Assessing the Water Survival Skills Competency of Children

Research report prepared for Water Safety New Zealand

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Executive Summary

Learn-to-swim programmes have historically accentuated the teaching of classical swimming strokes as a means to equip children with competencies to survive in diverse aquatic environments. The assumption that this is sufficient, however, has been challenged in recent efforts to elucidate the prevailing causes of drowning in open bodies of water. This study sought to demonstrate that a rational and balanced emphasis on fundamental aquatic skills in education programmes can improve the ability of New Zealand's (NZ) children to evaluate risk and behave appropriately in and around water.

Primary school aged children were recruited from six schools around Dunedin. Participants were invited from schools scheduled to undertake swimming lessons through a local learn-to-swim organisation in the second school term of 2016. Schools administered the safety knowledge and awareness modules in their usual manner. Children were tested prior to, immediately upon cessation of, and ten weeks after cessation of lessons. Simulated open water testing of participants was undertaken at an indoor swimming pool in the absence of parental supervision. Assessment evaluated each child's water survival competencies at 6 tasks: knowledge, buoyancy, submersion, simulated rescue, negotiating obstacles, and propulsion.

Before teaching, the survival skills competency of children was varied, but in general quite low. To a variable and modest extent between tasks and individuals, children improved their overall knowledge competency from pre to post-testing, but that improvement was not retained and was not apparent ten weeks later. Encouragingly, competency for buoyancy improved significantly ($p<0.01$) after lessons and was maintained in retention testing. A small, but not statistically significant improvement was observed in propulsion competency. No significant improvements were observed in submersion and simulated rescue tasks.

The results supported the notion that NZ children aged between 7 and 11 years of age have a low level of survival skills competency. Children's propulsion skills were limited, with 62% unable to swim 100 m unaided. Although knowledge of risks and emergency response was notably low, there was some encouraging evidence that education of survival skills can bring about improvements of competency. The results of this research reveal that NZ children typically lack a range of important survival skills and that further attention to how these skills are acquired is also needed amongst education providers.

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Introduction

Background

> *"Swimming is learned indoors while drowning happens primarily outdoors. How many children have the opportunity to experience swimming while clothed or the discomfort of cold water? For all too many, swimming is a matter only of performing the correct movements. We believe it is much more."*
>
> (Stallman, Junge, & Blixt, 2008: p. 372)

According to the World Health Organisation (2014), we are in the midst of a global drowning pandemic with an estimated 372,000 fatalities per year. That figure is almost certainly an underestimate (Peden, 2008). In New Zealand, approximately 100 people drown annually, which is one of the worst records per capita in the developed world (Claridge, 2013). In Australia and New Zealand, 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. For example, a recent review of Swim-to-Survive programmes in New Zealand (UMR) signalled a shared desire amongst water safety organisations to improve the teaching delivery of swimming and survival skills for children in this country.

Traditionally, there has been a strong focus on learn-to-swim programmes in New Zealand to teach survival skills. Learn-to-swim teaching programmes place great emphasis upon learning to perform classical swimming stokes (i.e., freestyle, breaststroke, and backstroke). Indeed such complex movement patterns typically require a significant amount of practice and teaching to be learnt effectively. Despite such an emphasis, recent research has revealed that a high proportion of NZ children (up to 54%) cannot swim up to 100 m in a swimming pool and have a low level of water safety knowledge (Moran, 2008). A general assumption amongst swimming educators is seemingly that if children are taught to swim, they possess the necessary basic skills to survive in the water. However, traditional measures of swimming ability are inadequate when evaluating the skills needed to prevent drowning (Brenner, Moran, Stallman, Gilchrist, & McVan, 2006). It is possible that learning to swim within the sheltered confines of a swimming pool creates a misplaced confidence in aquatic ability that does not transfer well to other aquatic environments (Stallman et al., 2008). For example, a child may believe that swimming 25 metres in a pool equates to an ability to swim the same distance in the ocean, however, such comparisons are made invalid and potentially dangerous by numerous environmental factors that can change unpredictably (e.g., tide, current, water temperature, fear). It is also possible (although not empirically confirmed to our knowledge) that

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overestimated aquatic abilities may lead to more exposure to aquatic environments and misjudgement of relative risk in such environments.

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) undertook a review into the way basic water survival skills are taught to kids aged five to thirteen. 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. The review 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 evidence, WSNZ 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” programme launched in 2016 is the result of these findings and includes a range of swimming and water safety skills that children are expected to have achieved by the time they are 13. These skills are crucial for the safe enjoyment of aquatic activities in a range of environments. Water Skills for Life also provides the essential basis for participating in most water-based sports.

Pedagogical model for fundamental aquatic skills

Interestingly, the debate about how best to teach fundamental aquatic skills has surfaced in the motor learning literature in recent times. A radical shift has been proposed in the teaching of aquatic skills, to be based upon acquiring a range of survival skills rather than certain classical swimming strokes (Stallman et al., 2008). This shift in emphasis seems appropriate, as survival skills are typically absent, or at least downplayed, in learn-to-swim programmes. Stallman et al. (2008) suggest a list of eight aquatic fundamental motor skills (FMS, see Figure 1), each of which are closely linked to common causes of drowning (i.e., did not recognise danger, unintentional immersion, difficulty in returning to the surface, unable to orient in the water, panic, fatigue, etc.). Core skills, such as how the child enters the water (skill 1) and then subsequently reorients their body into a streamline position (skill 2), form the building blocks from which more sophisticated ways to move through the water can later be developed.

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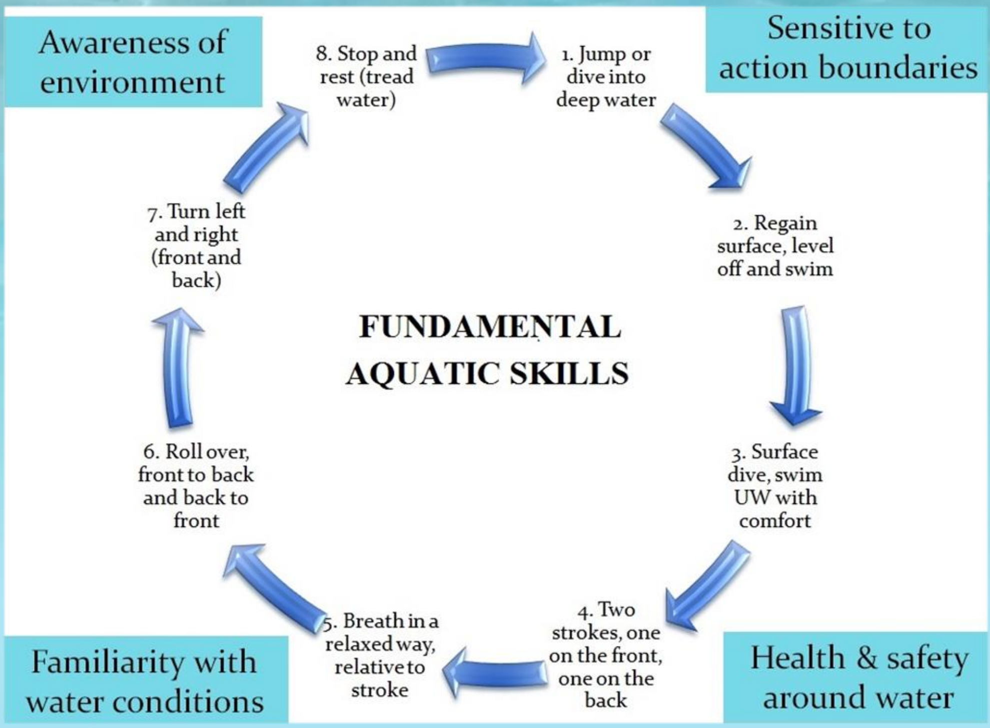

Figure 1. Proposed model of fundamental aquatic skills based upon the 8 skills linked to common causes of drowning by Stallman et al. (2008). Four key cognitive elements (blue panels) have been added in this model to reflect the necessity to develop awareness of the context within which aquatic skills are acquired (see Button, 2016). UW: under water.

The teaching of these core skills also needs to be supported by improved awareness of the aquatic environment and the learner's ability to move in that environment (Kjendlie et al., 2013). Hence the model in Figure 1 includes four additional cognitive elements to the Stallman et al. (2008) list that could form the basis of a pedagogical model of fundamental aquatic skills. Robust motor learning requires skills to be transferable across performance environments, which demands sensitivity to one's own maximal action capabilities and an appreciation of how they can change from one situation or environment to the next (Seifert, Button, & Davids, 2013). While this model may not yet be complete (e.g., there may be value in adding an object manipulation skill in the water such as putting on a lifejacket), this version can still provide an important direction for aquatic pedagogy. The 'first principle model' developed above (Button, 2016) is closely aligned with the Water Skills for Life competencies proposed by Water Safety New Zealand.

Retention of Water Survival Skills

Whilst there is now general agreement about the information and skills that should be taught to children, there are few data on the current level of competencies that New Zealand children possess. There is also a lack of research on the retention of water survival skills and knowledge in children. Existing efforts to better understand the impact of water survival 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

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educating children in safety awareness and risk identification also lack investigative insight into how best to cement this type of knowledge long term (Hillier et al., 1998).

As such, the current research set out to examine the level of water skill competency amongst a sample of NZ primary school age children (from 6 -11 years old). Furthermore, we sought to monitor the impact of a survival skills-focussed educational programme on the retention of water survival skills amongst children.

Aims and hypotheses

We aimed to demonstrate that a rational and balanced emphasis on fundamental aquatic skills in education programmes can improve NZ children's ability to evaluate risk and behave appropriately in and around water. Based on the limited research to date that has been conducted within New Zealand, the following hypotheses were derived:

Null hypotheses (H_0): The water survival skill competency of children is already high and there will be no influence of teaching on skill competency.

Experimental hypothesis (H_1): The water survival skill competency of NZ children is low (Moran, 2008).

Experimental hypothesis (H_2): Teaching children a range of water survival skills will improve their performance and retention of these skills.

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Methodology

Participants

Advertisements were circulated in 6 primary schools via weekly newsletters. The schools were chosen by convenience as they were scheduled to receive swimming lessons delivered by an independent swimming education company during the second term of the school calendar. Participant invitation letters and information sheets were then sent to the parents or caregivers of 240 children (6-11 years old). From that initial mail out, 48 parents (20%) responded and agreed for their child/children to participate. 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 parents.

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

						Extra-curricular swim lessons?			Swimming Pool	Waterway
Sex	**Number**	**Age (Y)**	**Height (m)**	**Weight (kg)**	**Perceived ability (/4)**	***Previous***	***Not Current***	***Current***	**Frequency (visits/yr)**	**Frequency (visits/yr)**
F	23	9.1	1.40	35.99	2.31	11	10	2	43	14
		(1.3)	(0.11)	(10.84)	(1)				(38)	(16)
M	25	8.8	1.38	33.20	2.44	9	13	3	35	14
		(1.0)	(0.08)	(6.06)	(1)				(28)	(13)
Total	48	8.96	1.39	34.54	2.38	20	23	5	38	14
		(1.16)	(0.09)	(8.70)	(1)				(32)	(14)

The parents were sent instructions about how to schedule their child for testing via an online registration system. Participants were typically allocated into one hour blocks in small groups of between 2-6 children, although occasionally one child was tested alone (with assistance from a lifeguard). 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.

Testing facility and equipment

All testing took place in a private swimming pool not familiar to the participants. The pool dimensions were 8 x 25 m, there was a shallow end of 1.2 m, a deep end of 2.5 m with a continuous sloping floor. The pool had an access ladder in each corner. For all testing sessions, the water temperature was set at 25°C, however, due to the different times of year in which the testing sessions took place, the ambient temperature was varied (i.e., Pre-test = 17-22°C, Post-test = 12-18°C, Retention-test = 13-28°C). The pool had private, secure

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changing rooms located next to it. Participants were advised to bring their own set of cotton pyjamas, typical swimwear, towel, and if desired, a pair of goggles. Caregivers were also advised to provide children with a second towel to keep warm if the child was out of the pool for any considerable duration.

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), 3 coloured diving rings attached by hooks and weighted string to empty plastic bottles, assortment of plastic dumb-bells (2-5 kg) to anchor buoys, a plastic kayak (3 m), a hose and water-spray attachment, a stopwatch, and 8 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 (Figure 2). 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 (could add in ethics number). All children and parents provided written informed consent before participating. Participants and their parents or care-givers attended the swimming pool on three separate occasions (pre-test, post-test conducted 3 months later immediately upon cessation of the teaching intervention, and then a further 3 months retention test). The children were instructed to refrain from heavy exercise or a large meal at least one hour before each testing session. 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 parent/care-giver.

For the pre-test session, a number of anthropometric and self-reported variables were measured and recorded. 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. The participant's responses to these questions was checked and confirmed by their parent/care-giver. Once the participant was ready to begin testing the parent/care-giver was asked to leave the swimming pool and return to collect their child in one hour. The purpose of requiring the parent/child-giver to absent themselves during testing was to prevent them from intentionally (or unintentionally) influencing their child's responses to the tasks. In the subsequent post-test and retention tests only height and weight were re-tested before the participants began the tasks.

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There were six tasks to be attempted by each participant. The order of the tasks was randomised between participants and conditions except for the quiz (first) and propulsion task (last), which were ordered consistently for logistical reasons. A summary of the tasks is presented below in Table 2.

Before each task was attempted, verbal instructions were given to the participant until they confirmed they understood what was required. Then they were shown a 4-point scale on which they were asked to rate their confidence of completing the task goal successfully (Figure 2). The scale resembled a traffic light sequence in which green corresponded to “Very confident”, yellow was “Quite confident”, orange was “Not very confident” and red was “Not at all confident”. Once participants had expressed their pre-task confidence, the experimenter asked them to begin their attempt. Immediately after each task attempt, participants were also asked to rate how well they thought they had performed using the same scale. Participants were then escorted to the next task by the experimenter.

Figure 2. The 4-point Likert Scale presented to children in A4 size to gauge their level of confidence before and after each task.

Once all six tasks had been attempted, the participants were asked to rank how difficult they found each task. The experimenter used a large whiteboard to help the participants recall the different tasks and to order them from “easiest” to “hardest”. The participants then went to the changing room for a warm shower and dressed prior to being collected by their parent.

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Table 2. Overview of 6 survival skills and competencies

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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, private pool: 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 (2.5 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). They then chose one brightly coloured ring situated at varying distances from them. They were then asked to submerge completely underwater, swim to the ring 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 furthest (6 m) ring. Grade 2: Successfully retrieved middle ring (4 m) or furthest (6 m) ring with an additional breath required. Grade 3: Successfully retrieved nearest ring (2 m) or middle ring (4 m) with an additional breath required. Grade 4: Unable to retrieve nearest ring (2 m) without a breath.
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 (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 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 3a).	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.

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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 3b).	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 (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 4 lengths but stops once or twice Grade 3: Unable to complete 4 lengths or 5 minutes, requiring multiple rests Grade 4: Unable to complete 2 lengths or 2 ½ minutes, requires multiple rests

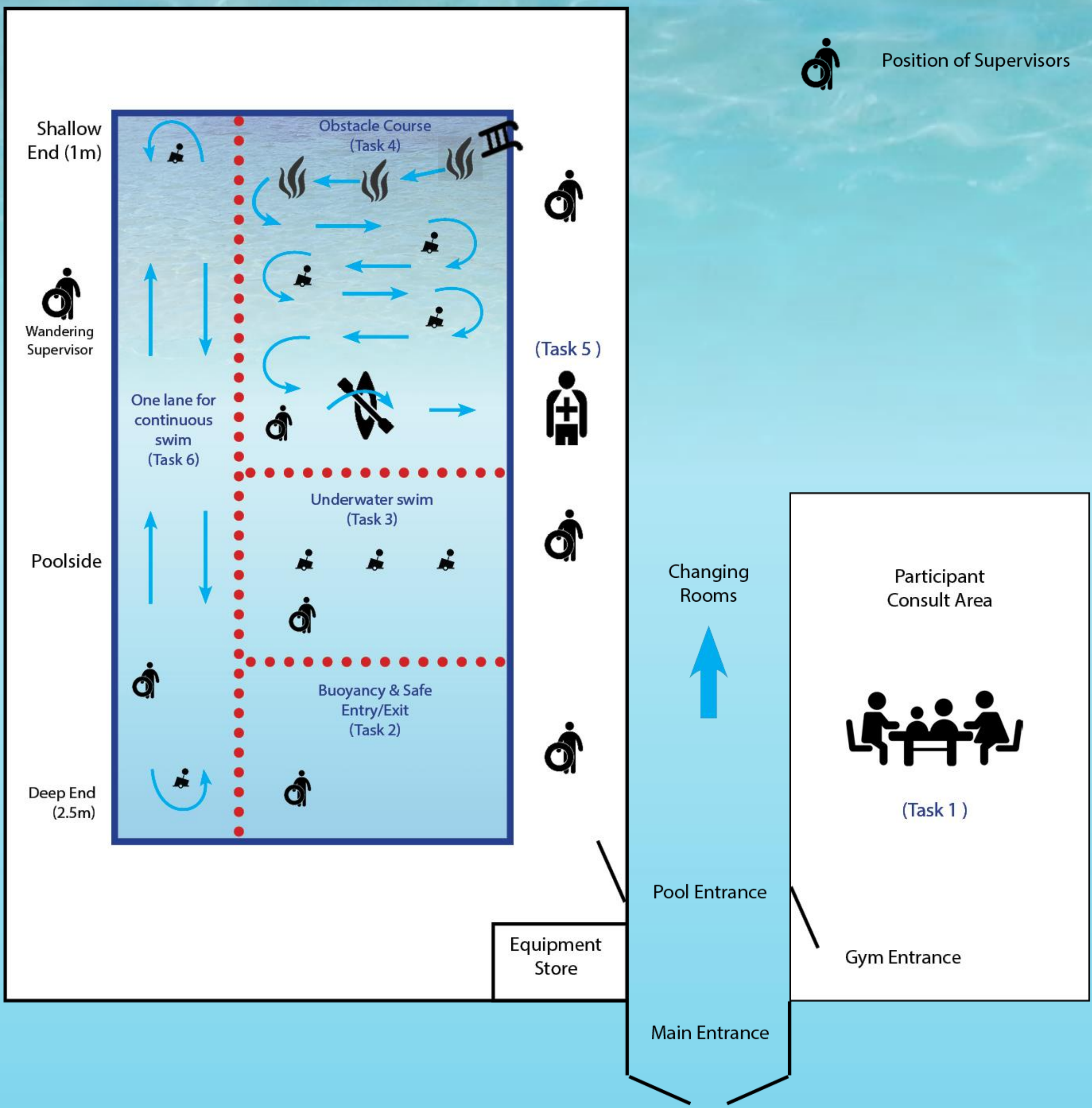

Figure 3. Diagram showing how the pool facility was set-up to accommodate all six tasks, and the placement of supervisors. Nb. The Safe Entry task was combined with the Buoyancy task.

Figure 3a) Photograph of obstacle course. Experimenter explaining the simulated rescue task to a participant. In the foreground are fake seaweed plants, brightly coloured buoys and a lifeguard.

Figure 3b) Alternate view of the obstacle course. Participant wearing pyjamas is completing the swim part. A lifeguard is waiting by the kayak that the participant will next attempt to climb over.

Figure 3c) Photograph of simulated rescue task. Participant wearing a life jacket pulling a partner back to the side of the pool.

Data Analysis

Anthropometric and background participant data were summarised with descriptive statistics (Table 1). The majority of test data were typically ranked scores, either from a four- or seven-point scale depending on the variable assessed. As the data was ordinal level, nonparametric comparisons were made with Friedman's N related samples tests, followed by corrected Wilcoxon contrasts as post-hoc tests.

Independent assessments of the participant's competency were also provided by the swimming education provider at the completion of their 10 week block of lessons. The independent assessments were collected by various swimming teachers (not trained researchers) therefore the independent assessments were subsequently analysed for internal reliability and association with the test performance (Appendix B). Due to the high potential for variation in assessment methods between the independent assessments and those taken during the experiment comprehensive analysis of this data was not deemed appropriate.

Assessing the WATER SURVIVAL SKILLS COMPETENCY of Children

THE QUIZ

THE TASK

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.

GRADING

1 — 13-12 correct

2 — 11-8 correct

3 — 7-4 correct

4 — 3-0 correct

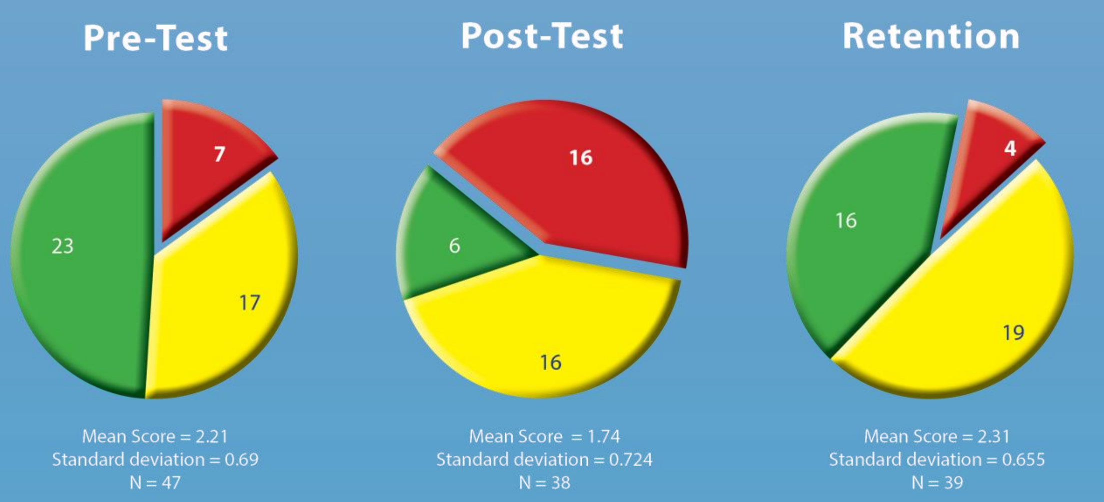

Figure 4. Frequency analysis of Quiz scores for pre-, post- and retention testing.

Initially, 15% of children attained a competency grade of 1.

This increased to 42% of children

...and then decreased to 10%.

"The children improved their overall quiz competency from pre to post-test (p < .001) but that improvement was lost by the retention test."

BUOYANCY

GRADING

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

THE TASK

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.

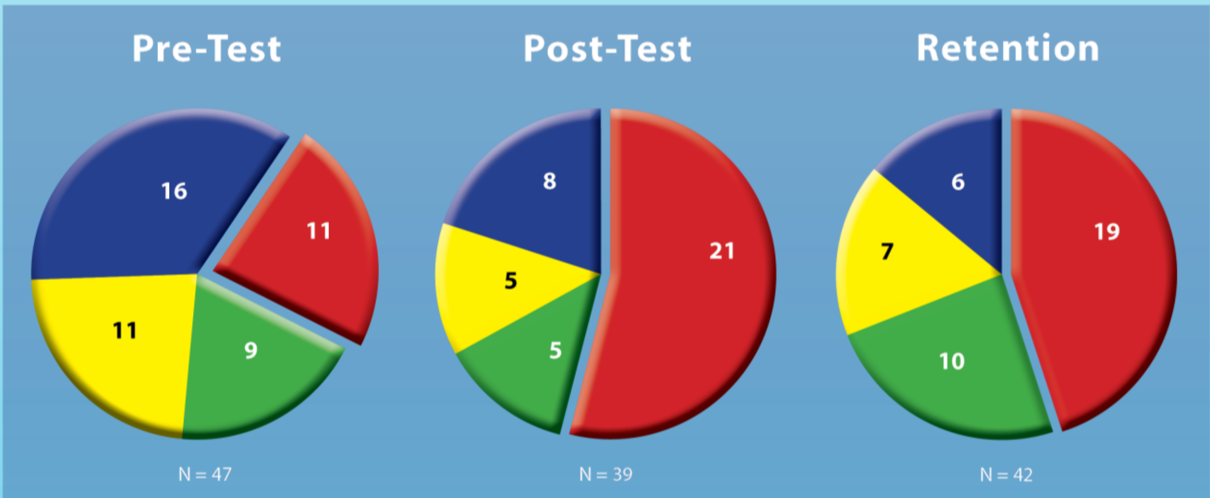

Figure 5. Frequency analysis of Buoyancy scores for pre-, post- and retention testing.

The frequency of high competent scores (grade = 1) increased from 23% to 54% of children at post-test and 45% at the retention test.

The frequency of poor competency scores (grade = 4) fell from pre-test (34%) to post-test (21%) and then to retention (14%).

The children ranked the buoyancy tasks as the second most difficult task at pre-test. The children's confidence about completing the buoyancy task independently only improved from post-test to the retention test ($p < .05$). Despite improved confidence prior to the buoyancy task, in the retention task it was rated overall the most difficult of the 7 tasks (mean ranking of 5.5).

> **"Overall competency for this task improved from pre-test to post-test ($p < .01$) and the improvement was maintained in the retention test ($p < .001$)."**

SUBMERSION

There were no competency changes in the submersion task over the three phases (p=0.08). There was a small improvement in competency between the post-test and retention test but this change was not statistically significant.

OBSTACLE COURSE

GRADING

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.

THE TASK

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

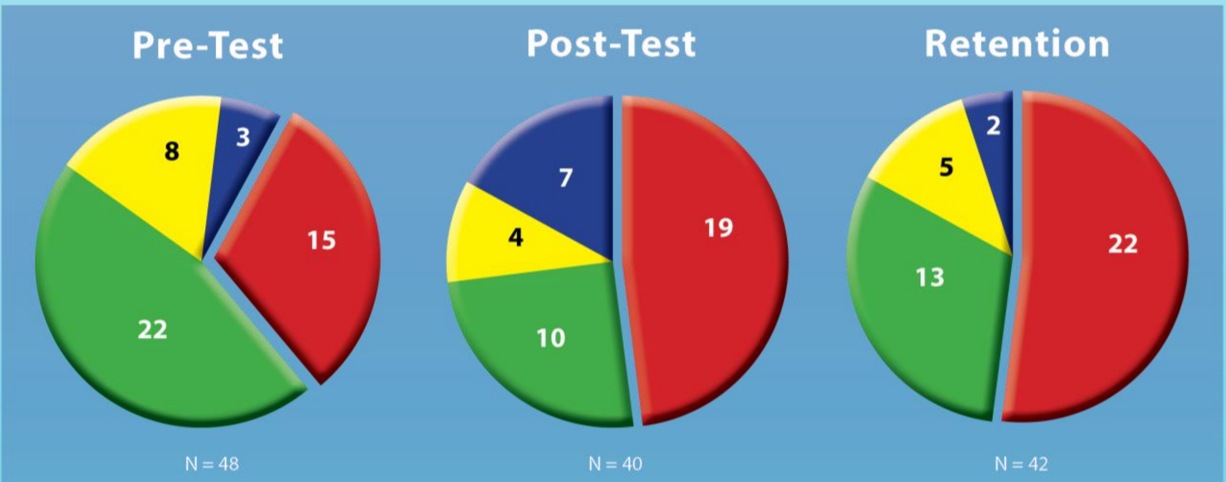

Figure 6. Frequency analysis of Obstacle Course scores for pre-, post- and retention testing.

For each test, relatively few children demonstrated poor competency at the obstacle course (mean frequency of grade 4: pre-test = 6%, post-test = 18%, retention test = 5%).

There were no changes in confidence about completing the obstacle course over time.

> **There was an improvement in competency between the post-test and retention test (p<0.05) but not between any other phases**

SIMULATED RESCUE

There were no significant differences in the simulated rescue task over the three phases (p=0.12). There was a small improvement in competency between the pre-test and post-test but this change was not statistically significant. The frequency of children rated at 3 or 4 was less than 23% for each phase.

PROPULSION

THE TASK

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.

GRADING

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

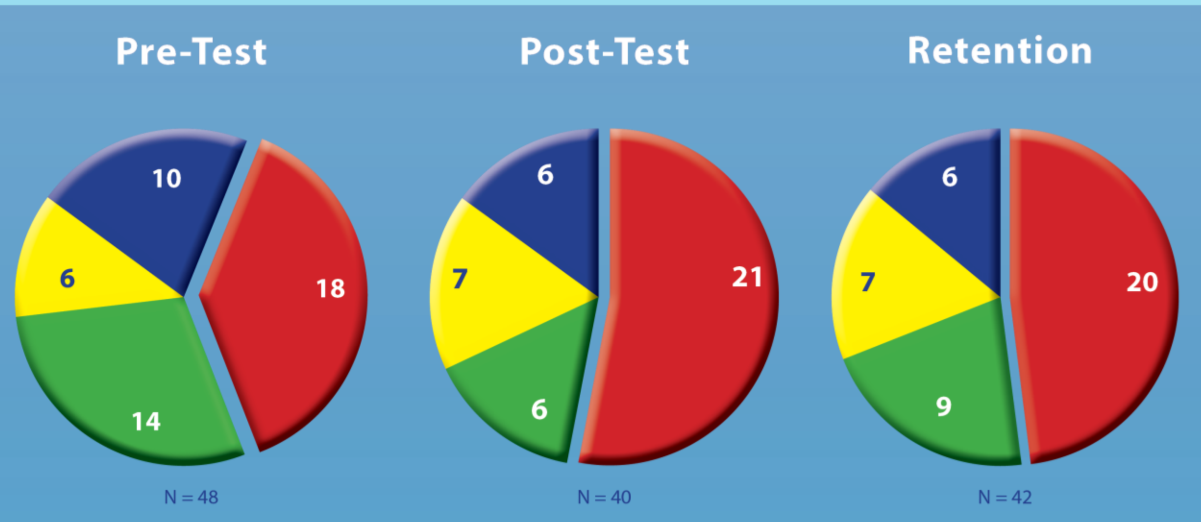

Figure 7. Frequency analysis of Propulsion scores for pre-, post- and retention testing.

There were no significant differences in the propulsion task over the three phases (p=0.21).

> **"There was a small improvement in competency between the pre-test (mean score = 2.2) and post-test (mean score = 1.9) but this change was not statistically significant."**

Figure 8. Self-reported confidence and actual competence associated with the Buoyancy task at pre-, post-, and retention phases

Figure 9. Self-reported confidence and actual competence associated with the Submersion task at pre-, post-, and retention phases

Figure 10. Self-reported confidence and actual competence associated with the Obstacle Course task at pre-, post-, and retention phases

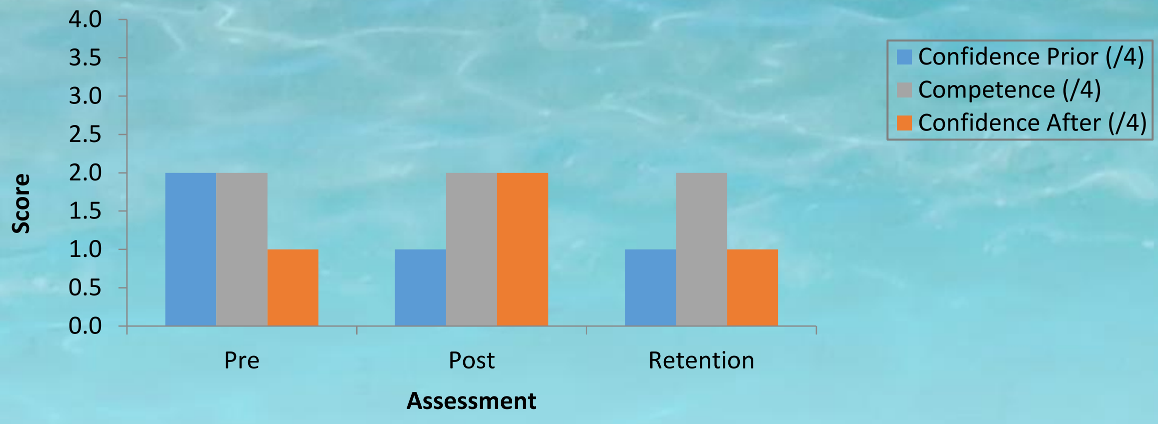

Figure 11. Self-reported confidence and actual competence associated with the Self Rescue task at pre-, post-, and retention phases

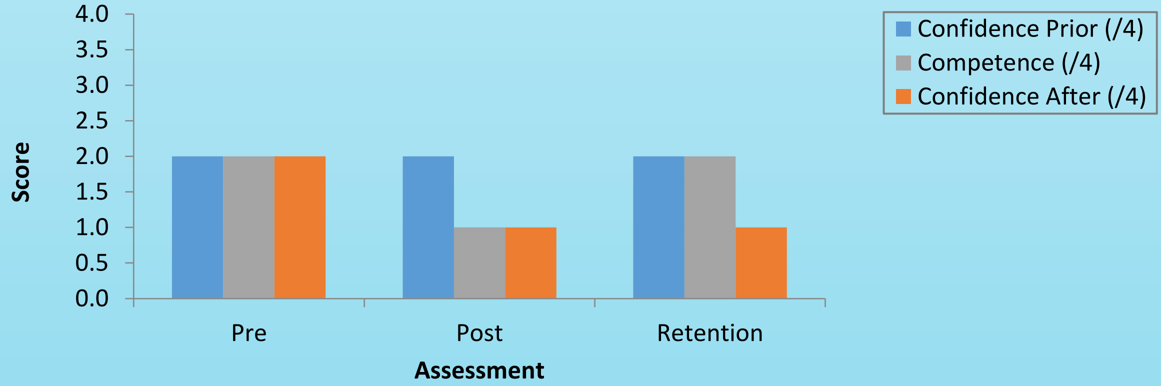

Figure 12. Self-reported confidence and actual competence associated with the Propulsion task at pre-, post-, and retention phases

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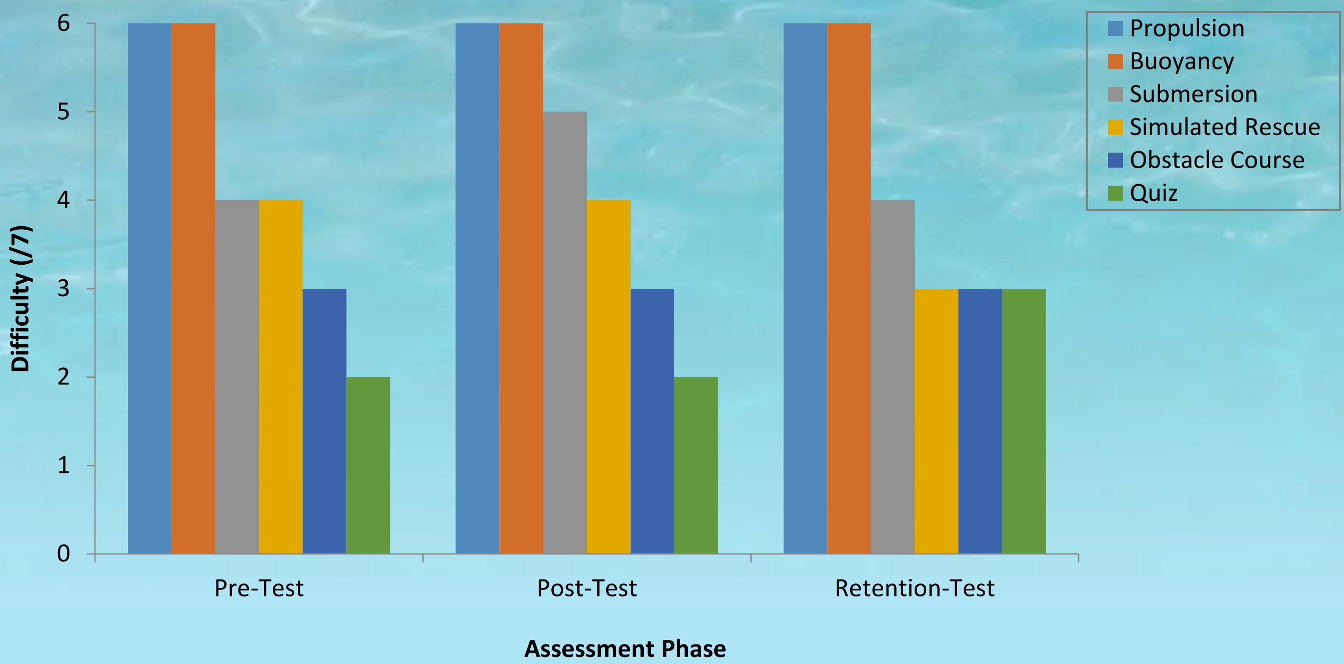

Figure 13. Perceived difficulty of each task immediately upon cessation of the pre-, post-, and retention assessment sessions (Most difficult is 6, least difficult is 1)

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Discussion

The aim of this study was to demonstrate that a rational and balanced emphasis on fundamental aquatic skills in education programmes can improve NZ children's ability to evaluate risk and behave appropriately in and around water. The prediction, based on recent research (Moran, 2008), was that the current survival skill competency of NZ children would be low. It was expected, however, that teaching children a range of survival skills would improve their performance from pre-test to the post- and retention tests.

Water survival skills competency

The percentage of children achieving a high competency rating at pre-test was typically low, as expected (see Table 3). The task with the highest portion of competent performance was the Propulsion task (just 38% at Grade 1) whereas the Quiz (15%) showed the lowest percentage of highly competent performers at pre-test. The data obtained for the propulsion task are similar to those reported by Moran (2008) who found that 54% of NZ children could not swim 100 m continuously in a pool; in our study this percentage was comparable, at 62%. Swimming lesson data for each of the participants further validated these findings, revealing strong correlations between tasks measured in this study and swimming teachers' assessments of similar tasks (Appendix B). Collectively these data highlight that NZ children between the ages of 7-11 years of age generally display average to low competency in a range of survival skills. Of concern is that knowledge and awareness of dangers in aquatic environments, and what to do in an emergency, was also particularly low. This was despite the children ranking the quiz as one of the easiest tasks to complete (Figure 13).

Table 3: Percentage of children achieving high competency grade at different phases of the study

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

No previous research has employed all of the tests used in the present study. As such, internal reliability tests were conducted (see Appendix B) to ascertain how stable and robust the competency data were. The reliability of the independent tests was generally reasonably high, furthermore

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strong associations between the independent assessments and our research tests indicates that similar attributes were measured. However, comprehensive analysis of these data was not deemed appropriate as they were collected by a range of swimming teachers and often differed in relation to the criteria used within the lessons and in our testing. Furthermore, there were many blank entries in the lesson data, which limits the power of any statistical comparisons.

Effect of teaching

In general, the competency of children improved after 10 weeks of survival skills education. The improvements between pre-test and post-test were statistically significant for the Quiz and Buoyancy tasks (see Table 3). In the Obstacle course, Simulated rescue and Propulsion tasks the trends also indicated improvement in competency, without reaching statistical significance. In the Submersion task there was no noticeable influence of the training on competency.

The results highlight that further consideration of how certain survival skill competencies are taught would be prudent. For example, education providers may wish to consider how best to teach competencies associated with tasks such as underwater swimming (submersion), wading and swimming in clothes (obstacle course), putting on a life jacket and throwing a rescue aid (simulated rescue), and continuous swimming (propulsion). The data presented here indicate that these practical skills may require more attention during training.

Whilst such findings are generally encouraging, it should be noted that the levels of improvement are fairly modest and less than 50% of children exhibited high competency in each of the tasks at post-test. A further reason to be encouraged by the influence of teaching is that the improvements were typically still evident 3 months after the education programme had been completed. Five out of six tasks showed a good level of skill retention with only the Quiz task showing a notable drop in retention performance (Table 3).

The quiz competency increased at post-test but the knowledge was not retained by children after 3 months. Given previous studies on the retention of skills, it comes as little surprise that the cognitive and knowledge based tasks were not retained as strongly as the motor tasks. Arthur Jr., Bennett Jr., Stanush, & Theresa (1998) conducted a review of the literature pertaining to skill acquisition decay and retention, and found that physical, natural, and speed-based tasks were less susceptible to skill loss than cognitive, artificial, and accuracy-based tasks. These results indicate that knowledge and awareness of water survival strategies should be addressed more frequently for knowledge to be retained. The teaching of this competency was delivered by the schools themselves rather than the swimming provider. Schools should consider alternate ways to deliver this information to enable children to remember and apply this crucial knowledge when required. For example, it may be more

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effective to teach such knowledge in a relevant context (such as at camp) or embedded within a special project topic focussed around water or the environment. Indeed a systematic review of drowning prevention interventions for children and young people incorporating fifteen articles (Leavy, Crawford, Leaversuch, Nimmo, & Nimmo, 2016) highlighted that a majority of educational strategies rely primarily on the delivery of information, in spite of evidence advocating an approach that incorporates a more holistic approach that employs multiple pedagogies. These researchers attribute the adoption of less comprehensive methods of delivering water safety knowledge to tensions between classroom time constraints in the face of an abundance of content. According to Leavy and colleagues, water safety messages should be tailored to the context of the child to avoid confusion with other genres of safety messaging. Additionally, these researchers accentuate the role of interpersonal discussion for developing recall and establishing deeper message processing in younger individuals. They assert that such tactics amplify the message in those who have not had direct experience with the environmental context. These sentiments are echoed by Wallis et al (2015) who found that successful interventions hone content tailored to the age and nature of the group.

Finally the difficulty we encountered in terms of recruiting participants for the present study through schools may signal a general apathy amongst parents and schoolchildren for the learning of water survival skills. Whilst the school principals who were contacted were keen to promote the study, the reality was that less than 20% of parents/children who were contacted volunteered to take part.

Perceived versus Actual Confidence

The perceived and actual confidence of the children were typically well aligned. For example, in the buoyancy and safe entry/exit task the children were most often moderately confident before and after the activity (Figure 8). Similar findings were apparent for the Submersion task (Figure 9). Prior and subsequent confidence in the obstacle course task (*Fig. 10*) exceeded task competence in the retention test. As such it could be speculated that the obstacle task was more enjoyable due to its novel and complex nature (anecdotal feedback offered by participants supported this interpretation). It should be noted that for many participants, the obstacle course task was also performed in the shallow end of the pool that did not demand the participant rely heavily on challenging skills such as sustained buoyancy, submersion, and endurance. In terms of difficulty, the children consistently rated the propulsion and buoyancy tasks as the most difficult to complete. In contrast the quiz and obstacle course were ranked as the easiest tasks to complete. Overall, the self reported confidence data did not indicate that children overestimated their abilities to perform the tasks.

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Limitations / Future Research

The small sample size was a limitation of the study: we aimed to recruit approximately 100 participants, however only 48 participants volunteered to participate. The sample we obtained restricts the power of the statistical comparisons over time and means that the findings discussed above must be interpreted somewhat tentatively. The low recruitment rate may reflect a general apathy amongst parents with regards the water survival skills of their family. It is also possible that the low competence data are representative of the larger population and that children of poor competency did not wish to participate due to anxiety and low confidence. Future research should consider alternate strategies to work with schools and parents to facilitate the ease of volunteering and participating. Furthermore children may require education and support in order to understand the value of this kind of testing and overcome concerns associated with participation.

The tasks were assessed subjectively with a 4-point scale by two independent experimenters. This approach is limited in terms of sensitivity. It is possible that more continuous, detailed measurement scales may have been more revealing in terms of changes over the course of the study. A counter argument is that the 4-point scale is easy to administer and reliable despite being used by different assessors (see data on internal reliability in Appendix A). Pilot work undertaken before testing ensured that the assessors had a good level of agreement in terms of independent assessments of the same children. Future research should examine how objective and accurate measures of these survival skills can be obtained potentially using emerging technology such as waterproof, miniaturised accelerometers worn by the participants. It is coincidental that feedback from various education providers across NZ to WSNZ suggests that the Water Skills for Life programme has presented some challenges in terms of recording and monitoring competencies.

The testing was conducted within a private pool rather than in open water situations. These simulated conditions were necessary for multiple reasons including control of extraneous factors and also to reduce the travel burden upon participants and care-givers. Also for ethical reasons lifeguards were always located close to participants to provide assistance if required. As such the participants were undoubtedly not as challenged as they would be in real-life survival situations. Future research should consider how to make the simulated testing environment as realistic as possible whilst managing the inherent risks to participants.

The teaching programme was limited in terms of its duration (10 weeks) and frequency of lessons (one 30 minute lesson per week). It is possible that more exposure to the survival skills was necessary to bring about reliable changes in behaviour. Such variables were delimited in the present study by constraints imposed by the schools' time-tabling. It would be of interest to compare these results to a more concentrated, frequent block of teaching (i.e., 10 lessons within 5 days).

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Additionally, one could speculate that the knowledge and awareness modules administered by schools were not subject to the same frequency and repetition as those conducted by the swimming school that was responsible for the motor learning intervention. In future studies, consideration for how these modules are timed in relation to practice of the motor tasks would help address this concern. Finally, to ensure a valid comparison between in-lesson assessments and intervention assessments in future studies, it would be useful to adopt similar scales and itemize skills in a similar manner.

Conclusion

The results confirmed that NZ children aged between 7 and 11 years of age have a low level of survival skills competency. As previously reported (Moran, 2008), children's propulsion skills were limited (62% were unable to swim 100 m). Our results reveal that children also lack a range of survival skills and that attention to these skills is required by education providers. One concerning aspect of the data was that children's knowledge of risks and emergency response was particularly low (85% of children at pre-test). There was some encouraging evidence that education of survival skills can bring about improvements of competency. Whilst such changes were relatively modest and limited to certain skills, practitioners can build upon this evidence to better integrate survival skills teaching into their programmes. It proved difficult to recruit a representative sample of children to participate in the study. WSNZ and the water safety sector as a whole should consider the extent to which the general public see the acquisition of water survival skills as an essential factor in the continuing fight against drowning in this country.

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Appendix A

Table 4. Sample photos and diagrams used to prompt questions in the Quiz task.

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Appendix B

Table 5. Analysis of Participants' Swimming Lesson Data for Internal Reliability (Cronbach alpha > 0.7 indicating good internal reliability)

Component	Component Variables	Internal reliability for components (Cronbach Alpha)	Assessment internal reliability - Cronbach alpha for various components and overall score
Water Safety and Awareness	Recognise Closed Environment Open Environment Activities Decisions	0.961	0.884
Safe Entry and Exit	All Environments Buddy	0.337 (Cronbach is affected with only 2 variables included)	
Submersion	Submerge Recover Dive-propel	Cannot be conducted as 2 variables (Submerge and Recover) have 0 variance	
Personal Buoyancy	Float recover Regulate Breathing Sculling horizontal Float lifejacket Tread scull	0.743	
Orientation	Horizontal rotation Hor-Vert rotation Vertical rotation	0.591	
Safety of self and others	Float signal Rescue throw Lifejacket & huddle Hypothermia	0.837	
Propulsion	15 min Currents, waves, depth (excluded from analysis) 3 mins 5 mins	0.859	

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Table 6. Analysis of Participants' Swimming Lesson Water Safety and Awareness Scores for Pearson Correlation

	Total	Grand Total
Recognise	.916**	.618**
Closed Env	.929**	.763**
Open Env	.955**	.677**
Activities	.958**	.648**
Decisions	.936**	.570**
Total	1	.703**

Table 7. Analysis of Participants' Swimming Lesson Safe Entry and Exit Scores for Pearson Correlation

	Total	Grand Total
All Envs	.585**	.571**
Buddy	.972**	.874**
Total	1	.910**

Table 8. Analysis of Participants' Swimming Lesson Submersion Scores for Pearson Correlation

	Total	Grand Total
Submerge	.[a]	.[a]
Recover	.[a]	.[a]
Dive-propel	.989**	.652**
Total	1	.595**

1st and 2nd variables have no variance

Table 9. Analysis of Participants' Swimming Lesson Personal Buoyancy Scores for Pearson Correlation

	Total	Grand Total
Float recover	.686**	.620**
Regulate Breathing	.763**	.769**
Sculling horizontal	.610**	.383*
Float lifejacket	.805**	.790**
Tread scull	.643**	.430*
Total	1	.871**

Table 10. Analysis of Participants' Swimming Lesson Orientation Scores for Pearson Correlation

	Total	Grand Total
Horizontal rotation	.517**	.644**
Hor-Vert rotation	.825**	.621**
Vert rotation	.843**	.482**
Total	1	.766**

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Table 11. Analysis of Participants' Swimming Lesson Safety of Self and Others Scores for Pearson Correlation

	Total	Grand Total
Float signal	.882**	.703**
Rescue throw	.821**	.760**
Lifejacket & huddle	.852**	.721**
Hypothermia	.720**	.682**
Total	1	.873**

Table 12. Analysis of Participants' Swimming Lesson Propulsion Scores for Pearson Correlation

	Total	Grand Total
15 min	.714**	.646**
3 mins	.966**	.807**
5 mins	.958**	.846**
Total	1	.867**

*. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

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Table 13. Intercomponent correlation for participant swimming lesson component total scores

		Water Safety and Awareness	***Safe Entry and Exit***	***Submersion***	***Personal Buoyancy***	***Orientation***	***Safety of Self and Others***	***Propulsion***	***Grand Total***
Water Safety and Awareness	Pearson Correlation	1	.617**	.521**	.504**	.472**	.570**	.405*	.703**
	Sig. (2-tailed)		.000	.002	.003	.006	.001	.019	.000
	N	33	33	33	33	33	33	33	33
Safe Entry and Exit	Pearson Correlation	.617**	1	.571**	.726**	.642**	.744**	.836**	.910**
	Sig. (2-tailed)	.000		.001	.000	.000	.000	.000	.000
	N	33	33	33	33	33	33	33	33
Submersion	Pearson Correlation	.521**	.571**	1	.487**	.773**	.422*	.290	.595**
	Sig. (2-tailed)	.002	.001		.004	.000	.014	.102	.000
	N	33	33	33	33	33	33	33	33
Personal Buoyancy	Pearson Correlation	.504**	.726**	.487**	1	.798**	.718**	.705**	.871**
	Sig. (2-tailed)	.003	.000	.004		.000	.000	.000	.000
	N	33	33	33	33	33	33	33	33
Orientation	Pearson Correlation	.472**	.642**	.773**	.798**	1	.609**	.485**	.766**
	Sig. (2-tailed)	.006	.000	.000	.000		.000	.004	.000
	N	33	33	33	33	33	33	33	33
Safety of Self and Others	Pearson Correlation	.570**	.744**	.422*	.718**	.609**	1	.727**	.873**
	Sig. (2-tailed)	.001	.000	.014	.000	.000		.000	.000
	N	33	33	33	33	33	33	33	33
Propulsion	Pearson Correlation	.405*	.836**	.290	.705**	.485**	.727**	1	.867**
	Sig. (2-tailed)	.019	.000	.102	.000	.004	.000		.000
	N	33	33	33	33	33	33	33	33
Grand Total	Pearson Correlation	.703**	.910**	.595**	.871**	.766**	.873**	.867**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	
	N	33	33	33	33	33	33	33	33

* Correlation is significant at the 0.05 level (2-tailed).

**.Correlation is significant at the 0.01 level (2-tailed).