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Do Water Safety Lessons Improve Water Safety Knowledge?

Michael J. Tipton
Extreme Environments Laboratory, University of Portsmouth, michael.tipton@port.ac.uk

Joseph Muller
University of Portsmouth, joseph.muller@port.ac.uk

Cristian Abelairas Gomez
Universidade de Santiago de Compostela, cristianabelairasgomez@gmail.com

Jo Corbett
University of Portsmouth, jo.corbett@port.ac.uk

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Cover Page Footnote

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Abstract

A person, usually a child or young adult, dies by drowning every 90 seconds around the planet. Most drowning prevention initiatives do not assess the efficacy of the intervention. In this study, thirteen- to fourteen-year-olds had their level of water safety knowledge (covering cold shock, rips and tides) assessed before, just after, and 3-6 months after one, 25-minute water safety lesson on these topics. We evaluated the knowledge gained and retained on water safety "awareness" (i.e., knowledge of risks) and "confidence" in terms of knowing what to do in an emergency. The results demonstrated that the lesson significantly increased water safety awareness and confidence in pupils, and these benefits were retained for at least six months. We accept our hypothesis that theoretical, classroom-based instruction in water safety can improve the water safety awareness and confidence of children and may represent a "lesson for life." Given the large numbers who drown around the globe annually, a lesson on water safety should be part of every national curriculum.

Keywords: drowning prevention, water safety knowledge, education program

Introduction

Drowning is a leading cause of unintentional death worldwide: on average, every hour of every day, more than 40 people lose their lives to drowning. This is an underestimation, given the number of deaths that go unreported in the Third World. It also does not reflect the many hundreds of thousands who do not die but suffer life-long physical or mental morbidity due to drowning (WHO, 2014). Drowning is also a "disease of youth," since 64% of those who drown are under the age of 30 years, and 43% under 15 years of age. This represents an enormous loss of human potential and a public health challenge.

The study of drowning can be addressed from different perspectives with epidemiology, physiology and pathophysiology, and pre-hospital and in-hospital treatment amongst the most important approaches. In the last two decades, the number of publications about drowning has increased (Kloft & Groneberg, 2014) with the large majority agreeing that many of the deaths caused by drowning could have been prevented. In this regard, the lack of education in drowning prevention is considered a leading contributory factor (WHO, 2014; WHO, 2017), and drowning prevention education has been identified as a principal intervention to tackle this cause of death (WHO, 2014; WHO, 2017).

Whilst interventions for the prevention of drowning often have laudable motives, unless their impact is assessed, their value (both economic and social) and efficacy remain unknown. The critical question is therefore, *how many of the interventions across the topic of "drowning" have had their impact assessed?* One of the most important series of international conferences on

drowning have been the "World Conferences on Drowning Prevention." The main goal of these conferences is to bring together experts and researchers working in topics related to drowning, and to facilitate the exchange of experiences and strategies and thereby decrease drowning deaths. A book of abstracts comprising all the material presented (including oral and poster presentations and plenary sessions) has been published for every meeting. The book of abstracts for the meeting held in Vancouver (2017) (which three of the current authors of this paper attended) included 328 submissions, about 22% of which could be considered as relating to drowning prevention, rising to 45% if "swimming and water safety" are considered part of prevention. Hence, the area of "drowning prevention," as reflected in the book of abstracts of this major meeting, represented a substantial proportion of the global research on drowning.

Using the book of abstracts from 2017, we performed an analysis of the number of abstracts that reported any assessment of the impact of the interventions followed (e.g., a pre- and post-intervention assessment of efficacy such as increased knowledge, reduction in incidents/drowning). Eight of 148 abstracts (5%) on drowning prevention, swimming and water safety reported such results. Of these, only two projects presented results on the effect of their drowning prevention measures on actual drowning deaths.

It seems, therefore, that drowning prevention is a topic that is being reported in the literature, but the impact/value of interventions is not generally being assessed. If it is assessed, the retention of any skills taught is rarely considered; the focus being on the immediate effect of an intervention, such as a lesson, on knowledge (McCool et al., 2009). This is understandable; obtaining data on the effectiveness of such interventions is not easy. Longitudinal studies may be necessary, but they require research capability, collaboration, effort, and time to design and implement a prevention strategy, collect data, and analyse results to determine the impact on outcomes.

A consensus has agreed that water safety education for children is an important drowning prevention tool (Ramos et al., 2018); we therefore designed, in collaboration with the Royal National Lifeboat Institution (RNLI) and Hampshire County Council (Education department) a short water safety lesson that could be delivered to 13- to 14-year-old children in Hampshire, UK. This age group was chosen as it represents the age considered old enough to appreciate the water safety messaging, but just younger than the group in which drowning numbers begin to increase (15 years + https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6234a9.htm?s_cid=mm6234a9_w). The lesson focused on the practical aspects of cold shock (hazardous initial responses to immersion in cold water), rip currents and tidal flows. These areas were chosen as they represent the most common, non-sailing, causes of calls for lifeboat assistance (RNLI data). The lesson included information on

ways of mitigating the problems associated with these factors. The impact of the lesson was assessed immediately following its delivery and three to six months later. It was hypothesised that children would improve their understanding of water safety as a result of the lesson and retain critical aspects of the lesson, thereby making it a "lesson for life."

Method

The project received ethical approval from the University of Portsmouth Science and Health Research Ethics Committee. Prior to undertaking the questionnaire-based survey, the teachers read a brief statement to pupils describing participant information and the rights of the participant. This information was duplicated at the start of the questionnaire, and it included a "yes/no" question asking whether the participant consented to the use of their data. Thereafter, completion of the questionnaire was considered as implied consent. No questions pertaining to personal information were included in the questionnaire to ensure it was GDPR compliant, and all data were anonymous and securely stored on a password-protected university network.

To reduce error and maximize the quality of responses, attention was paid to the readability of the questions with consideration of the target population. For this, the Flesch-Kincaid Grade Level test (Kincaid et al., 1981) was applied to the draft questionnaire to ensure the reading level was age appropriate. The questionnaire was then verified by all members of the research team and the University of Portsmouth Science and Health Faculty Research Ethics Committee.

The questionnaire was administered just before, immediately after, and 3-6 months after a 25-minute lesson on water safety. The lesson combined slides and embedded film which was delivered by a member of the RNLI youth education team; the lesson content is available as supplementary material. To ensure content validity, the research team and the intervention providers met on several occasions prior to the first lessons. These meetings helped to ensure a synergy between the content of the sessions and the research aims.

The tailored questionnaire was designed for distribution to secondary school children aged 13 to 14 years. It consisted of an opening paragraph to explain the purpose of the research, some demographic questions, and three topic sections focusing on cold-water shock, tides, and rip currents, respectively. To elicit a mixture of quantitative and qualitative responses each topic section consisted of a closed-ended question, two open-ended questions and a rated (Likert scale 1 to 5) question. Of the two open-ended questions in each topic section, one was designed to extract data on the children's knowledge of each topic; the other was designed to examine what the children would do if they found themselves caught in a situation related to the topic areas. The rated

questions were designed to test their confidence level in 'knowing what to do' in each of the situations.

Following approval, a member of the research team distributed the questionnaire in either an online version using SurveyMonkey® or a paper-based format to children immediately prior to a pre-arranged water safety presentation. The same questionnaire was then distributed to the same children immediately following the lesson (immediate follow-up). The questionnaire was again distributed to the same children a third time after a three to six-month period (long-term follow-up). A member of the research team was present for all the interventions. The same research team member undertook the data extraction phase to ensure consistency within the methods applied.

Questions 6, 7, 9, 10, 12, and 13 were regarded as questions about the pupils' "Awareness" (or knowledge) of the hazards associated with immersion. Questions 8, 11, and 14 were regarded as measures of the pupils' "Confidence" in knowing the correct thing to so in an emergency.

To extract the data from the open-ended questions (6b, 7, 9b, 10, 12b and 13) a scoring system was applied based upon the key points of each topic. Each question had three key points that were assigned a point each if the student made an accurate reference to it. These pre-determined criteria helped to reduce the risk of confirmation bias during this data interpretation stage. The Likert scale questions (8, 11, 14) were assigned a score of one for 'not at all confident', to five for 'very confident'.

The results were then analysed using IBM SPSS Statistics version 26. Alpha was set at 0.05. Significant differences between pre- and immediate post-intervention scores, post-intervention and long-term follow up scores, and pre-intervention and long-term (3-6 months) follow up scores were examined using the Mann Whitney U test for non–parametric data. These tests were carried out on questions 6b, 7, 8, 9b, 10, 11, 12b, 13 and 14. In addition, a 'total awareness' score was calculated for each participant (sum of scores from relevant tests) and analysed using the same test. Where significant differences were found, the r statistic was calculated (z score divided by the square root of the total number of observations) to assess the strength of the experimental effect. The effect sizes were: 0.1 small; 0.3 medium; and 0.5 large (Field, 2013). The anonymity of the data set prevented repeated measures testing of just the pupils who had provided responses at all three time points.

Table 1.
The questionnaire questions identified by number and actual text

Question Number	Question
1	What school year group are you in?
2	What is your gender?
3	What is the name of your nearest town/village?
4	What is the name of your school?
5	Have you previously watched a water safety video/lesson?
6a	Do you know what cold water shock is?
6b	If you answered yes, please state in the box below what you think cold-water shock is.
7	What would you try to do first if you fell into cold water?
8	How confident are you that you would know what to do if you fell into cold water?
9a	Do you know what tides are?
9b	If you answered yes, please explain in the box below what you think tides are.
10	When stood or sat on the beach, but not in the sea, what do you need to be careful of with regards to the tide?
11	How confident are you that you would know what to do if you were trapped by an incoming tide?
12a	Do you know what a rip current is?
12b	If you answered yes, please state in the box below what you think rip-currents are.
13	What would you do if you were caught in a rip current?
14	How confident are you that you would know what to do if you were caught in a rip current?
15	Lastly, are you happy for us to use the answers you provided in our research? (*remember, it will not be possible to identify you by your answers and your data will be kept strictly confidential*)

Results

A sample of 921 children were tested before the lesson, 748 children immediately after the lesson and 280 children 3-6 months after the lesson. The "Awareness" results for the intervention scores are presented in Figures 1 & 2 and Table 2. The maximum possible score was 3. See Table 2 for results of statistical analysis.

Figure 1

Mean "Awareness" test scores pre- and post-intervention and 3-month follow up (Pre-intervention [n=921]; Post-intervention [n=748]; and long-term follow-up [n=280]). Maximum possible score = 3.

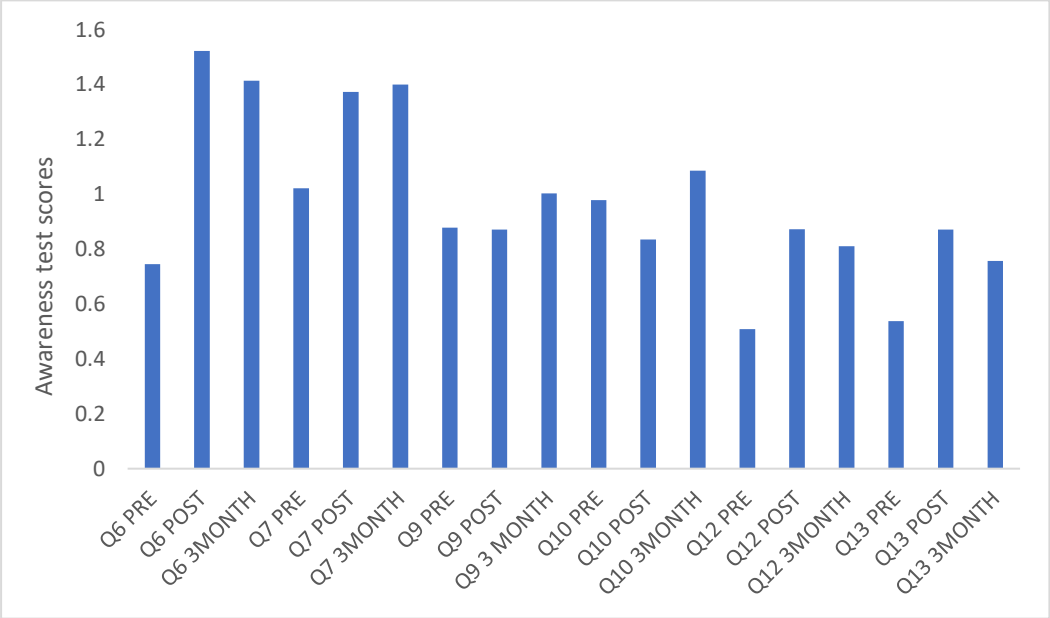

Figure 2

Overall "Awareness" test scores pre- and post-intervention and 3-month follow up (Pre-intervention [n=921]; Post-intervention [n=748]; and long-term follow-up [n=280]). Maximum possible score = 18.

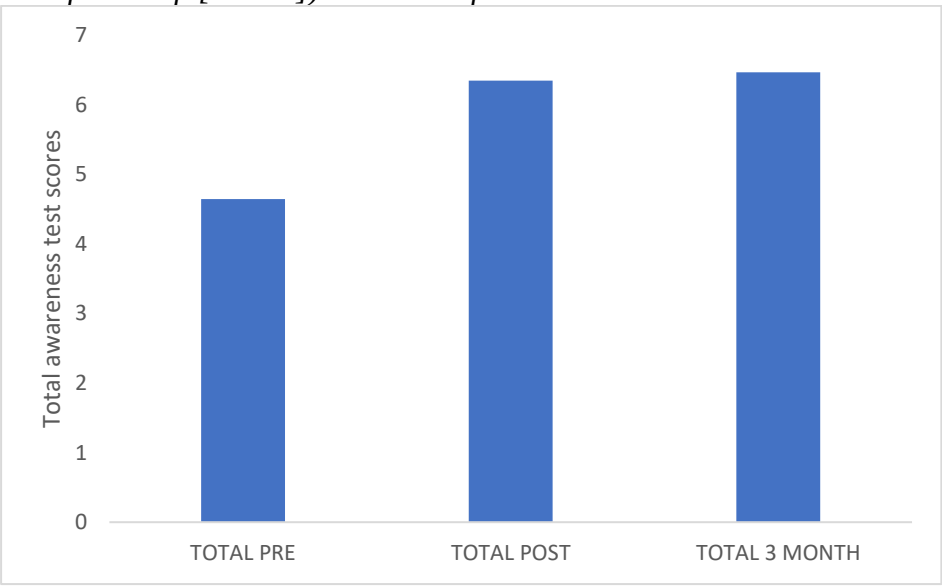

Table 2

Significant difference values (p) and effect sizes (r) for water safety awareness scores between time points: pre- and immediately post-intervention; post-intervention and long-term follow up; and pre-intervention and long-term follow-up.

Question Number	p value **Pre to Post**	*r* value Pre to Post	p value **Post to +3 month**	*r* value Post to +3 month	p value **Pre to +3 month**	*r* value Pre to +3 month
6	0.01*	0.40	0.035*	-0.07	0.01*	0.36
7	0.01*	0.26	0.39	n/a	0.01*	0.28
9	0.56	n/a	0.01*	0.08	0.03*	0.08
10	0.01*	-0.09	0.01*	0.16	0.037*	0.07
12	0.01*	0.23	0.095	n/a	0.01*	0.18
13	0.01*	0.28	0.002*	-0.10	0.01*	0.18
Total awareness scores	0.01*	0.31	0.69	n/a	0.01*	0.30

* = significant difference identified

For question 6 (*knowledge of cold shock*), a significant improvement between pre- and immediate post-intervention questionnaire scores was found. There was a significant, but slight reduction between the immediate post-intervention questionnaire scores and the long-term follow-up. A significant improvement was found between the pre-intervention questionnaire scores and the long-term follow up.

For question 7 (*what to do on initial immersion in cold water*), a significant improvement was found between pre-intervention questionnaire scores and immediate post-intervention questionnaire scores. There was no significant difference between the immediate post-intervention questionnaire scores and the long-term follow-up. There remained a significant improvement between the pre-intervention questionnaire scores and the long-term follow-up scores.

For question 9 (*understanding of tides*), no significant difference was observed between the pre- and immediate post-intervention questionnaire scores. However, a significant improvement was found between the post-intervention questionnaire scores and those obtained at long-term follow-up. A significant improvement also was observed between the pre-intervention questionnaire scores and the long-term follow up.

For question 10 (*what to do when trapped by a tide*), a significant, but slight reduction was found between the pre- and immediate post-intervention questionnaire scores. A significant improvement was found between the immediate post-intervention questionnaire scores and the long-term follow-up. A significant improvement was found between the pre-intervention questionnaire scores and those recorded at the long-term follow-up.

For question 12 (*knowledge of rip currents*), a significant improvement between pre- and immediate post-intervention questionnaire scores was found. There was no significant difference between the post-intervention questionnaire scores and those obtained at the long-term follow-up. There remained a significant improvement between the pre-intervention questionnaire results and those at the long-term follow-up.

For question 13 (*what to do if caught by a rip current*), a significant improvement was reported between the pre- and immediate post-intervention questionnaire scores. A significant, but slight reduction in questionnaire scores was found between the post-intervention and those of the long-term follow-up. A significant improvement was found between the questionnaire scores recorded pre-intervention and those recorded at long-term follow-up.

For the total awareness scores, a significant improvement was found between the pre-intervention and immediate post-intervention questionnaire scores. There was no significant difference between the post-intervention

Figure 3

Mean "Confidence" test scores pre and post intervention and 3-month follow up (Pre-intervention [n=921]; Post-intervention [n=748]; and long-term follow-up [n=280]). Maximum possible score = 5.

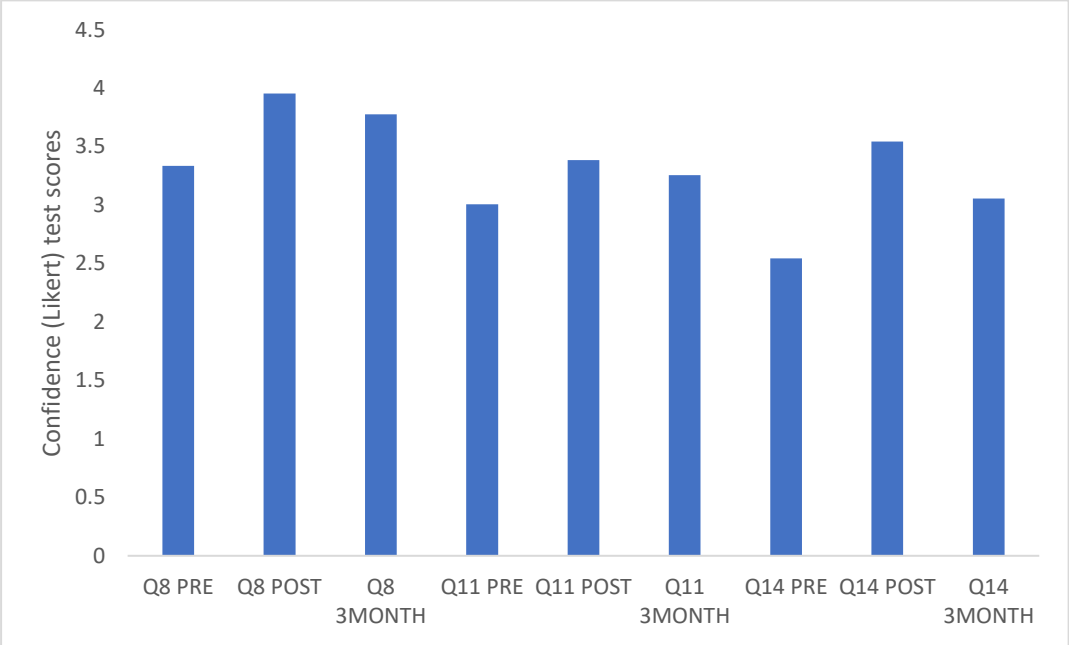

Figure 4

Overall "Confidence" test scores pre and post intervention and 3-month follow up (Pre-intervention [n=921]; Post-intervention [n=748]; and long-term follow-up [n=280]). Maximum possible score = 15.

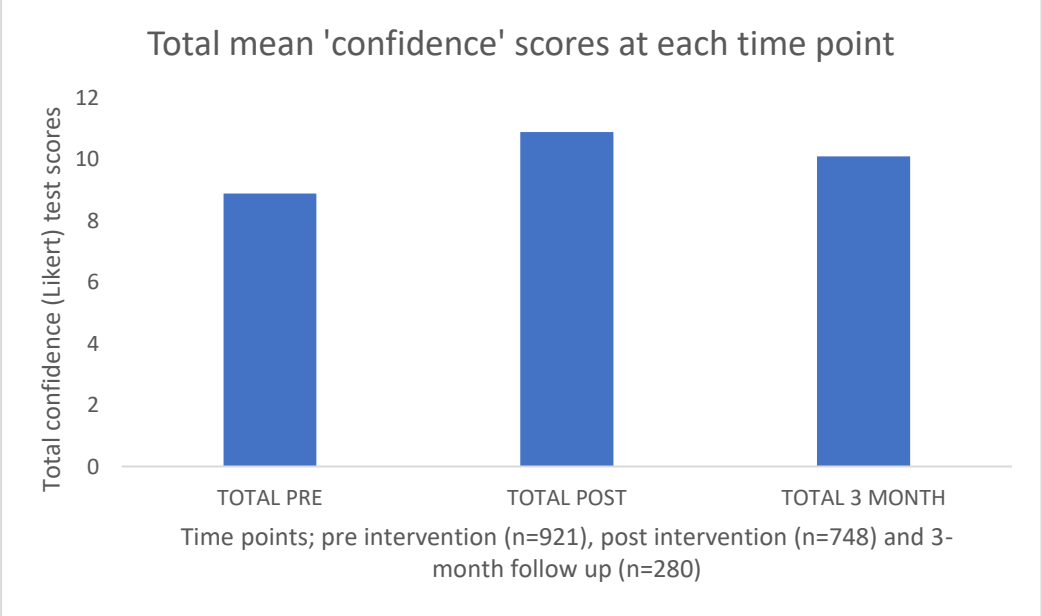

Table 3

Significant difference values (p) and effect sizes (r) for the "Confidence" (Likert) scores between time points: pre- and immediately post-intervention; post-intervention and long-term follow-up; and pre-intervention and long-term follow-up.

Question Number	p value Pre and Post	*r* value Pre and Post	p value Post and 3-month	*r* value Post and 3-month	p value Pre and 3-month	*r* value Pre and 3-month
8	0.01*	0.29	0.01*	-0.10	0.01*	0.22
11	0.01*	0.17	0.68	n/a	0.01*	0.12
14	0.01*	0.38	0.01*	-0.20	0.01*	0.20
Total confidence scores	0.01*	0.34	0.01*	-0.15	0.01*	0.22

**significant difference identified*

scores and those recorded at long-term follow-up. A significant improvement remained in the scores achieved between the pre intervention and long-term follow up.

Confidence (Likert scale) Results

The Confidence results for the intervention scores are presented in Figures 3 & 4 and Table 3. See Tables 2 and 3 for results of statistical analysis.

For question eight (*confidence*: *knowing what to do if falling into cold water*), a significant improvement was found between the pre- and immediate post-intervention Likert scale scores. A significant, but slight reduction was found between the immediate post-intervention and the long-term follow-up Likert scale scores. A significant improvement was found between the pre-intervention and long-term follow-up Likert scale scores.

For question 11 (*confidence: knowing what to do if trapped by tide)*, a significant improvement was found between the pre- and immediate post-intervention Likert scale scores. There was no significant difference between the immediate post-intervention and long-term follow-up. There was a significant improvement between the pre-intervention and long-term follow-up Likert scale scores.

For question 14 (*confidence: knowing what to do in a rip current)*, a significant improvement between the pre- and immediate post-intervention Likert scale scores was found. A significant, but slight reduction was found in these scores between the post-intervention and long-tern follow-up. A significant improvement was found between the pre-intervention Likert scores and those recorded at the long-term follow up.

For the total Likert scores, a significant improvement was found between the pre- and immediate post-intervention scores. A significant, but slight reduction was found between the immediate post-intervention scores and those recorded at long-term follow-up. There was also a significant improvement between the pre-intervention scores and those at the long-term follow-up.

For clarity, the result of the learning-related aspect of the present study are presented in Table 4. In this table, the pre-intervention level of knowledge for each variable is set at one star and subsequent results related to that score by significance and effect size.

Discussion

This study focused on some of the leading causes of immersion incidents: rips, physiological responses (“cold shock”) associated with initial entry into cold

water and becoming stranded by tides. A simple lesson was taught that included practical advice on each of these topics but with limited theory; the aim was to teach how to recognise a potential risk or problem and how to mitigate or avoid it. The low baseline, pre-lesson scores achieved by the pupils for total awareness (4.6 out of 18) and total confidence (8.9 out of 15) regarding the most common hazards associated with immersion in water (Figures 2 & 4) helped to explain the large number of immersion deaths seen in the UK and internationally and underlined the urgent need for an adequate intervention. The relatively higher level of "confidence" compared to hazard "awareness" was also concerning and helped justify initiatives such as the RNLI's "Respect the Water" campaign.

Table 4

*Summary of results (scores). * = baseline (pre-intervention); *** = significant improvement compared to pre-intervention scores, with a small effect size*

Question	**Pre-intervention**	**Immediate post-intervention (Pre- to Post-)**	**Long-term follow up (Pre- to +3-6 mo)**
6. Knowledge of cold shock	*	*****	*****
7. What to do on initial immersion in cold water	*	***	***
9. Understanding of tides	*	*	***
10. What to do when trapped by a tide	*	***	***
12. Knowledge of rip currents	*	***	***
13. What to do if caught by a rip current	*	***	***
Overall Awareness	*	*****	*****
8. Confidence: knowing what to do if falling into cold water	*	***	***
11. Confidence: knowing what to do if trapped by tide	*	***	***
14. Confidence: knowing what to do in a rip current	*	*****	***
Overall Confidence	*	*****	*****

***** = significant improvement compared to pre-intervention scores, with a medium effect size

In accepting our original hypothesis, that children would improve their understanding of water safety as a result of a lesson and retain critical aspects

of that lesson, we have demonstrated that such a lesson can improve the knowledge, understanding, and self-confidence of children with respect to the threats associated with water immersion. Importantly, these improvements in water-safety knowledge were retained for at least six months. Thus, the current findings assure those engaged in teaching young people water safety skills that, provided their water safety messaging is simple and focussed, it can be learnt and retained for a substantial time period. Given the simple nature of the practical advice taught, it is not unreasonable to assume that these "lessons for life" might be retained permanently, but this requires confirmation via a longitudinal study to determine if "refresher" lessons are required and, if so, how often. The available evidence from other areas suggested that, contrary to popular belief, much of the knowledge taught in the classroom was retained.

Custers (2010) concluded that in the general educational domain as well as in medical education, approximately 66-75% of knowledge gained was retained for one year with a further decrease to slightly below fifty percent in the next year. Increasing the level of original learning improves retention, as did the absolute level of ability of pupils and instructional strategies adjusted to the age and ability of pupils (Semb & Ellis, 1994; Lindsey et al., 2014). Spaced learning (i.e., reiteration after a retention period) also assisted with retention (Roediger et al., 2019). These findings pointed towards achieving as high a level of initial water safety knowledge in the classroom as possible and then reinforcing the messages, adjusted for changing age and ability on an annual basis.

A similar pattern was observed for most of our results; as a group, the children improved their water safety knowledge because of the lesson and then retained that knowledge or had only a slight reduction in its level over the next 3-6 months (Table 4). This pattern was supported by the results of the total awareness scores which showed that overall, the water safety intervention improved awareness of the issues presented and that, for the most part, this information was retained following a three-to-six-month period. It is worth noting that for the majority of the questions, the effect sizes between the pre- and post-, and the pre- and three-month post-assessments, post-test scores decreased very slightly. This suggested that, as a group, only a small amount of knowledge was not retained over these periods and that children may benefit from a periodic reminder of water safety messages.

The one exception to the general pattern was the topic of tides (Questions 9 & 10). No significant improvement in the pupils' awareness of what tides are was found immediately following the intervention, yet a small improvement was found at the three-month post-intervention assessment. This suggested that perhaps some additional learning, or the opportunity to apply the knowledge, had occurred between these time points and improved the pupils' understanding of the material. These results highlighted the clear advantage of

periodic assessment of the impact and efficacy of such interventions; such assessments also highlighted areas in the taught material that might be improved in terms of content or delivery. They also acted as a reminder of the water safety messages.

Importantly, the results of the questionnaire also identified an increase in the confidence children had in their ability to deal with specific water safety hazards, and in their overall level of confidence. This confirmed that the knowledge gained from the taught content of the lesson translated into knowing what to do to mitigate the risks associated with immersion. Future studies should also examine the extent to which greater theoretical knowledge and confidence translate into behavioural change in a practical situation.

A word of caution is warranted; others (e.g., Button et al., 2018) have tested children's water survival competencies on six tasks: knowledge, buoyancy, submersion, simulated rescue, negotiating obstacles, and propulsion. Regarding knowledge, the authors reported that, to a variable and modest extent between tasks and individuals, children improved their overall knowledge from pre- to immediately post-being taught, but the improvement was not apparent 10 weeks later. A major difference between the present study and that of Button et al. (2018) was the age of the children tested with Button and colleagues testing 7-11-year-olds. It is possible that older children retained and translated water safety theory more effectively whereas children "learn by doing" at an earlier age. Educational theory suggested differences in learning abilities with age (Bruner, 1966; Piaget, 1964), but little specifically related to learning water safety theory has been published.

Terzidis et al. (2007) examined age-specific changes in knowledge of, and attitudes towards, water safety following a school-based intervention in Greece. These authors investigated 5-6-, 7-11-, and 12-15-year-old children. Over one month, age-specific knowledge and attitude assessment questionnaires, and age-adjusted water safety educational materials were developed and delivered, and pre- and post-delivery testing was undertaken. The water safety materials included a short audio-visual presentation followed by discussion on the personal experiences of children, comments on how relevant events could have been averted, and/or drama plays. Take-home materials included leaflets, crosswords, stickers, and badges with water safety messages. The interventions resulted in considerable positive change in knowledge and attitude towards water safety in the youngest age group (i.e., children younger than7-years) but these benefits were less evident, or absent, in older children.

Ramos et al. (2018) examined the efficacy of an existing 1.5-hour practical, in-school water safety educational programme in 229 schools in Vietnam. The programme included knowledge and skills related to safe self-

rescue and bystander rescue. The authors collected 40,198 pre- and post-intervention paper and online questionnaires from 5-11-year old children. The questionnaires included eight questions on water safety based on the main concepts delivered in the course. The results indicated that, overall, a significant change in scores occurred with an acceptable effect size between measures.

On the basis of these contradictory findings, it seems reasonable to conclude that the effectiveness of taught educational programmes on water safety can vary with the design of the programme and the age and culture of the group taught. Therefore, it is difficult to generalise the effectiveness of a given intervention from one group to another, especially if those groups differ in terms of their age or culture. This suggests that the impact of such interventions should be evaluated wherever possible in order to confirm efficacy and refine the water safety messaging and approach to teaching. As noted, periodic ongoing assessment will help determine the retention of the critical messaging and act as a refresher.

We concluded that a short, simple, one-off taught water safety programme significantly increased the lifesaving water safety knowledge of 13–14-year-old children in the UK and could equip them with the confidence that they know what to do in an emergency, or to mitigate one. This knowledge endured for at least 3-6 months, but reiterating these simple, key safety messages might help to ensure they are retained into adult life.

Given the burden represented by fatal and non-fatal drowning around the globe, one 25-minute lesson on water safety, repeated occasionally, does not seem too great a price to reduce this burden and help people to help themselves. Such a lesson should be an integral part of national educational curricula.

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