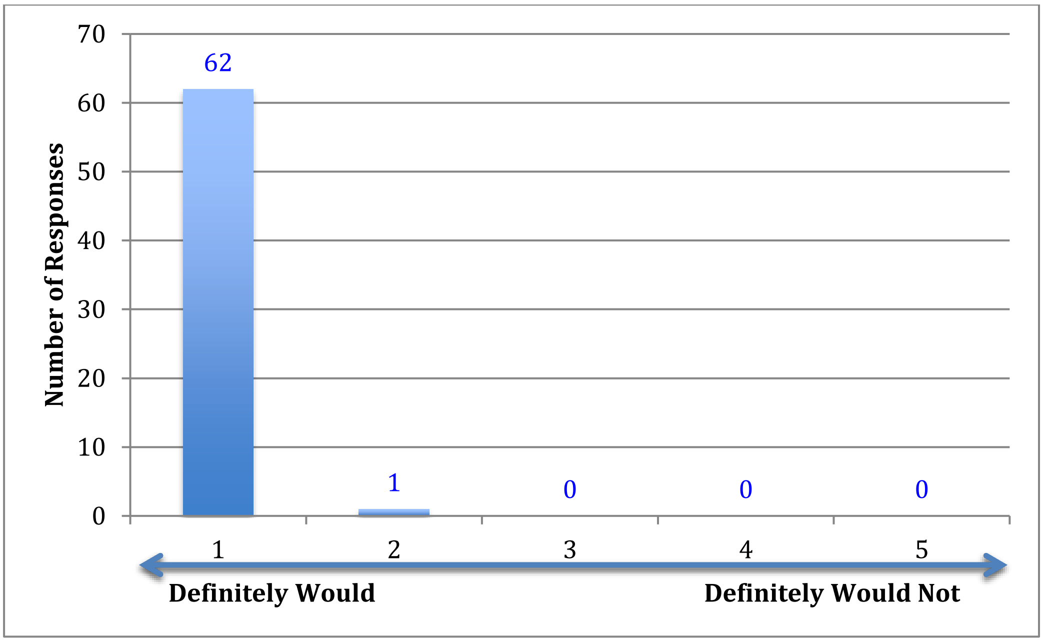


Figure 17: Likert responses (1-5) to the statement: Based on your child's children's experience how likely are you to recommend the water safety program to others?

Whilst most families would be willing to pay for their children to attend the water safety course, an issue raised by three of the families was how the cost of travel to the various venues could be prohibitive.

"The travel to the different places was a huge cost to us. Any extra cost we would most likely not be able to do this program. We did really appreciate it."

When asked how much they would be willing to pay for their children to attend the course, responses varied greatly. One family highlighted that if there had been a cost, they would have not been able to attend the program:

"Very happy we got to take part [in the program]. Had it cost money we probably couldn't have done it as we are on a very tight budget. NZ government should subsidise water safety lessons. So important in our country … summer holidays spent in and around water, we need to keep our kids safe!"

Suggested fees for the water safety program ranged from $10 to $180. However, there were two main clustering of responses with 15 caregivers indicating they would be willing to pay $50 for the course and 17 caregivers willing to pay $100 for the course."

Many of the caregivers highlighted how important they felt a water safety program that emphasises water safety skills and not just swimming ability is and the need for such a program to be widely available:

“[The Program is] a great opportunity for children to improve their skills and be safer in our environment. Would be great if every child could have this experience”

“It is definitely a very important course for Dunedin children and I hope and wish it could become an annual event”

“Awesome idea and strongly agree with the hypothesis that water safety skills as important as swimming ability.”

"So vital for kiwi kids. It should be rolled out further afield to cover as many kiwi kids as poss.!"

"What a great program, please run it again. Our younger child would really benefit from it too.”

“Please make this available for all kids!”

“Needs to be affordable for all kids.”

“Hope you repeat next year so my younger daughter can participate.”

“Would love to do this with my older child too.”

“The whole course was great and it would be really good if schools could implement this program so lot more children could benefit from it.”

“A very valuable program! There needs to be a program like this in the NZ curriculum!”

“Hopefully this [program] will be available to more children.”

“Get ACC on board, Bendigo and lottery and turn it into a water safety passport for kids to get at school before school holidays and maybe get sponsors to give a prize for completed passports.”

“Would be keen on my children taking part in something like this on a regular basis to keep it fresh. Perhaps courses throughout the school term or school holidays.”

Finally, many caregivers just expressed their gratitude and thanks for having had an opportunity to be involved in the program:

“Thank you. This is such an important lesson for all children”

“Just a big thank-you to all the organisers, the life guards, and kayak people for giving my children this valuable experience”

Discussion

In this section the results will be related to the three experimental hypotheses posed in the Introduction and other associated research findings. The limitations and implications of the study will also be provided followed by the conclusions.

H_1: The water safety skill competency of NZ primary school children will be varied but overall quite low i.e., less than 50% children would exhibit competency in core tasks (e.g., Button et al., 2017; Moran et al., 2008)

There was strong support for this prediction. At pre-test, the percentage of children achieving a high level of competence on the six water safety tasks was typically less than 50% (Figure 9). However, when the two highest level of competencies (levels 1 and 2) are combined the percentage of children increases to between 50-80% depending upon the task. There were relatively few children that demonstrated the two lowest levels of competence although it should be noted that the two tasks rated most difficult (Buoyancy and Propulsion) had between 20-40% of children graded at level 3 or 4.

In support of previous research (Button et al., 2017) the water safety competencies of 7-11 year old NZ children were spread across a wide continuum of skilled behaviour and overall is quite low relative to several of the standards recommended in the Water Skills for Life program (Appendix). It is concerning that approximately 60% of participants failed to complete a 5 minute continuous swim or an unsupported floating exercise without receiving additional help. The data obtained for the propulsion task are similar to those reported by Moran and colleagues (2008) who found that 54% of NZ children could not swim 100 m continuously in a pool and 62% in the study of Button et al. (2017). These findings also corroborate a recent review of NZ schools swimming education programs (Stevens, 2016) which found that only about a quarter of schools are providing the minimum accepted standard of 8 hours of swimming lessons per year. The poor aquatic competency of children remains a worrying concern in New Zealand where open water features are so profligate and accessible to the public.

H_2: The water safety skill competency of children will improve following a one week intervention program taught in open water environments, i.e., significant increase in competency after the program.

There was strong support for the second hypothesis. The study found significant improvements in competency between pre and post-test for five of the six tasks tested. Previous work (Button et al., 2017) had shown that 10 weeks of lessons taught in swimming pools was effective in improving water safety knowledge and competency. The data presented in the current study indicate that similar levels of improvement can be obtained from an education program conducted within three days (albeit with a similar duration of 10 hours). Furthermore, rather than being taught in swimming pools, the current study has shown that it is possible to improve water safety competencies through education delivered in open water environments.

The only task that didn’t elicit an improvement by post-test was the Submersion task (underwater swim to retrieve an object) although there was a significant improvement by the retention test for this activity. Participants were allowed to wear swimming goggles if they chose to during testing (although many chose not to) so it doesn't seem likely that impaired vision underwater influenced these findings. Whilst underwater swimming featured in the Beach and Harbour sessions of the program (Table 3a and 3c), the distance/depth swum underwater and requirement to retrieve an object was not imposed. A more explicit focus on the practice of submersion activities aquatic education programs in the future seems advisable.

The extent of improvements were typically limited to one competency band (i.e., level 2 to level 1). For some of the tasks (i.e., Quiz, Obstacle Course, Simulated Rescue) at least 80% of children were graded at level 1 or 2 by the post-test. Perhaps the task showing the greatest improvement in terms of increasing competence was the Quiz. At pre-test only 30% of children achieved a high competency score in the quiz (at least 12 from 13 answers correct). At post-test the proportion of children had increased to 83% and this level was maintained in the retention test (82%). These findings are particularly encouraging and indicate that knowledge of water conditions, safety considerations and emergency procedures may be most effectively taught in open water environments rather than in pools or a classroom.

H_3: Following an intervention program taught in open water environments, the improvement in water safety skill competency of children will be retained for at least three months, i.e., no significant decrease in competency after 3 months.

There was strong support for the final hypothesis. All six competency tests were significantly improved from pre-test to the retention test. By the retention test, the percentage of children achieving the highest level of competence had increased to at least 60% or more. Whilst the participants' activities were not controlled or monitored following the education program (see Limitations) this impressive level of retention is very encouraging. In contrast, Button et al. (2017) found that skill and knowledge retention following a pool-based intervention was not uniformly maintained (see Table 9). Notably in that study the Quiz competency decreased following 3 months to a level similar to that observed in the pre-test. As discussed in the Limitations section there are several other factors that may have contributed to the strong retention effects found in the present study.

Table 9: Percentage of participants obtaining high competency grade in previous study of Button et al (2017) in which children (N=48) were taught water safety knowledge and skills in a combination of swimming pools and school classrooms

Phase	**Quiz**	**Entry/exit & buoyancy**	**Submersion**	**Obstacle course**	**Simulated rescue**	**Propulsion**
Pre	15	23	23	31	23	38
Post	33*	44*	23	40	35	44
Retention	8**	40	38	46**	38	42

NB: High competency grade = 1 out of 4. * difference between pre and post; ** difference between post and retention

The only task in which competency decreased from post-test to the retention test (although not significantly) was the Simulated Rescue. An important component of this task was the requirement to put on and tighten a lifejacket. Assessors noted that several participants physically struggled to undo and tighten plastic buckles. It is possible that insufficient practice of this fundamental skill was provided in the education program and that may need further investigation in future work.

Limitations and Implications

A potential limitation of the study was that the sample of participants obtained for the study was not representative of the general population (i.e., the children may have possessed a moderately high level of aquatic competency) due to sampling bias. In the recruitment process we relied on caregivers voluntarily signing their children into the program. As such children with very low competency may have been less likely to participate due to their pre-existing fears of water. Indeed only 12 of 98 children self-reported their swimming competency as ‘fair’ or less than ‘good’ (Table 3). Hence, it seems a strong likelihood that the procedure of recruiting participants in the present study resulted in sampling bias towards more competent participants which would need to be addressed in future work. Despite this limitation and given that pre-test competency levels may have already been reasonably high it is notable that the program was <u>still effective</u> in improving knowledge about aquatic environments and emergency procedures as determined via the quiz. On a less positive note, the potential of sample bias renders the confirmation of hypothesis 1 even more concerning in terms of the possibility that New Zealand children may have poorer competency than reported here.

A further limitation of the study was the reliance on subjective measures of perceived and actual competency. In order to obtain reliable analyses of competency a 4-point Likert scale based on the previous study of Button et al. (2017) was employed. The actual competencies were rated based on the observations of four trained assessors. Whilst consistent cross-checking of data occurred between the assessors, a more reliable and sensitive method might have been to video the children performing the tasks and to subsequently rate performance by an independent expert panel. In the interests of maintain a ‘natural’ testing environment and minimising the extent of surveillance perceived by the children the observational technique was deemed the best compromise in the present study. Exploring means to improve the reliability and sensitivity of water safety competency measures would be a useful exercise for future research.

Furthermore, it is also important to acknowledge that all the water safety tests were conducted in a supervised swimming pool. Within the confines of the experimental design it is not possible to conclude that children taught in open water environments will effectively reproduce their skills in such environments when required. For safety reasons and the logistical barriers of conducting such measurements outdoors, this was a necessary limitation however it does limit the extent to which one can be confident of the transferability of skills and knowledge in the current study. The topic of transfer and representative design of the practice environment is currently receiving attention by our research group (Guignard et al., 2019) and will form the focus of a future WSNZ grant application.

Finally, a clear limitation of the experimental design was the lack of a control condition or group of children did not receive the open water education program. As such it is possible that a range of other factors have contributed to the findings. For example, the participants may have simply become more familiar and comfortable with the testing protocol and therefore an order effect led to their improvements in competency. Similarly because the participants' activities were not controlled or monitored between the post-test and retention test they may have reinforced their learning with additional practice. Given financial constraints and the number of participants tested in the study it was not possible to include a control group or to monitor additional practice activities. Instead some of the findings were contrasted with a previous study (Button et al., 2017) in which children were taught water safety skills in swimming pools. Whilst this was not deemed a valid or suitable comparison to run any statistical analysis, the general trends are of interest, albeit in need of confirmation by future work.

A number of practical implications arise from the present study. It is recommended that the organisations that represent New Zealand's water safety sector work collaboratively to inform policy and strategies to reduce drowning incidence in New Zealand.

- **Explore and promote** opportunities to teach water safety knowledge and skills to New Zealanders in open water environments

- **Identify and support** 'expert' organisations best placed to provide education in different open water environments (e.g., Coastguard NZ; Surflife Saving New Zealand; Mountain Safety Council; private outdoor education specialists, etc.)

- **Link and coordinate** a multi-partner approach to provide New Zealanders with education in different open water environments

- **Liaise with and lobby** Ministry of Education and NZ schools to consider how best to integrate open water safety education with swimming pool based skill acquisition programs (e.g., outdoor camps)

Conclusions

The present study confirmed that the water safety knowledge and skills of New Zealand children was varied but overall quite low in terms of competency levels recommended by Water Safety New Zealand. Encouragingly there was strong support for the efficacy of an education program focused on water safety that was delivered in open water environments. Children improved their competency in a range of different tasks assessed in a swimming pool. Furthermore, children demonstrated a good level of retention of these skills when assessed three months after the program had concluded. A key challenge for future research will be to determine the transferability of water safety skills learnt in open water environments.

Image Gallery

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Appendix

Table 10a: Changes in Quiz competence scores following water safety program

Quiz Competence Pre-Test Score	Pre-Test Score				Post-Test Score				Retention Test Score			
	1	2	3	4	1	2	3	4	1	2	3	4
1	**29**				**22**	6	1	0	**20**	8	1	0
2		**61**			52	**8**	1	0	54	**7**	0	0
3			**7**		6	1	**0**	0	6	1	**0**	0
4				**1**	1	0	0	**0**	0	1	0	**0**
Number of Children with an improved Score					**60**				**62**			
Number of Children who achieved the same Score					**30**				**27**			
Number of Children who did less well					**8**				**9**			

Table 10b: Changes in Buoyancy competence scores following water safety program

Buoyancy Competence Pre-Test Score	Pre-Test Score				Post-Test Score				Retention Test Score			
	1	2	3	4	1	2	3	4	1	2	3	4
1	**44**				**41**	3	0	0	**33**	5	3	3
2		**13**			10	**3**	0	0	10	**1**	1	1
3			**22**		5	8	**8**	1	14	4	**1**	3
4				**19**	1	1	6	**11**	12	3	3	**1**
Number of Children with an improved Score*					**31**				**46**			
Number of Children who achieved the same Score*					**63**				**36**			
Number of Children who did less well *					**4**				**16**			

* Compared to pre-test values

Table 10c: Changes in Obstacle competence scores following water safety program

Obstacle Competence Pre-Test Score	Pre-Test Score				Post-Test Score				Retention Test Score			
	1	2	3	4	1	2	3	4	1	2	3	4
1	**51**				**46**	5	0	0	**36**	10	5	0
2		**31**			20	**8**	3	0	21	**9**	1	0
3			**9**		2	6	**1**	0	5	2	**2**	0
4				**6**	0	1	5	**0**	4	2	0	**0**

	Post-Test Score	Retention Test Score
Number of Children with an improved Score*	**34**	**34**
Number of Children who achieved the same Score*	**55**	**47**
Number of Children who did less well *	**8**	**16**

* Compared to pre-test values

Table 10d: Changes in Life-Jacket competence scores following water safety program

Life-Jacket Competence Pre-Test Score	Pre-Test Score				Post-Test Score				Retention Test Score			
	1	2	3	4	1	2	3	4	1	2	3	4
1	**41**				**36**	4	1	0	**23**	16	2	0
2		**49**			33	**15**	1	0	32	**16**	1	0
3			**8**		5	3	**0**	0	6	2	**0**	0
4				**0**				**0**				**0**

	Post-Test Score	Retention Test Score
Number of Children with an improved Score*	**51**	**39**
Number of Children who achieved the same Score*	**41**	**40**
Number of Children who did less well *	**6**	**19**

* Compared to pre-test values

Table 10e: Changes in Propulsion competence scores following water safety program

Propulsion Pre-Test Score	Pre-Test Score				Post-Test Score				Retention Test Score			
	1	2	3	4	1	2	3	4	1	2	3	4
1	**47**				**40**	7	0	0	**31**	9	3	4
2		**21**			15	**5**	1	0	16	**4**	0	1
3			**14**		7	2	**3**	2	10	3	**1**	0
4				**14**	0	3	1	**11**	10	3	1	**1**

	Post-Test Score	Retention Test Score
Number of Children with an improved Score*	**28**	**43**
Number of Children who achieved the same Score*	**59**	**37**
Number of Children who did less well *	**10**	**17**

* Compared to pre-test values

Table 10f: Changes in Submersion competence scores following water safety program

Submersion Pre-Test Score	Pre-Test Score				Post-Test Score				Retention Test Score			
	1	2	3	4	1	2	3	4	1	2	3	4
1	**48**				**37**	10	1	0	**34**	6	8	0
2		**26**			10	**12**	4	0	17	**4**	5	0
3			**13**		1	6	**4**	2	6	2	**4**	1
4				**11**	0	1	6	**4**	6	3	2	**0**
Number of Children with an improved Score*					**24**				**36**			
Number of Children who achieved the same Score*					**57**				**42**			
Number of Children who did less well *					**17**				**20**			

* Compared to pre-test values

Water Survival Program: Parent Feedback Form

1. **Overall, I am very pleased with the experiences my child/children had on the water survival program:**

Strongly Agree				Strongly Disagree
1	2	3	4	5

Any Comments:

....

....

....

2. As a result of being involved in the program, I feel my child / children ....

	Definitely	Probably	Not Sure	Probably Not	Definitely Not	Add any further comments ....
a. Has become more aware of the dangers around natural water environments						
b. Has a greater understanding of how to keep safe when in different water environments						
c. Has improved their swimming ability						
d. Has developed important water survival skills						

3. What did we do well?

....

....

....

....

Figure 18: Caregiver questionnaire to evaluate water safety education program (administered whilst participants completed retention test)

Figure 19: Promotional poster for Water Safety New Zealand's Water Skills for Life Program