International Journal of Aquatic Research and Education

Volume 10 | Number 2 Article 3

10-6-2017

From Swimming Skill to Water Competence: Towards a More Inclusive Drowning Prevention Future

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Recommended Citation
Stallman, Robert Keig; Moran, Kevin Dr; Quan, Linda; and Langendorfer, Stephen (2017) "From Swimming Skill to Water Competence: Towards a More Inclusive Drowning Prevention Future," *International Journal of Aquatic Research and Education*: Vol. 10 : No. 2 , Article 3.
DOI: 10.25035/ijare.10.02.03
Available at: https://scholarworks.bgsu.edu/ijare/vol10/iss2/3

From Swimming Skill to Water Competence: Towards a More Inclusive Drowning Prevention Future

Cover Page Footnote
Other members of the International Working Group who contributed to this review are Per-Ludvik Kjendlie, Stavern Campus, Norwegian Police Academy; Richard Franklin, James Cooke Univ., Australia; Aminur Rahman, Center for Injury Prevention and The Int. Drowning Research Center, Bangladesh, and Elizabeth Bennett, Seattle Children's Hospital, USA. Without their many contributions, this review could not have been completed. Thank you!

Abstract

Brenner, Moran, Stallman, Gilchrist and McVan, (2006) recommended that "swimming ability be promoted as a necessary component of water competence, but with the understanding that swimming ability alone is [often] not sufficient to prevent drowning" (p. 116). Tradition and expert opinion are no longer enough. Science can now help us select essential competencies. What does research evidence show us about the protective value of specific individual personal competencies? Since the term "water competence'' was coined by Langendorfer and Bruya (1995) and adapted for drowning prevention by Moran (2013), it has gained in use and acceptance. As a construct, it is indeed more inclusive than "swimming skill'' alone for addressing drowning prevention. Our proposed taxonomy of water competencies re-emphasizes the need for a broad spectrum of physical aquatic competencies as well as the integration of cognitive and affective competencies. The purpose of this review article is to a) identify all the key elements of water competence, b) support each recommended type of water competence with examples of research evidence, and c) suggest areas requiring further research.

Keywords: water competence, swimming skill, drowning prevention, water safety

Drowning is a multifaceted and complex phenomenon that has, at its heart, the way in which humans interact with their aquatic environment (Moran, 2006). A multitude of possible causes of drowning necessitate a multitude of possible interventions to prevent their occurrence. In high income countries (HICs), many drownings occur in relation to intentional immersion and are often associated with recreational pursuits. Others are the consequence of unintentional immersion and can occur in a variety of settings such as the home, on farms, or construction sites and under a variety of climatic and weather conditions such as heat and cold (ice), storm and flood. In low and middle income countries (LMICs), most drownings occur in connection with domestic life, occupational pursuits, travel, and natural disasters.

Conventional wisdom has suggested that teaching people to cope with the risk of drowning through the acquisition of swimming skills is one of the more important drowning prevention interventions. While such axiomatic wisdom has been built on a tradition of teaching swimming and lifesaving skills, this approach has been primarily underpinned by anecdotal evidence and expert opinion. More recently, debate among drowning prevention experts has suggested that further research needs to include water safety knowledge and attitudes along with aquatic motor skills. In 2007, the International Lifesaving Federation (ILS) adopted a Position Statement for Swimming and Water Safety Education (ILS, 2007) which noted that evidence is rapidly accumulating that a basic level of water safety knowledge, coupled with a basic level of swimming skill, is sufficient to prevent most drowning episodes.

A decade ago, Brenner and colleagues (Brenner, Moran, Stallman, Gilchrist, & McVan, 2006) recommended that "the concept of swimming ability be replaced by the more encompassing notion of water competence with regards to drowning prevention" (p. 116). In LMICs where exposure to water abounds during daily living activities and therefore the risk of unintentional immersion is omnipresent, acquisition of survival swimming and associated water competencies (i.e., 18 competencies) has reduced fatal drowning among young children in a large cohort trial in rural Bangladesh (Linnan, Rahman, Rahman, Scarr & Cox, 2011). A case-control study in rural China has found that swim instruction provided a protective effect on drowning among children aged 1–4 years (Yang, Nong, Li, Feng, & Lo, 2007). Supporting evidence also has been reported in high income countries (HICs). A case-control study in the U.S. found a positive association between swimming lessons and lower drowning risk in children less than five years of age (Brenner, Taneja, Haynie, Trumble, Qian, Klinger et al., 2009).

Such studies support the need for water safety education; yet deeper understanding of the protective effects of the water competencies taught within these programs has continued to be elusive. Consensus on which water competencies to include has yet to be achieved. Considerable variation exists among current water safety programs even around which physical water competences should be required to swim in deep water (Quan, Ramos, Harvey, Kublik, Langendorfer….Wernicki, 2015). The primary aims of this paper are to describe and provide research evidence regarding what physical, cognitive, and affective competencies contribute to a person's water competence and reduce the risk of drowning. For the purpose of this study, water competence is defined here as "the sum of all personal aquatic movements that help prevent drowning as well as the associated water safety knowledge, attitudes, and behaviors that facilitate safety in, on, and around water" (Moran, 2013, p. 4). Adoption of this more encompassing construct will allow us to focus on what should be sequentially and developmentally taught. We therefore specifically have addressed the rationale justifying the inclusion of selected water competencies as well as have examined the research evidence for inclusion of each competence in our proposed taxonomy (see Table 1). By providing the rationale and evidence, we hope that weaknesses in the evidence for the proposed water competencies will be exposed and stimulate additional systematic research.

Method

Discussions regarding the use and definition of "water competence" were launched in Da Nang at the World Conference on Drowning Prevention (WCDP 2011). An international Working Group was assembled and planned and offered a workshop during the subsequent WCDP held in Potsdam in 2013. The ongoing global input has allowed the water competence construct to evolve over time. Members of the Working Group liaised with members of the Drowning Commission of International Life Saving Federation (ILSF). A detailed report on water competence and drowning prevention is planned for public dissemination in the near future.

In the first round of discussions, Working Group members identified water competencies currently promoted in the curricula of high profile international and national organizations, scholarly journal articles, and organization position statements. Moran's (2013) adaptation of the original Langendorfer & Bruya (1995) meaning for use in a drowning prevention context served as the foundation for this work. The primary goal was to provide agencies involved in water safety education, program planners, and individual instructors with a recommended taxonomy of water competencies which research evidence has shown to offer protective value in reducing the risk of drowning.

A literature search was conducted with the assistance of the University of Washington Library to identify evidence that supported or refuted the inclusion of water competence elements identified in the initial discussion. An expanded list including potential competencies to be examined were used as key words in searches. Studies were identified by searching electronic databases using search strategies developed and executed by a medical librarian. Searches were performed in February and March 2015 in the following databases – on the Ovid platform: Medline and PsycInfo; on the EBSCOhost platform: SPORTDiscus; elsewhere: EMBASE. Retrieval was limited to human studies written in English from 1970 to March 2015. In all databases, appropriate index terminology (Medical Subject Headings, Thesaurus of Psychological Index Terms, thesaurus of SPORTDiscus descriptors and Emtree headings) were used, along with text words. Concepts searched were swimming, with many terms related to specific aspects of swimming or the environment of water, such as stroking, respiration, floating, underwater, deep water, fresh water, swimming pools, and lifejackets. Other terms related to competence or survival, such as psychomotor performance, aquatic motor skills, cognition, bystander, response time, lifeguards, and rescue. In a subsequent round, each contributing author added references known to them or discovered in their own search. Adjustments were then made by adding to or subtracting from the original list of competencies, as supporting evidence was or was not found. A second formal literature search was conducted in May, 2016 that identified several new studies of relevance. Finally, expert opinion was used to translate this evidence to a pragmatic rationale for support of each water competency.

In the subsequent pages, we present each of the water competencies with the rationale developed by the collective working group. We then examined the evidence gathered during the review process, summarized the evidence basis for each competency, and made recommendations for future practice and research.

Results

Table 1 shows the fifteen water competencies identified. Each of these competencies is closely interwoven with one or more of the others. The most common drowning scenarios place demands on several of these essential competencies, either simultaneously or serially.

Table 1. Proposed water competencies related to drowning prevention

Water Competencies			
1	Safe entry competence a) Entry into water b) Surface and level off	9	Clothed water competence
2	Breath control competence Integrated and effective breathing	10	Open water competence
3	Stationary surface competence a) Buoyancy control: floating b) Treading water	11	Knowledge of local hazards competence
4	Water orientation competence a) Roll from front to back, back to front b) Turn, L & R, on front & back	12	Coping with risk competence - awareness, assessment, avoidance
5	Propulsion competence a) Swim on front b) Swim on back and/or side	13	Assess personal competence
6	Underwater competence a) Surface dive b) Underwater swimming	14	Rescue competence a) Recognize a drowning person b) Assist a drowning person safely
7	Safe exit competence	15	Water safety competence a) Attitudes b) Values
8	Personal flotation device (PFD/lifejacket) competence		

1. Safe Entry Competence

1a. Entry into water. The degree of risk when entering the water varies according to the individual, the task, and the environment (Langendorfer, 2010). Unintentional falls into open water are a frequent cause of drowning. Sudden immersion places demands on breath holding, reorientation, regaining the surface, regaining the breath, stopping to float and rest and/or leveling off in preparation for moving in a certain direction. Where entry into water is intentional, drowning or injury can also occur because of poor technique, failure to check depth, or underwater hazards. Risk is exacerbated when the entry involves great height above water and therefore greater impact forces on entry.

Spinal cord injury (SCI) is often associated with recreational diving, the act of entering the water head first during recreational activity and hitting the bottom or an object (Blanksby, Wearne, Elliott, & Blitvich, 1997). Diving has been identified as the most frequent sporting activity related to SCI (Hartung, Goebert, Taniguchi, & Okamoto, 1990; Katoh, Shingu, Ikata, & Iwatsubo, 1996; Schmitt & Gerner, 2001). While the numbers of hospital admissions are relatively few, the financial cost to society of SCI is high given that those most frequently affected are healthy young persons under twenty-five years of age (DeVivo & Sekar, 1997).

1b. Surface and level off. Surfacing and leveling off are intimately related to safe entry itself. The manner of the entry and its consequences influence the surfacing process and its success or failure (Junge, Blixt, & Stallman, 2010). Breath holding and buoyancy control (among other competencies) are challenged while regaining the surface (Oliveira, Aranha, Resende, Cardoso, Pimenta, & Garrido, 2013). Surfacing in itself is a specific skill and includes the above, plus some form of propulsion to the surface. The depth of submersion, the consequences of impact, and the need to orient oneself and hold the breath will all affect the surfacing process. Upon breaking the surface of the water, leveling off involves taking the initial breaths and then may require shifting the center of mass forward or backward to reduce body angle. A few propulsive arm strokes or leg kicks may assist this process. Managing this process in an effective fashion interact with multiple other competences. Immediately upon surfacing, orientation to possible hazards, to the presence of waves, and to the direction of safety, must be successfully executed. In cold water, the first seconds following immersion and resurfacing, may induce a cold shock response (CSR) which is an immediate life-threatening condition associated with respiratory impairment (Golden & Tipton, 2002).

Research evidence. In a study of children (N = 70) who had swum 25m and been declared 'swimmers,' one quarter (26%) were unable to enter deep water by either a jump or dive (Junge, Blixt, & Stallman, 2010). Of those who attempted to enter by jumping or diving and failed to do so (18 = 26%), the discomfort of resurfacing, regaining their breath, and regaining orientation, forced over one-third (7/18 = 39%)) to abandon the trial. Working with children (N = 22) who had mastered eight skills considered essential to drowning prevention, Oliveira and colleagues (2013) assessed these children's capacity to cope with an unexpected capsize of an inflatable boat (involuntary entry). Video analysis of the simulated capsize showed that one third (32%) of the children were observed to be 'at risk'. Stallman and colleagues (2008) found that drowning survivors reported that the challenge of involuntary entry and resurfacing were life threatening.

Analysis of unsafe techniques have resulted in clear recommendations with regard to head first entry (Blitvich, Mc Elroy, Blanksby, & Douglas, 1999). Risk factors contributing to recreational diving injury have been well reported with males aged 15–29 years, especially when consuming alcohol (Aito, D'Andrea, & Werhagen, 2005; Blitvich, Mc Elroy, Blanksby, & Douglas, 1999; Herman & Sonntag, 1991). In open water settings, entering the water from a pier or dock, diving headfirst, not having checked water depth, and being unfamiliar with location have also been identified as risk factors (Branche, Sniezek, Sattin, & Mirkin, 1991).

DOI: 10.25035/ijare.10.02.03

Other studies have shown that young and adult males are most likely to engage in high risk entries from height (Moran, 2014c) and adopt unsafe entry behaviors (Moran, 2008; 2011b).

Recommendations. Further research is required on the teaching of safe entry skills, what is currently taught, and the associated knowledge, attitudes, and behaviors especially of high risk groups such as male youth.

On the basis of the research reported above, the following recommendations are made:

1. Safe voluntary entry technique for feet and head first entry should be considered fundamental competencies taught in all aquatics and water safety programs,
2. Simulating unintentional entry experiences should be taught, and
3. Where developmentally appropriate, entry and resurfacing should be combined in creative ways, challenging the learners' capability to cope with realistic emergency situations.

2. Breath Control Competence

Integrated and Effective Breathing. Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid (van Beeck, Branche, Szpilman, Modell & Bierens, 2005). This definition was formally adopted by the international drowning prevention community at the World Congress on Drowning, 2002. Lanoue (1963) reminded us that people don't drown because they can't swim, they drown because they can't breathe. The obvious cause of any drowning is thus failure to breathe at need, with eventual asphyxiation, with or without aspiration.

The American Red Cross has, for many years, suggested that breath control is the key to learning to swim (American Red Cross, 1961; 2015). It is usually considered to be the most important of all personal physical survival competencies and of the foundational skills for further learning. It is therefore, most commonly placed first in any teaching progression (American Red Cross, 1961; 2015; Junge et al., 2010; Langendorfer & Bruya, 1995; Stallman, Junge, & Blixt, 2008). Effective breathing is the key to economic movement (Stallman et al., 2008).

In the aquatic activity context, we define effective breathing as 1) a comfortable exchange of air, when needed or desired and adding no extraneous energy expenditure, 2) a spatially and temporally integrated breathing movement allowing inhalation and exhalation without interfering with other movements (e.g., that of the limbs), 3) a technique which in no way compromises optimal body position, and 4) a technique which meets the needs of the task at hand, the person involved, and the environment.

Research evidence. In a study of children who had previously swum 25m, Junge and colleagues (2010) reported that 94% were unable to stop and rest because of insufficient breath control and buoyancy control. Any attempt to stop and rest required more energy than continuing to swim. In a pilot to this study, children able to swim only 10-15 m but who did so comfortably and were skilled at floating in deep water, were able to swim 10m, rest, then 10 more and rest and even 10 more, a total of 30m (Junge, 1984). They out-performed those who could swim 25m only with great difficulty and who were unable to stop and rest.

Common during the learning process is swimming with the head up, having not learned optimal breathing. Head up swimming is a survival skill in its own right. The water competent person can do both. Zamparo and Falco (2010) reported greater energy expenditure and reduced arm efficiency in head up swimming compared with normal front crawl among female water polo players (N = 21). Working with physical education students (N = 21), Stallman and colleagues (2010) showed increased heart rate, oxygen uptake, and lactate levels when swimming breaststroke with the head continually above the surface compared to swimming with a more efficient breathing pattern involving face submersion. Importantly, in the context of survival, the latter study also showed that swimming with the head up reduced simulated survival time (swimming to exhaustion). Kjendlie and colleagues (Kjendlie, Pedersen, Thoresen, Setlo, Moran, & Stallman, 2013) showed that breathing problems escalate in rough water. Drowning survivors named failing breath control as the primary threat to their life (Stallman et al., 2008). Oliveira and colleagues (Oliveira et al., 2013) observed children who had mastered essential swimming skills during an unexpected (arranged) capsize of an RIB. Video analysis showed that they had difficulty in regaining breath control.

Elevated respiratory frequency and possible hyperventilation is an immediate reaction to cold water immersion [CWI] and exacerbates the risk of drowning (Golden & Tipton, 2002; Barwood, Corbett, Green, Smith, Tomlin, Wier-Blankenstein, & Tipton, 2013). Button and colleagues (Button, Croft, Cotter, Graham, & Lucas, 2015) showed that both the physiological and behavioral reaction to CWI did not vary appreciably between skilled and unskilled swimmers. Voluntary breath control as a strategy to prevent or alleviate the cold shock response [CSR] improved cerebral blood flow (Mantoni, Rasmussen, Belhage, & Pott, 2008; Croft, Button, Hodge, Lucas, Barwood, & Cotter, 2013). Croft and colleagues (2013) also reported that advance information on cold water response and training prior to CWI can improve breath control and help the return to relatively normal breathing. Barwood and collaborators (Barwood, Dalzell, Datta Avijit, Thelwell, & Tipton, 2006) showed that breath holding improves with psychological skills training and habituation. They later demonstrated that breath holding improves with psychological skills training alone (Barwood, Datta Avijit, Thelwell, & Tipton, 2007). Recent work by Bird and colleagues suggests that habituation in cold water is sustained for several months after training among young children (Bird, House, & Tipton, 2015a, 2015b). Barwood and colleagues (Barwood, Bates, Long, & Tipton, 2011) reported that floating first to help regain breath control is in fact aided because buoyancy is improved by air trapped in clothing.

Recommendations. Future research should include: a) mapping the extent to which effective breathing is or is not emphasized in teaching, b) exploring the consequences of added attention to or lack of effective breathing during teaching/learning, c) exploring possible stroke modifications to enhance head up swimming, and d) exploring the nuances of effective breathing in open water, surf, when clothed, or in other task/environmental situations.

On the basis of the research reported above, the following recommendations are made:

1. Effective breathing is the foundation upon which economic movement (including movements which can contribute to drowning prevention) can be learned and performed,
2. Effective breathing should be promoted in all forms of moving and stationary water competences,
3. Where developmentally appropriate, fatigue-inducing activities should be experienced in order to challenge maintenance of effective breathing in simulated survival activities, and
4. Where developmentally appropriate, effective breathing should be developed in stressful situations such as simulated rough, cold, or open water.

3. Stationary Surface Competence

3a. Buoyancy control: Floating. Closely related to breath control, buoyancy control is a key element in the teaching of water competence. It is widely accepted as foundational for water competency (American Red Cross, 2015; Langendorfer & Bruya, 1995; Stallman et al., 2008; 2010). Human flotation is dependent on the relationship between the body's mass and volume, i.e. density. The volume of the thorax increases and decreases as we breathe, changing body density. For many, positive buoyancy can be maintained by ínflating dormant alveoli space and increasing respiration rate via breath control. For the beginner, the capacity to inflate and maintain the expanded lung volumes is greatly assisted through relaxation and familiarity with the stationary actvity. In the learning process, as one gains confidence, there may be no greater a confidence than being able to float.

With a full inspiration, prepubescent children, women, and most men have the anatomical capacity to float. The true non-floater is rare (< 5/100) and, with maximal lung ventilation, even these have some buoyancy, albeit slightly less than the gravitation on their mass (Stallman, 1997). For the non-floater, the capacity to maintain the airway while stationary without some limb motion is compromised.

3b. Treading water. Treading water is usually used when wishing to remain stationary with the head above the surface. It is one of the most versatile and essential of physical water competencies. Treading water can be an alternative method of resting, or stopping to seek or wait for help. When performing a task with the hands, treading allows one to stay at the surface using legs only. In cold water, keeping the head above the surface not only maintains visibility, it also reduces heat loss (Hayward, Collis, & Eckerman, 1973; Hayward, Eckerson, & Collis, 1975).

Saving energy by moving less or remaining stationary is an issue when choosing a strategy for short vs long term exposure. Exercise produces heat, normally beneficial but also enhances heat loss (Golden & Tipton, 2002). For long term exposure, saving energy is critical. Total energy available is fixed. Increasing heat loss will hasten the depletion of energy and the onset of hypothermia. Short term exposure may require a different strategy, i.e. intentionally producing heat (swimming). Exposure of unknown duration must be treated as long term and may require alternative motionless floating.

Research evidence. Drowning survivors named being unable to float, a threat to their life, (Stallman et al., 2008). Junge and colleagues (2010) found that most children (94%, n=70) who had swum 25m and been declared 'swimmers' were unable to stop and float. In the initial Can You Swim? study of university students (N = 373), most (76%) could comfortably swim more than 300 m nonstop, but only 40% could float for 15 minutes and more than one third (35%) could not stay afloat for more than 2 minutes (Moran et al, 2012). Kjendlie and colleagues found a 24% decrement in floating performance among 11 year old children when introducing waves (Kjendlie et al., 2013). On the basis of this evidence, swimming competency alone does not appear to guarantee floating competency (Moran et al., 2012, Junge et al., 2010).

Graham (1977) and Fritzvold (1986) showed that floating required less energy than treading water. Wade and Veghte (1977) found that swimming increased heat loss over still immersion. Duffin and colleagues (1975) found that, when comparing water of 11^0C to 28^0C, the rate of respiration could be multiplied 4-5 times. Hayward and colleagues (1973) identified the areas of greatest heat loss - the head and throat, the axilla and the groin. The H.E.L.P. technique (adopting a fetal position, when wearing a PFD) reduces the surface area of exposure to cold water and covers areas of greatest heat loss (Hayward et al., 1975). This technique reduced heat loss by 69% while treading water caused more heat loss than floating (with PFD). Gagnon and colleagues (2013) found that while there was great heat loss from the head, there was no difference between face in, back of head in or whole head in the water. This suggests that having chosen to float and wait for help, one could choose back or front survival float. Kjendlie and colleagues (2013) found that children's floating skills were negatively affected by waves.

Moran (2015) reported that clothing did not effect floating efficency among physical education students *(N* = 37) during a 5-minute flotation test.

Recommendations. Future research should include further exploration of the energy cost, heat loss, cerebral blood flow parameters, behavioural characteristics, etc. - comparing treading water, floating and swimming, among persons of various degrees of competence, in various states of fatigue, and in variable open and closed environments.

Based on the available evidence, we recommend that:

1. Stationary surface competencies be developed at earliest stages of competency development and progressively made more challenging,
2. Both floating and treading water are taught and treated as equally important surface competencies,
3. Ensure that, where developmentally appropriate, the competencies are practised in closed and open water, and
4. Where developmentally appropriate, stationary surface competencies should be developed in stressful situations such as simulated rough water or open water

4. Water Orientation Competencies

Changing position by either rolling from one position to another, or changing direction by turning, are classified here as skills of orientation. In a drowning situation, one must be able to change position in the water as the need arises. Constantly changing conditions are a characteristic of open water environments where most drowning occurs. The dynamic nature of open water (with frequently changing influences such as wind, waves, tides, and currents) demand versatility so as to accommodate change and re-orientate the body to cope with the hazards.

4a. Roll from front to back and back to front. Rolling from front to back and back to front is included in almost all organizational teaching progressions (ARC, 1961; 2015; Junge, 1984; 2010; Stallman, 2008). Each of these positions has advantages which may make their use situationally advantageous. Floating or swimming on the back allows easier breathing. Floating or swimming on the front allows better visibility. The water competent person is comfortable in all of these positions and easily changes from one to the other.

4b. Turn Left & Right, on Front & Back. Changing direction when in the water is required to negotiate hazards, avoid dangers, and return to safety. In open water, negotiating breaking waves, keeping clear of obstacles (such as rocks, reefs, sandbars), avoiding debris, and moving out of rip or river currents, all require movement agility that demands more than the capacity for straight line swimming. After a fall into deep water, one may not only find themselves in virtually any position, but also, facing any direction, including away from safety. With toddlers, Asher and colleagues (Asher, Rivara, Felix, Vance, & Dunne, 1995) found that turning back toward the point of unintentional entry was central in their attempts to return to safety. Turning as a skill in itself would allow a reasonably quick reversal of direction and back toward the point of entry by the shortest possible route. If this is not a possible or a safe place to exit, another turn might be required to move in the direction of a safe exit or a place where one can be rescued.

Research evidence. Drowning survivors revealed that failing to orient oneself in either of these ways, became life threatening (Stallman et al., 2008). Junge and colleagues (2010) showed that among children who had previously swum 25 m, after swimming 12.5 m on the front, 10% were unable to turn, changing direction 180^0 and 43% were unable to roll from front

DOI: 10.25035/ijare.10.02.03

to back to continue swimming on the back or to stop and rest. Asher and colleagues (1995) found that after entry, most toddlers found themselves in a semi vertical position facing forward. They then needed to roll over to their back for ease of breathing and to turn towards the point of entry. A study of 5-year-old children (*N* = 22) showed that the random positions the children found themselves in after falling from a boat demanded that they needed to be able to both roll and turn (Oliveira et al., 2013). Both rolling over and turning were negatively influenced by clothing (Laakso, Horneman, Grimstad, & Stallman, 2014). One early British study reported that nearly half of all drownings in the UK happened within 2-3 meters of safety and over 60% within 3-4 m (Home Office, 1977). Golden and Tipton (2002) surmised that the shock reaction to cold incapacitates many so that they are unable even to turn and swim this short distance. Even without cold shock, poor swimmers might fail to turn, as shown by Junge and colleagues (2010).

Recommendations. Further research should include a) exploration of the role and assessment of rolling and turning in relation to swimming and floating competency, b) the extent to which these orientation skills are affected by clothing, rough water, and cold water, and c) the effects of habituation on these rotational skills and how they might transfer from a calm, warm water learning situation to an open, cold water, high risk situation.

Based on the available evidence, we recommend that:

1. Changing body position and direction must be prioritized in all water safety educational programs. When developmentally appropriate, they should be combined,
2. All orientation competencies can easily be creatively incorporated into games and play activities,
3. Ensure that, where developmentally appropriate, the competencies are practised in closed and open water, and
4. Where developmentally appropriate, swimmers should perform/ develop orientation competencies in stressful situations such as simulated rough water or open water

5. Swimming Competencies

The teaching of swimming has long been advocated as a way of promoting water safety and reducing drowning risk (e.g., Swimming and Water Safety Position Statement, ILS, 2007, 2012). Until recently, the protective role of swimming skill in the prevention of drowning has not been clearly understood (Moran, Quan, Franklin, & Bennett, 2011). A lack of consensus as to what swimming competency is and the associated difficulties of its' practical assessment have exacerbated this lack of understanding. Recent studies have, however, provided some evidence of the value of swimming competency in preventing drowning among children (for example, Brenner et al., 2009; Linnan et al., 2011; Rahman, 2009; Yang et al., 2007).

5a. Swim on the front. Being able to move through the water on the front using a variety of swimming techniques offers several potential protective benefits. Swimming with the head up facing forward (for example, breaststroke or head up swimming in front crawl) allows for good visibility of surrounding hazards and clear sight of a safe destination. Using the front crawl stroke offers speed when rapid movement is required to get to safety quickly over a short distance, or to avoid hazards. Using resting strokes such as breaststroke or sidestroke offers endurance capabilities when time is a critical factor and maneuverability when having to negotiate obstacles.

Swimming on the front may require the face to be in the water or out of the water but the selection of which may be situationally dependent rather than a matter of preference or choice. The water competent person can do both. In a developmentally-oriented program, individualization leads to multiple solutions (Langendorfer & Bruya, 1995). In a drowning prevention context, for purposes of assessment Junge, (1984), Stallman and colleagues (1986, 2010), Langendorfer and Bruya, (1995), Junge and colleagues (2010), and Mercado and colleagues (2016) intentionally do not identify any specific style, considering economy of movement more important than style itself, and allowing the learner to self-select.

5b. Swim on the back/side. Drowning survivors related that failure to swim and float on the back contributed to their swimming failure and the need to be rescued (Stallman, 2008). Being able to swim on the back/side permits the possibilities of easier breathing and forward propulsion but offers poor forward visibility. In most situations, swimming on the back/side allows easier breathing. It may be beneficially used in conjunction with forward facing swimming techniques to overcome the lack of vision. The water competent person is proficient on both front, back and side, thus having a choice regarding preferred body position in which to swim. A study by Junge and colleagues (Junge, et al., 2010) showed that, in a program which placed lesser value on swimming on the back, children who had swum 25m on the front, half (49%) were unable to swim 12.5m on the back. This suggested that learning to swim on the front does not necessarily transfer to competence in swimming on the back.

Research evidence. Acquisition of survival swimming and associated water competencies (18 competencies) reduced fatal drowning among young children in a large cohort trial in rural Bangladesh (Linnan, Rahman, Rahman, Scarr, & Cox, 2011). A case-control study of swim instruction in rural China also found a protective effect on drowning among children aged 1–4 years (Yang, Nong, Li, Feng, & Lo, 2007). Supporting evidence has also been reported in high income countries (HICs). A case-control study in the U.S. found a positive association between swimming skill and drowning prevention in children less than five years of age (Brenner et al., 2009).

Kjendlie and colleagues (Kjendlie, Pedersen, Stallman, & Olstad, in press) found that introducing simulated waves (in a wave pool) caused a mean decrement of 3% - 7% (moderate [ca 20cm] and larger [ca 40cm], respectively) in maximum sprint time for young swimmers. The performance order was front crawl as the fastest (therefore most efficient) followed by front crawl with head up, then back crawl and finally breaststroke. The decrement when introducing waves was approximately the same for all strokes. Back crawl was less efficient than front crawl (head up and down) but suffered no greater decrement when waves were introduced. Choi and colleagues (Choi, Kurokawa, Ebisu, Kikkawa, Shiokawa, & Yamasaki, 2000) focused on swimming with clothes but examined three escalating velocities and three styles (front crawl, breaststroke and elementary back). Elementary back stroke was as expected, less efficient than crawl or breaststroke (with and without clothes). As expected, energy cost increased exponentially with increased velocity. For our purposes the most interesting was that as velocity decreased, elementary backstroke compared *more* favorably with the other strokes. Fujimoto and colleagues (Fujimoto, Inokuchi, & Ishida, 2001) directly compared crawl and elementary backstroke. The subjects were asked to swim at the same level of perceived exertion for both strokes. The elementary backstroke recorded lower heart rate and lactate levels than the crawl although taking a longer time to swim 200m. This suggested that using the elementary backstroke may be a viable strategy for some in an unexpected emergency.

Recommendations. Further research on the preventive effect of swimming competency on drowning is required especially for older children, youth, and adults. Future research should explore comparisons between front and back swimming, the influence of one’s personal competence profile on selection of strategic options, and the need to adopt different aquatic propulsion strategies in different environments.

DOI: 10.25035/ijare.10.02.03

Based on the available evidence, we recommend that:

1. Swimming on the back and front are equally important and require equal attention in the teaching process while swimming on the side lacks evidence of efficacy,
2. Ensure that, where developmentally appropriate, the competencies are practised in closed and open water environments, and
3. Where developmentally appropriate, swimming competencies should be practiced in stressful situations such as simulated rough or open water.

6. Underwater Competencies

In some circumstances, swimming underwater to negotiate hazards may be a competence required to avoid drowning. Underwater swimming is often initiated by a surface dive. Recreational pursuits often involve persons swimming in an area occupied by other activities (surfing, kite skiing/flying, water skiing, paddling, etc.). Swimmers/bathers may naively select an inappropriate place to swim and be exposed to both domestic, industrial and recreational hazards. Sudden capsize in sailing, paddling, and boating activities may also require underwater competency to negotiate confined spaces (such as cabins) and entrapment hazards (such as sails and shrouds) in order to return to the surface. Transportation accidents often place many people and hazardous objects suddenly in the water in a chaotic situation - consider the Titanic and Estonia episodes (Golden & Tipton, 2002).

6a. Surface dive. Experiencing and coping with depth, pressure, and reduced visibility are considered an essential part of water competence (Stallman et al., 2008) and should be experienced early in the learning process (Langendorfer & Bruya, 1995). A quick manoeuver by surface diving to avoid an oncoming hazard, may be life preserving. Surface dives maybe performed headfirst where visibility is good and no underwater hazards exist, alternatively feet first dives may be performed where visibility is poor and underwater hazards may be present.

6b. Underwater swimming. Swimming underwater requires both breath control and buoyancy control, essential foundational water competencies. Swimming underwater may include a variety of techniques with variations of underwater breaststroke common. Adding dolphin or crawl kicks after each breaststroke kick is a viable alternative especially where the breaststroke kick is not efficient. A diagonal (crawl like) arm stroke is recommended in situations of poor visibility, with one arm always forward protecting the head. In addition to face down underwater swimming (prone body position), underwater swimming with the face up (supine body position) is also a useful competency when locating the water surface is required.

Research evidence. Drowning survivors named failure to dive or to swim underwater as life threatening (Stallman et al., 2008). Junge and colleagues (2010) showed that some children (10%) who had previously swum 25 m continuously, were uncomfortable underwater after entry, and that this caused them to abort an attempt to swim 12.5 m. Moran and colleagues (2012) showed that many young adults overestimate their ability to surface dive and to swim underwater. Witt and colleagues (2011) found that when swimming faster with fins, objects seemed closer and larger than when swimming slower without fins.

In North America, 5-11% of all drownings occur in submerged vehicles (Giesbrecht & McDonald, 2011). Giesbrecht and McDonald (2010) further identified the phases of the submersion of a passenger car as a) *floating*, b) *sinking* and c) *submerged*. The floating phase was approximately one minute in a reasonably air-tight vehicle. In a later review, McDonald and Giesbrecht (2013a) recommended a survival strategy of: 1) release seat belts, 2) open windows, 3) release children, 4) children out first, and 5) adults out. In a difficult trial escape, three adult men and one child mannequin all escaped from a single window in 51 sec. In another study, the same authors found little difference in various forms of thermal protective flotation clothing regarding impedance of exit from a submerged simulator (McDonald & Giesbrecht, 2013b). Gagnon and colleagues (Gagnon, McDonald, Pretorius, & Giesbrecht, 2012; Gagnon, Pretorius, McDonald, Kenny, & Giesbrecht, 2013) found little difference in exit, escape, and horizontal underwater swim distance when using various thermal flotation clothing combinations while an inflatable vest did impede exit and underwater swim distance.

As early as 1961, Craig identified the risk of pre-submersion hyperventilation (Craig, 1961; 1976). In a recent and comprehensive review, Pearn, Franklin, and Peden (2015) defined "hypoxic blackout" as "loss of consciousness in the underwater swimmer or diver during an apnea submersion preceded by hyperventilation, where alternative causes of unconsciousness have been excluded" (p.343). They described the syndrome as having a high fatality rate but preventable. They emphasized the risk and the lack of measures of predictability and recommended that all swimmers and divers be educated about the risk of pre-submersion hyperventilation. Lindholm and Gennser (2004) also warned of the increasing popularity of breath-hold diving as an adventure/risk sport. Following a systematic review of hypoxic underwater blackout, the American Red Cross has recommended against teaching hyperventilation to swimmers and warning instructors and lifeguards about the dangers (American Red Cross Manual, 2015, p. 39).

Recommendations. Though the need to include surface diving and swimming underwater in water competence appears axiomatic, little research has been conducted on their value in drowning prevention education. Further research should include a) comparative analysis of various surface diving techniques relative to starting point, speed of execution, depth to be achieved, etc. b) comparative analysis of various techniques for underwater swimming relative to mechanical efficiency and physiological effects and demand, c) exploring the effects of clothing, rough water, and cold water on surface diving and under water swimming.

Based on the available evidence, we recommend that:

1. Underwater competencies be introduced early in the teaching process and, where developmentally appropriate, exposure to depth be increased gradually,
2. All swimmers and divers should be educated regarding the dangers of pre-dive hyperventilation and hypoxic blackout, that is, it must be included in all water competency educational programs. Male children and youth should be specifically targeted, and
3. Where developmentally appropriate, coping with underwater hazards in simulated open water activities be encouraged and experienced.

7. Safe Exit Competence

Reasons for drowning are most commonly associated with failure to stay afloat or swim to safety yet some evidence suggests that victims may also drown because they are unable to exit the water upon reaching the water's edge (Moran, 2014b). This has aptly been referred to as 'the exit problem' (Connelly, 2014). It appears to be more prevalent when the immersion is sudden, unintentional, and occurs in an open water setting. A problem exists in quantifying the extent of this phenomenon since most drowning incidents of this nature are not witnessed and such details are thus not reported. In spite of the likelihood that some drowning victims die because they cannot exit the water once reaching the water's edge, little is known about the real and perceived capacity of potential victims to extricate themselves from the water in an emergency.

In New Zealand, non-recreational immersion incidents, where the victim had no intention of being in the water, accounted for one quarter (25%) of all drowning fatalities in the five year period from 2008-2012 (Water Safety New Zealand, 2013). In Australia, in the year ending 30th

June, 2013, one fifth (18%) of all drowning fatalities were attributed to falling into water - more than the proportion that drowned during recreational swimming (16%) (Royal Life Saving Society Australia, 2013). In the UK, an analysis of accidental drowning fatalities in 2004 reported that more than a quarter (28%) of the annual drowning toll were unintentional submersions and, of these, half (52%) were attributed to falling in (Royal Society for the Prevention of Accidents, 2005).

Research evidence. Connelly (2014) examined over 3,000 reports, from both official and media sources, which indicated that many victims had succumbed to various debilitating environmental factors such as cold, exhaustion, entrapment, water movement, and the inability to hold on at the water's edge.

In a study of exit competencies among young adult students (n = 37) in the confines of a swimming pool, all participants were able to exit shallow and deep water when fresh, after a swim when wearing clothing or a lifejacket, but many failed to exit deep water over a 410mm ledge in clothing (35%) or in a lifejacket (49%) (Moran, 2014b). Significantly more females than males found exiting deep water difficult. Most participants (especially males) under-estimated the demands of exiting deep water. It is worth noting that swimming competency also did not appear to be a factor in successful exiting of the water, with very good female swimmers experiencing similar difficulties to their male and female counterparts of lesser swimming competency.

The difficulty encountered by many in exiting the water wearing a lifejacket requires further investigation (Moran, 2014b). It appeared that the bulk of the lifejacket restricted the lifting phase of the deep water exit over a 410mm ledge for many participants both male and female, irrespective of swimming proficiency. This raises an interesting question as to whether a lifejacket should be removed prior to attempting an exit of this nature in an emergency; the consequences of which would be lost buoyancy in the event of a failure to exit that may then exacerbate continued survival in the water (Moran, 2014b). Further research of lifejacket exits in a variety of settings and with varied victim capabilities is required so as to determine what strategy to recommend.

Recommendations. As suggested by Golden and Tipton (2002), the issue of hand grip, dexterity, and the capacity to hold on is also likely to influence exiting competency in cold conditions and perhaps should be listed as a sub-category in this competence.. Further study of the effects of cold and the effect of various forms of attire (for example, different layers of clothing for summer/winter, with and without footwear) on attempting to exit the water will add to understanding of the 'exit problem' and make safety and survival advice better informed.

On the basis of the research reported above, we recommend that:

1. Ways of exiting the water be introduced at an early stage and made progressively more challenging as the learner matures,
2. Exit competencies should be practiced in shallow and deep water, with and without clothing, in fatigue situations, in open water, and with different exit heights and surfaces, and
3. Explore appropriate and alternative techniques in a range of tasks that simulate possible exit problems.

8. Personal Flotation Device (PFDs/life jackets) Competence

In spite of the logic of life jacket use as protective practice, only in recent years has evidence appeared which directly links it with reduction in drowning incidence (Cummings, Mueller, & Quan, 2011). In the same period, more evidence has accumulated which documented the likelihood of PFD use or non-use associated with drowning episodes. While factors have been identified that increase compliance, mandated use in specific settings such as boating varies widely.

Research evidence. Use of approved life jackets has been shown to be effective in a 50% reduction in drowning deaths associated with boating activities (Cummings, Mueller, & Quan, 2011; Stempski, Schiff, Bennett, & Quan, 2015). Compulsory use of life jackets on boats decreased drowning fatalities from 63 to 19 % (Bugeja, Cassell, Brodie, & Walter, 2014). Several factors impacted life jacket effectiveness: these included using the crotch strap (Lunt, White, Long, & Tipton, 2014) and being familiar with how to use them - a critical issue (MacDonald, Brooks, Kozey, & Habib, 2015). A community campaign found reported life jacket use increased when a parent felt comfortable choosing and fitting it on their child (Bennett, Cummings, Quan, & Lewis, 1999). This finding suggests that specific training with a life jacket is essential.

Life jacket use has been promoted for children or weak swimmers recreating in and/or near water. Community-based campaigns have led to the availability of life jacket loaner stations with anecdotal case reports of saved lives (Bennett & Bernthal, 2001). A prospective study of a seasonal law mandating life jacket wear while in, on, and near rivers in a county in the state of Washington (WA) USA noted there were no drowning deaths that season. No other study to date has been conducted on the efficacy of life jacket use for non-boating activities such as wading or swimming.

Increasing life jacket wear among swimmers has primarily focused on children but resulted in observed, non-mandated use of life jackets of 50% among children less than 6 years of age and 20% of those 6-12 years while swimming/wading in designated swim areas in WA state (Quan, et al., in press). In contrast, 26% of teens and 21% of adults used some type of non-life jacket flotation device. Thus, flotation device use was surprisingly common at all ages, but better understanding of the need to use approved life jackets is needed (Quan, Mangione, Bennett, & Chow, in press).

Promotion of life jacket use is simple: Mandating life jacket use has led to very high life jacket wear rates (exceeding 90%) observed among those required to wear them: children, users of personal water craft, those being towed behind boats (e.g., water skiers), and those in boats in mandated waters (Chung, Quan, Bennett, Kernic, & Ebel, 2014; Mangione & Chow, 2014).

Promotion of voluntary use of life jackets has had mixed success. American and New Zealand teens, especially males, are either unaware of or resistant to life jacket use (Bennett, Quan, & Williams, 2002; Bennett et al., 1999; Moran, 2006). Surprisingly, 50% of WA state teens in boats wore them though non-mandated, probably because they grew up under the life jacket law which mandates use for children 12 years and under. Moreover, adult modelling promotes wear: children and teens had higher life jacket wear rates when an adult in the boat wore a life jacket (Chung et al., 2014). Promotional efforts have also led to increased use among land-based fishers at high risk fishing sites (Moran, 2011): fewer fishers reported *never* wearing a buoyancy aid (2010: 35% vs. 2006: 72%) and more reported wearing them *sometimes* (2010: 35% vs. 2006: 23%) or *often* (2010: 31% vs. 2006: 4%). Despite massive promotional efforts by their Coast Guard, life jacket use among US and Canadian boaters, especially motor boaters and fishermen, has remained stubbornly low for decades. When queried, boaters stated that a) life jackets were uncomfortable, b) wear implied inexperience, c) they wore life jackets in bad weather and bad water conditions, and d) would only wear them otherwise if mandated (Quistberg, Bennett, Quan, & Ebel, 2014, Quistberg, Quan, Ebel, Bennett, & Mueller, 2014).

DOI: 10.25035/ijare.10.02.03

Recommendations. Further research is required to determine the effectiveness of life jacket use in recreational activity such as while swimming or playing in or near the water (Quan, Liller, & Bennett, 2006). Further study of successful promotions of life jacket use among boaters along with subsequent reductions in drowning is also needed.

On the basis of the research reported above, we recommend that:

1. Life jacket wear should be promoted and taught as a key safety device when in, on, or near water,
2. Proper fitting and wearing of a lifejacket should be taught and practiced,
3. Donning of the life jacket should be physically practiced in all water safety programs, and
4. All physical water competencies should be practiced with a life jacket, recognizing that they permit only modest levels of surface diving and swimming under water.

9. Clothed Water Competence

Unintentional falls into water, often when fully clothed, are a frequent source of open water drowning. A widely held, and frequently reported, public perception of the impact of clothing in unintentional immersion is that clothing 'weighed the victim down' and was the cause of drowning. Yet little is known about the effect of clothing on water survival competencies such as swimming and floating in the prevention of drowning (Moran, 2014a). Moreover, little is known about how people perceive the physical exertion that such competencies may require if entering the water when clothed or how close their perception is to the reality of actually performing the tasks when clothed (Moran, 2015).

Research evidence. At an exercise intensity above 60%$\dot{V}O_2$, clothed swimmers showed a slightly higher rate of perceived exertion (RPE) in the front crawl stroke compared to the RPE reported for breaststroke and elementary backstroke (Choi, et al., 2000). Amtmann and colleagues compared the effect of standard work clothing for railway workers (*N* = 9) on the water competencies of speed swimming, and treading water (Amtmann, Harris, Spath, & Todd, 2012). They found that standard labor wear had an adverse effect on sprint swimming (11.4m), treading water time, and significantly increased the rate of perceived exertion (RPE) for both tasks.

Similarly, lightweight clothes significantly reduced both sprint swimming speed (33% slower time) of physical education students *(N* = 12) over a distance of 25m and distance swum in 5 minutes (28% less distance covered) without significant deterioration in flotation, irrespective of age or sex results were reported (Moran, 2014a; Moran & Moran, 2015). Greater depreciation was noted in the sprint swim for those who self-reported low water competence. In a follow-up study, participants (*N* = 37) reported significantly greater exertion ratings post activity than they had estimated for all activities, especially when clothed, irrespective of age, sex, or self-estimated water competency (Moran, 2015).

In an exploratory study by Stallman, Laakso and Kjendlie (2011), wearing clothing had a deleterious effect when performing of a 200 m combined test compared with the same test performed in swimwear among 10-year-old children (*N* = 63). Follow-up studies in 2013 with 128 children (Stallman, Laakso, & Hornemann, 2013) and in 2014 with 490 children (Laakso, Horneman, Grimstad, & Stallman, 2014) using the same 200 m combined competency test found that a significant number of children able to swim in swimwear were judged unable to swim with outer clothing.

Recommendations. The minimal effect of clothing on flotation recently reported (Moran, 2014, 2015) is interesting. First, it further reinforces previous evidence (Barwood, Bates, Long, & Tipton, 2011) that clothing, rather than weighing a victim down, may not only provide initial buoyancy in sudden immersion but also insulation and continued buoyancy in subsequent survival. Second, it suggests that in the event of a sudden immersion, lightweight clothing need not be removed since it does not appear to add to flotation difficulties and removing it may require additional energy expenditure and possible loss of trapped air,as well as increasing the rate of heat loss. Third, it appears that, in case of competent swimmers at least, differences in overall proficiency did not affect the capacity to float when wearing clothes. This needs to be tested with less able swimmers and with differing forms of clothing before firm conclusions can be reached (Moran, 2014).

On the basis of the research reported above, we recommend that:

1. The wearing of clothing when developing all physical water competencies is encouraged,
2. Clothing should be introduced at an early stage of competency development starting with lightweight clothing and progressively increasing the task demands and clothing coverage, and
3. The use of clothing in conjunction with simulated exercises such as falling in and climbing out, in calm and rough water, and in closed and open water is encouraged.

10. Open Water Competence

In an open-water situation (where most drownings occur), water competence is likely to be compromised by many impediments such as cold air and water temperatures, rough (e.g., waves, surf) water, and clothing (Moran, 2015). Water survival competencies in open and closed water environments have recently been identified as a research need in the revised edition of *Drowning: Prevention, Rescue, and Treatment* (Stallman, Moran, Rahman, & Brenner, 2014). The lack of consistency in safety advice is exacerbated by an underlying lack of research as to what constitutes open water competencies. Exploration of open water competency from a drowning prevention perspective would thus benefit from experiencing challenges that simulate survival conditions rather than simply assessing swimming performance (e.g., time, distance).

Research evidence. Several studies have noted the debilitating effect of cold on swimming performance (Datta & Tipton, 2006; Ducharme & Lounsbury, 2007; Golden, Hardcastle, Pollard, & Tipton, 1986; Tipton, 2003; Tipton, Eglin, & Golden, 1998; Tipton, Eglin, Gennser, & Golden, 1999; Tipton, Stubbs, & Elliott, 1990). An early UK study (Home Office, 1977) had shown that most UK drownings occurred within 3-4m of safety. This prompted experts to realize that hypothermia was unlikely the cause of these drownings. The cold shock response (CSR), the body’s immediate reaction to cold water immersion (CWI), was a far more plausible explanation (Tipton, 1989; Tipton, 2003; Tipton, et el., 1999). Mantoni and colleagues (Mantoni, et al., 2008) demonstrated that voluntary breath control alleviates elevation of respiratory rate and reduction of blood flow to the brain. Choi and colleagues (Choi, Ahn, Choi, Kim, & Park, 1996) showed that leg exercise while immersed in water (stepwise from 15^0C - 35^0C), tended to alleviate the reduction in core body temperature, especially at colder levels. Barwood and colleagues (Barwood, et al., 2016) examined treading water first compared to float first. They found that treading alleviated the reduction of cerebral blood flow found in floating, but alone did not alleviate the elevation of respiratory rate.

One study has suggested that clothing may have a beneficial effect in drowning prevention by providing immediate flotation, the consequence of trapped air in clothing layers (Barwood, Bates, Long, & Tipton, 2011). In addition to providing some insulation to the hypothermic effects of cold water immersion, the buoyancy also may help the victim to cope with CSR and importantly provide vital seconds to allow the victim to make rational decisions

DOI: 10.25035/ijare.10.02.03

about how to extricate themselves from the situation (Golden & Tipton, 2002). Habituation, mental training, and/or knowledge about CSR can alleviate the reflexive increase in respiration rate with attenuating danger of hyperventilation (Bird et al., 2015a; 2015b; Tipton et al., 1998; Barwood et al., 2006; Mantoni, Belhage, & Pott, 2006; Croft, et al., 2013). This new approach to sudden immersion in cold water has been termed the *float first* drowning prevention strategy (Barwood et al., 2011).

Recent evidence on the debilitating effect of simulated rough water on water competency among 11-year-old children (N = 66) concluded that rough water conditions resulted in an 8% decrement in swimming performance in a 200 m swim and a 24% decrement in floating performance (Kjendlie et al., 2013). Significantly slower swimming speeds of 30-57% have been reported among lifeguards swimming in calm versus surf sea conditions (Tipton, Reilly, Rees, Spray, & Golden, 2008).

Recommendations. Further research is required on the teaching of simulated open water situations (e.g., rip currents, choppy water, aerated water). Further study also is needed on whether and to what degree water competencies taught in the pool may transfer to open water conditions for all populations at risk, but especially those in high risk groups (e.g., males, youth, inexperienced swimmers, young adults) engaged in high risk activities (e.g., rock-based fishing, boating).

On the basis of the research reported above, we recommend that:

1. All competencies taught need to relate to both open and closed water environments,
2. Simulated open water competencies can be introduced at an early stage of competency development starting with simple tasks such as water splashing to create wave and currents,
3. Increasing the task demands by using combinations of activities (e.g., entry, swimming on the surface, swimming underwater through underwater hoops, negotiating obstacles) both when fresh and fatigued, and
4. All water safety programs taught in pools should simulate (e.g., with scenarios) rough water at developmentally appropriate levels for each physical water-based competence.

11. Knowledge of Local Hazards

The promotion of safety knowledge has been central in injury prevention interventions and is based on the supposition that by influencing people's knowledge, their attitudes will change and so will their safety behavior (Andersson, 1999). While the relationships among knowledge – attitudes-behaviors (KABs) appear axiomatic, empirical evidence to support these relationships in drowning prevention is sparse. Moreover, environmental hazards such as tides, wind, waves, rip currents, river currents, changing bottom conditions, and cold water are common at many open water recreational sites but are unique to each area. Thus, knowledge about one area may not be transferable to others.

Another characteristic of local hazards is that they represent what Newell (1986) has described as 'dynamical constraints,' which represent changes in demands based upon changing relationships among the individual's characteristics, the specific task demands, and the aquatic environment, thereby altering the individual's expression of their water competence (Langendorfer, 2015). An obvious example of the dynamic nature of local hazards are changes in the coastal morphology of bays, headlands, and harbours at different points in the tidal flow. Seasonal changes in weather (e.g., wind and cold) and water conditions (e.g., waves and rough surface water) are other obvious dynamical constraints likely to impact one's competence and water safety. Having a basic understanding of such hazards and an awareness of the risks they pose should help inform safe decision making, especially when engaged in high risk activities (e.g., rock-based fishing) and in high risk locations (e.g., surf beaches).

Research evidence. Recent evidence has suggested that the public vary in their awareness and accuracy of information of environmental hazards and their impact on their water safety. Youth and young adults have been shown to have a poor understanding of rip currents (Gulliver & Begg, 2005; Moran, 2008c; Willcox, Moran, & Kool, in press). Adult beachgoers have been identified to lack knowledge of the danger of rip currents in New Zealand (McCool et al., 2008), in the US (Brannstrom, Trimble, Santos, Brown, & Houser 2014; Caldwell, Houser, & Myer-Arendt, 2013) and in Australia (Sherker, Williamson, Hatfield, Brander, & Hayen, 2010; Williamson, Hatfield, Sherker, Brander & Hayen, 2012).

Some studies have suggested that tourists are at greater risk of drowning because of unfamiliarity with local environmental hazards. In Australia, a study on beach drowning incidents suggested that a quarter of all fatalities from 2001-2005 were tourists (Morgan, Ozanne-Smith, & Triggs, 2008). Other Australian studies have suggested that the higher incidence of surf-related drowning among visitors reflects lack of water competency, surf safety knowledge, or experience of the beach (McKay, Brander, & Goff, 2014; Williamson et al., 2012). A recent New Zealand study found that, while international tourists were more likely than residents to hold unsafe beliefs about swimming and boating activity, both residents and visitors had a poor understanding of rip currents (Moran & Ferner, 2017).

Mounting evidence of the efficacy of rip current education has suggested that knowledge of environmental hazards is a critical competency for those exposed to such hazards. Studies of interventions in the US, in Brazil, (Klein, Santana, Diehl, & Menzies, 2003), in Australia (Hatfield, Williamson, Sherker, Brander & Hayen, 2012) and the UK (Woodward, Beaumont, & Russell, 2015) concluded that education and campaigns improved rip current awareness. A recent analysis of rip current videos on YouTube has suggested that while existing videos are good at providing a visual image and a range of escapes, greater emphasis needs to be placed upon rip current recognition and avoidance (Mackellar, Brander, & Shaw, 2015).

As previously reported in discussion of open water competencies (see previous competency 10), the debilitating effect of cold and rough water make open water immersion, intentional or otherwise, highly problematic. The effects of sudden immersion (CSR – cold shock response) and prolonged immersion (hypothermia) are now well known yet application of this knowledge to the teaching of water competence is not the norm. Similarly, while one study (Kjendlie et al., 2013) has measured survival in simulated rough water, routinely including such simulations in teaching is not common and is poorly understood.

Recommendations. Further research is required to determine a) how knowledge of water and weather conditions in other settings (e.g., ice, lakes, rivers) might impact the frequency of drowning incidents, b) the effect of environmental hazards such as ‘wind chill,’ ‘wave splash,’ and ‘white water’ aeration on drowning prevention and c) the effect of educational interventions aimed at enhancing knowledge of hazards in the aquatic environment.

On the basis of the research reported above, we recommend that:

1. Where developmentally appropriate, an understanding of environmental hazards be sequentially introduced during the acquisition of water competency in both pool and classroom environments,
2. Experiential exploration of hazards (e.g., simulated rip currents, rough water) be part of the development of swimming and floating proficiency,

3. Where developmentally appropriate and safe, beginners be given the opportunity to identify and observe local water hazards when discussing water safety principles and practice,
4. Where developmentally appropriate and safe, more advanced experiences of open water hazards and fatigue conditions be part of the curriculum, and
5. Ways to inform users of site hazards be developed at all local sites to aid development of this competency.

12. Coping with Risk Competence

Risk awareness, assessment, and avoidance. The risk of drowning inherent in aquatic activity, either intentional or otherwise, is pervasive and omnipresent. It encompasses, at its heart, how humans interact with the environment and what competencies and understanding they bring to that environment (Moran, 2006). Even though judgment of risk is considered to be an essential element of decision-making competence (Gittler, Quigley-Rick, & Saks, 1990), the role of risk judgment in relation to drowning is poorly understood (Moran, 2006). Although little evidence is currently available to evaluate poor risk judgment, some studies have claimed that males are more likely to drown than females as a consequence of overestimating their ability and underestimating risk (e.g., see Howland, Hingson, Mangione, Bell, & Bak, 1996). How individuals conceptualize and respond to various risk dimensions is crucial to the development of salient health promotion messages aimed at increasing safe behavior around water (McCool et al., 2008). Furthermore, the slow maturational rate of development of both risk awareness and judgement until age 25 years, the peak years of drowning, suggests the need to develop additional approaches among the 15-24 year-old high risk group.

Some have suggested that the protective effect of being able to swim might be offset by the increased exposure to aquatic risk inherent in performing that skill (Baker, O'Neil, Ginsburg, & Li, 1992; Smith, 1995), yet little documented evidence exists to confirm the validity of this relationship. Baker and colleagues (1992) went further and suggested that the ability to swim "could lead to overconfidence or to swimming in places with hazardous currents or undertow" (p. 183). Given this possibility, it would be prudent to make learners (especially males) aware of the risks associated with the aquatic environment while concurrently engaging in risk awareness, risk assessment, and risk avoidance when developing physical water competencies. Wiesner and Rejman (2015) suggested that, in addition to risk avoidance, risk can be effectively managed in the aquatic environment by teaching sound risk management strategies that included risk retention, risk transfer, risk compensation, risk diversification, and risk monitoring techniques as a routine part of swimming/water safety education.

Research evidence. Differences in public perceptions of drowning risk have become more apparent in recent years. Traditionally youth have been identified as being unable to accurately assess risk (Millstein & Halpern-Felsher, 2002). A national water safety study of New Zealand youth (N = 2,202) found significant gender differences with males consistently underestimating the risk of drowning associated with a range of risk scenarios (Moran, 2009). For example, almost twice as many males thought being caught in a rip at an unpatrolled beach to be *slight /no risk* (males 40%, females 24%) and twice as many males considered being swept off isolated rocks when fishing to be *slight /no risk* (males 23%, females 12%).

In the *Can You Swim?* international study (N = 373), young adult males from four countries consistently reported lower estimates of drowning risk even though their water competence was no better than that of their female counterparts (Moran et al., 2012). In a study of beachgoers (N = 3,371), McCool and colleagues (2008) found that young adults and men were more likely to self-report strong swimming competence along with lower perceptions of drowning risk. Similarly, low perceptions of the risk of water-related injury or drowning among males have been reported among rock-based fishers (Moran, 2008b), among young adults, (Gulliver & Begg, 2005), and new settlers (Moran & Willcox, 2010). In contrast to these findings, females and those with poor self-estimated swimming competence have been found to have a heightened sense of the risk of drowning and thus a greater tendency towards risk aversion (McCool et al., 2009; Moran, 2009). Emerging evidence in a low income rural setting, where domestic rather than recreational activity is the more frequent reason for immersion, suggested that risk taking or risk exposure was not adversely affected by participation in swimming lessons (Mecrow et al., 2015).

Some evidence has been published on variable parental perceptions of safety and risk at the beach (Moran, 2009). Of special concern was that male parents' estimates of risk of drowning for their 5-9-year-olds differed significantly from that of female parents with twice as many males reporting *no risk* at the beach on the day of the survey (males 37%, females 18%). The implication of this on young children's water safety is that male caregivers may not provide close and constant supervision of young children in the water at the beach in the mistaken belief that conditions are not potentially dangerous.

Recommendations. Further research is required to ascertain the risk assessment capacities of population groups at greatest risk (e.g., males engaged in high risk activities and high risk environments). Further study also is needed on the effect of future water safety programs on shaping drowning risk perceptions and subsequent aversive behaviors.

On the basis of the research reported above, we recommend that:

1. Risk awareness and risk avoidance be an integral part of any water safety program from the outset,
2. Where developmentally appropriate, risk assessment activities be sequentially developed alongside the acquisition of physical competencies,
3. Identifying and coping with the risks associated with water activity be taught in simulated survival activities, and
4. Risk identification and avoidance activities be an integral part of situated learning in open water environments such as the beach, river or lake.

13. Assess Personal Competence

While most drowning prevention advocacy has beenunderpinned by the assumption that the possession of "swimming skill" is protective, little is known about how people assess their competence or the accuracy of their estimates. Because little consensus has existed on what constitutes water competence and the difficulty of assessing competence under varying conditions, much drowning prevention research has had to rely on participants' self-estimates regarding their competence in relation to risk of drowning. The lack of an international measure to define swimming competence is suggested as one reason that people may have inflated self-efficacy of their swimming competence (Dixon & Bixler, 2007). The likelihood of inaccuracy of self-estimation is further compounded by the likely lack of any real swimming assessment that is recent or relates to the variable demands on personal competence posed by clothing and open water environments. The implications of an overly-optimistic belief in the protective value of minimal levels of swimming competency for open water safety is that it is likely to increase the risk of drowning for not only the individual but also those in their care (Morrongiello, Sandomierski, Schwebel, & Hagel, 2013; Morrongiello, Sandomierski, & Spence, 2013; Moran & Stanley, 2006). Given these potential dangers, it would be prudent to inculcate realistic competence appraisal strategies from the outset and make continual associations between the

DOI: 10.25035/ijare.10.02.03

adequacy of an individual's physical competence base and the variable demands likely to be placed upon it by challenging activities and environments.

Research evidence. Recent evidence suggested that, in conjunction with underestimation of risk previously discussed, overestimation of ability might be another critical factor in male over-representation in drowning statistics (McCool et al., 2008; 2009; Moran, 2008; 2011). Significant differences between estimations and actual competencies have been shown with other survival competencies such as swimming in moving water (Kjendlie, Pedersen, Thoresen, Setlo, Moran & Stallman, 2013), in clothes (Moran, 2014a; 2015), and exiting the water safely (Moran, 2014b). A study on minority groups (*n* = 194), traditionally reported as among those at high risk of drowning, found that most (70%) considered themselves to be good swimmers even though most (73%) could not swim more than 25m and most (73%) thought that this capability would keep them safe (Stanley & Moran, 2017).

Several studies within the "Can You Swim?" international project have shown that both young adult males and children are not particularly good at accurately predicting what they really can do in the water (Moran et al., 2012). In New Zealand (Moran, 2010), Australia (Petrass, Blitvich, McElroy, Harvey, & Moran, 2012), Norway (Stallman, Dahl, Moran, & Kjendlie, 2010) and Japan (Goya, Teramoto, Matsui, Shimongata, Doi, & Moran, 2011), young adult males perceived their competence to be better than it really was. In both Norway (Kjendlie et al., 2013) and Portugal (Queiroga, Blitvich, McElroy, Moran, Fernandes, & Soares, 2013), children were unable to accurately predict what they could do in the water. A recent US study has found that educated, affluent parents (*N* = 482) attending a public pool session with their school-aged child and who reported that their children had 'good skill,' in fact correlated with passing the swim test; a report of having had formal swim lessons did not correlate (Mercado et al., 2016).

An Auckland parent/caregiver study (*n* = 309) on perceptions of how much swimming competence was required to provide protection from drowning found that most parents (58%) considered themselves *good/very good* swimmers although more than half (55%) estimated that they could swim 25 m or less (Stanley & Moran, 2017). Most parents (87%) reported that their children could swim with more than one half (52%) believing that their child's swimming competence was *good/very good*; yet most (74%) considered their child could swim only 25 m or less. Most parents (59%) and almost all children (81%) had never actually swum their reported distance in open water. In spite of these low levels of competence, one half (51%) of parents thought their children were *safe/very safe* in open water. A study of parents (*n* = 769) and their children at beaches found male caregivers were more likely to rate themselves and their 5-9-year-olds as good swimmers and less likely to estimate a high risk of drowning for that age group (Moran, 2009). Higher estimation of a child's swimming capability may reduce the level of attention paid by males when supervising their children at the beach.

Recommendations. Further research on the relationship between perceived and real water competencies may provide valuable insight into the possibility that overconfidence in one's capability to cope with the risk of drowning may exacerbate that risk. Further investigation is needed to determine the degree to which these findings are replicated in other populations to ascertain whether low association indeed exists between perceived and actual swimming competence.

On the basis of the research reported above, we recommend that:

1. Throughout the acquisition of water competence, learners should have the opportunity to assess their real competency and compare it with perceived estimates,
2. Where developmentally appropriate, real competencies should be assessed along with self-

estimated in closed and open water settings,

3. Where developmentally appropriate, real and perceived competencies should be assessed under varying fatigue-inducing conditions (e.g., rough, wavy water) and while performing challenging tasks (e.g., survival circuits), and
4. Where developmentally appropriate, differences between real and perceived competence be discussed in the context of drowning prevention when caring for self and others in water.

14. Recognise and Assist a Drowning Person

The potential value of bystanders as rescuers has been identified in the *Global Report on Drowning* as one of the key components in a list of ten actions to prevent drowning worldwide (WHO, 2014). Because most bystander rescues are not reported, the real extent of life-threatening submersion experiences (LTSEs) that have involved bystanders in rescue activity remains elusive (Moran, 2010). A survey of 1,000 adults in the U.S. found that the magnitude of the problem may be greater than imagined with one in every two adults (48%) having reported an LTSE (American Red Cross, 2009). A survey of 3,000 adult beachgoers (McCool et al., 2008) found that one third (30%) reported having had an LTSE.

Research evidence. While most drowning events are preventable, many require the intervention of others and, in some circumstances, the consequences of such intervention can itself result in loss of human life. The loss of rescuer life in drowning emergencies has been described by Franklin and Pearn (2011) as the aquatic-victim-instead-of-rescuer (AVIR) syndrome. In many developed countries, it is a small but persistent cause of drowning mortality (Moran & Stanley, 2013). In China, rescuers' mortality rates were similar to those being rescued; a majority of rescues were person to person (Zhu, Jiang, Li, Li, & Chen, 2015). While the risk factors associated with bystander rescue are now well known and reported, it is unlikely that altruistically motivated rescuers will resist impulsive attempts to rescue a drowning person (Pearn & Franklin, 2012). Given this likelihood, educating the public about how to recognise those in trouble in the water and providing safe ways of assisting them are needed.

Recently, some attempt has been made to analyze the underlying motivations of the rescuer who drowns (Pearn & Franklin, 2012), but little is known about what skills and knowledge the rescuers possessed that would have prevented their drowning. One study has found that more than half of fit adults tested in a simulated drowning incident on dry land could not throw a lifeline accurately (Pearn & Franklin, 2009).

A nationwide water safety survey of New Zealand youth found that one third (35%) considered that they had no rescue ability, and more than one half (59%) expressed doubts about their ability to perform a deep-water rescue (Moran, 2008). A lack of rescue ability has also been reported among 21-year-old Dunedin young adults, most of whom (52%) had not received any lifesaving training (Gulliver & Begg, 2005). In a study of parents/caregivers (N = 769) in charge of children under 10 years of age at 18 New Zealand beaches during the summer of 2007, more than three quarters (76%) of the adults surveyed had not received any rescue/lifesaving training (Moran, 2009). Importantly, male beachgoers were more confident of their ability to rescue their child even though they reported no more lifesaving training than females that took part in the study.

In an attempt to ascertain the level of public knowledge of safe rescue techniques, festivalgoers (N = 415) attending a cultural event in Auckland, New Zealand took part in a water safety survey that included information on their readiness to respond in a drowning emergency (Moran & Stanley, 2013). Many indicated they would jump in and rescue a victim (47%) – the most at-risk option - while less than one third (30%) would get flotation to the victim – the most effective and low risk option. Significantly more males responded that they would jump in and attempt a rescue (males 55%, females 40%).

In a follow-up study designed to promote safe rescue techniques, parents (N =174) participating in a family-oriented water safety program were exposed to a new teaching resource entitled the 4Rs of rescue – recognise, respond, rescue, and revive (Moran, Webber, & Stanley, 2016). At the start of the program, most respondents (71%) had never been taught rescue techniques, and males were more confident than females of their rescue ability. Upon completion of the program, significant differences were evident in respondents' understanding of rescue safety but this did not translate to greater confidence or disposition towards performing a rescue.

Emerging evidence from the SwimSafe program taught in rural Bangladesh from 2006, found that children who had participated in the program reported more rescue activity when compared with age- and sex-matched controls (Mecrow et al., 2014). Most reported contact rescues of younger children with the rescuer standing in the water less than 10m from land.

Recommendations. Further research is required on a) public perceptions of how best to assist others in trouble in the water, b) the nature, extent, and effectiveness of current public lifesaving education, and c) the effectiveness of easily-accepted and learned contact and non-contact rescue techniques for lay persons.

On the basis of the research reported above, we recommend that:

1. Ways of recognising and assisting others in trouble in the water be sequentially introduced from the outset. Where developmentally appropriate, safe non-contact ways of assisting others from land be taught with 'safety of self' paramount in all teaching,
2. Where developmentally appropriate, simulated rescue activity be taught in sequentially more challenging scenarios,
3. Where developmentally appropriate, in water rescue techniques (using various forms of at hand objects) and its inherent dangers be discussed in a variety of simulated open water scenarios, and
4. The use of direct body contact swimming rescues (DBC) be systematically discouraged in any educational attempt to impart lifesaving/water safety skills to the general public.

15. Water Safety Competence

15a. Attitudes. Attitudes are defined as "a relatively enduring organization of beliefs around an object or situation pre-disposing one to respond in some preferential manner" (Rokeach, 1986, p. 112). Water safety attitudes are considered important to the construction of drowning risk because they serve both motivational and cognitive functions by providing a frame of reference for organizing information (Aiken, 2002). They are thus likely to be closely associated with knowledge.

15b. Values. Similar to attitudes, values are strongly-held personal principles that may impact the probability of a person acting or not. Values may or may not depend upon knowledge, but are related more to affect or emotions.

Research evidence. The relationship between attitudes and behavior regarding life jacket use closely resembles that of seat belt and bicycle helmet use. Chung and colleagues (Chung, et al., 2014) found that among those not covered by a life jacket law, use was significantly lower than for those covered by a law. Life jacket use among children and youth was significantly higher when at least one adult in a boat also was wearing a life jacket. In similar fashion, Ehrlich and colleagues (Ehrlich, Helmkamp, Williams, Hague, & Furbek, 2004) found that children who cycled together with their parents were more likely to wear a helmet and that children were more likely to wear a seat belt when the parents always did so. These studies suggest that both child attitude and behavior are influenced by parents, though the mechanism is poorly understood. Petrass and Blitvich (2014) examined knowledge, attitudes, and water safety skills of young adults (N = 135). They then conducted a 12-week intervention and found that both knowledge and skills improved while attitudes changed only insignificantly. These results suggested that an intervention can provide positive effects but that changing attitudes was difficult. Wintermute and Wright (1990; 1991) found that among private pool owners who claimed to favor the compulsion of fencing, only 35% had themselves installed such fencing. In their second study, among pool owners who supported CPR training, only 50% had actually had such training.

White and Hyde (2010) examined the intentions of beachgoers to swim between the flags. Fourteen days later they asked a subgroup of the subjects to report their behavior during the previous fortnight. Their self-reported behavior correlated positively with their earlier "intention," although younger persons and males were predisposed to swim outside the flags, contrary to their original intention. A study of rock-based fishers found positive attitudes towards the wearing of lifejackets when fishing from rocks was initially not reflected in actual use of the lifejackets, but, as a consequence of a 5-year-long safety promotion, lifejacket use improved from 4 - 40% (Moran, 2011a).

Barriers to changing attitudes and values may be based on misconceptions as well as beliefs. Several studies have found that some parents of children involved in swimming lessons had the attitude that their children needed less supervision once they had received swimming lessons (Moran & Stanley, 2006a; 2006b; Morrongiello et al., 2013; 2014; Willcox-Pidgeon, Moran, & Kool, 2017). Sherker and colleagues (Sherker, Williamson, Hatfield, Brander, & Hayen, 2010) found that beachgoers between 30 and 49 years of age were more likely to swim outside of the flags believing themselves to be safe while those with children and those with a basic knowledge of rip currents were less likely to swim outside of the flags. Vietnamese American parents believed that drowning was ascribed to "fate" and were not receptive to preventive measures (Quan, Crispin, & Bennet, 2006). However, despite similar beliefs in Bangladesh, specific interventions that increased supervision and swim skills decreased drowning deaths (Rahman, et al., 2011).

Recommendations. How water safety attitudes and values relate to knowledge and how they might affect behavior is difficult to measure and remains poorly understood. Further studies within the realm of water safety research should include exploration of a) how likely attitudes and values are to change, b) the role of attitudes and values in changing behavior, and c) how attitudes and values are related to and influenced by knowledge.

On the basis of the research reported above, we recommend that:

1. Positive attitudes be recognized from the outset of water competence development as foundational and consciously integrated into all water competence/water safety educational programs. This should include safety for both self and for others,
2. Verbal or physical expression of positive attitudes be systematically rewarded,
3. Creative ways be devised to promote positive attitudes towards water safety as a way of life, and
4. Practical interventions be developed and instituted that change the culture around water safety.

DOI: 10.25035/ijare.10.02.03

Discussion and Conclusions

Our paper presents water competence as an inclusive and comprehensive multi-faceted construct that provides the foundation for the teaching of water safety as a means to prevent drowning. Multiple competencies are described and recommended because they represent the physical, cognitive, and affective competencies which together make a person water competent and thus less susceptible to the risk of drowning. These are supported by research evidence showing how each competency offers protective value. In some cases the studies cited were not originally conducted specifically to address or support water competence or the idea of drowning prevention. Nevertheless, several such studies provided powerful evidence of the protective value of water competence in preventing drowning.

To the best of our knowledge, justifying the inclusion of specific competencies in the content of educational programs by citing supporting research evidence has not been done before. We believe that this has not occurred primarily because much of the evidence cited in our extensive review has only become available in the past decade or two. As we have pointed out for each competence, further research is required on many if not all of the competencies introduced within the conceptual framework presented in this paper. As new research in each of the fifteen identified competencies becomes available, we fully expect that the way we view water competence and the issues related to drowning prevention will change. Additionally, we expect and hope that the list of competencies recommended here will be modified as new research evidence and our understanding evolves.

It is important to note that the teaching content and associated pedagogies have not been addressed here. We have recommended that developmentally appropriate pedagogies are absolutely necessary for the effective achievement of each of the competencies. The competencies as listed in our framework (refer to Table 1) are not intended to represent a teaching progression. Each must be further studied to provide explicit developmentally appropriate outcomes paired with specific pedagogical tools. In all likelihood, fifteen evaluative tools paired with separate teaching progressions will need to be developed and validated. In some of the more challenging competencies (e.g., open water, on-site risk appraisal, high risk activities and environments), the safety of participants will require best practice teaching and instruction including creative simulations. We offer this paper as a challenge to all aquatics educators and aquatic organizations to expand on what is taught, when it is taught, and how it is taught.

We humbly offer this paper and its evidence-based foundation as a model for future evidenced-based work. We propose the need for a more encompassing and dynamic view of water competence and drowning prevention education that addresses the dynamic and complex nature of drowning. It is time to move beyond teaching strokes. The water safety of all is too important to be left to chance or to be informed by tradition, anecdotes, and axioms.

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