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USE OF THE UNDERWATER ADAPTATION VISUAL INDEX AS A MONITORING TOOL FOR BEGINNER SWIMMING STUDENTS

UTILIZAÇÃO DO ÍNDICE VISUAL DE ADAPTAÇÃO SUBAQUÁTICA COMO FERRAMENTA DE MONITORAMENTO DO ALUNO INICIANTE NA NATAÇÃO

USO DEL ÍNDICE VISUAL DE ADAPTACIÓN SUBACUÁTICA COMO HERRAMIENTA DE SEGUIMIENTO PARA NADADORES PRINCIPIANTES

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ABSTRACT

Swimming requires the development of underwater vision, a process fostered by activities that encourage facial relaxation, the gradual opening of the eyes, and comfortable submersion. Facial expressions, eye-opening, and exploratory behavior are believed to serve as observable indicators of underwater visual adaptation. This study aimed to present a pedagogical tool capable of providing a practical, observational measure of visual adaptation to the underwater environment. This tool contributes to swimming instruction, aquatic adaptation, and drowning prevention by assessing facial expressions, eye-opening, comfort during submersion, and interaction with the aquatic environment. The sample consisted of 80 students divided into eight classes (averaging 10 students per class), aged 10 to 13 years. Assessments of underwater visual capability were conducted using the Underwater Adaptation Visual Index (UAVI) at two time points: on the first day of class (during the administration of the Water Familiarity Test) and after a 12-week intervention (during the re-assessment). The UAVI assessment covers ten body regions—eyes, eyebrows, mouth, forehead, cheeks, face, neck, shoulders, breathing, and body—assigning one point for each item corresponding to a behavioral sign of adaptation. With ten items evaluated, the score ranges from 0 to 10 points. The evaluator assigns one point for each item correctly recorded based on observed behaviors and compares the student against the scale's visual reference standards. If an observed characteristic corresponded to signs of maladaptation, a score of 0 was assigned. At the end of the assessment, the points were summed to determine the student's level of underwater visual adaptation. The higher the number of correct responses, the better the student's level of adaptation to underwater vision. The results indicate that the UAVI has potential pedagogical application in swimming instruction, as it allows for the visual monitoring of students' underwater adaptation progress through simple, observable, and easily interpretable indicators. In addition to aiding in the tracking of the learning process, the instrument can contribute to planning individualized activities that respect each participant's pace of adaptation and foster the development of essential aquatic skills related to safety in the water. Although the UAVI was not developed to predict drowning risk, progress in underwater visual adaptation can contribute to the development of safer behaviors in the water, thereby increasing the participant's autonomy during aquatic activities.

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Keywords: Aquatic Safety. Visual Adaptation. Aquatic Competence. Swimming. Drowning.

RESUMO
Para nadar, é necessário desenvolver a visão subaquática, que ocorre por meio de atividades que estimulam a descontração facial, a abertura gradual dos olhos e a permanência confortável em situação de submersão. Acredita-se que as expressões faciais, a abertura dos olhos e o comportamento exploratório podem funcionar como indicadores observáveis da adaptação visual subaquática. O objetivo deste estudo foi apresentar uma ferramenta pedagógica capaz de fornecer uma medida prática e observacional da adaptação visual ao ambiente subaquático, contribuindo para o ensino da natação, para a adaptação ao meio líquido e para a prevenção de afogamentos, por meio da observação das expressões faciais, da abertura dos olhos, do conforto durante a submersão e da interação com o ambiente aquático. A amostra foi composta por 80 alunos distribuídos em oito turmas, com média de 10 alunos por turma e idade entre 10 e 13 anos. As avaliações da capacidade de visão subaquática foram realizadas utilizando a ferramenta de avaliação denominada Índice Visual de Adaptação Subaquática (IVAS), em dois momentos: no primeiro dia de aula, durante a aplicação do Teste de Aquacidade, e após 12 semanas de intervenção, durante a reavaliação. De forma completa, a avaliação com o Índice Visual de Adaptação Subaquática foi baseada em dez regiões corporais olhos, sobrancelhas, boca, testa, bochechas, rosto, pescoço, ombros, respiração e corpo, considera cada item com 1 ponto correspondente ao sinal comportamental de adaptação. Com 10 itens avaliados, o escore varia de 0 a 10 pontos. O avaliador atribui um ponto para cada item registrado corretamente, de acordo com os comportamentos observados, e compara o aluno com os padrões visuais de referência da escala. Quando a característica observada correspondia aos sinais de inadaptação, era atribuído 0 ponto. Ao final da avaliação, os pontos eram somados para determinar o nível de adaptação visual subaquática do aluno. Quanto maior o número de acertos, melhor o nível de adaptação à visão subaquática do aluno. Os resultados incicam que o IVAS apresenta potencial aplicação pedagógica no ensino da natação, uma vez que permite monitorar visualmente a evolução da adaptação subaquática dos alunos por meio de indicadores simples, observáveis e de fácil interpretação. Além de auxiliar no acompanhamento do processo de aprendizagem, o instrumento pode contribuir para o planejamento de atividades individualizadas, respeitando o ritmo de adaptação de cada praticante e favorecendo o desenvolvimento de competências aquáticas essenciais relacionadas à segurança no meio líquido. Embora o IVAS não tenha sido desenvolvido para predizer o risco de afogamento, a evolução da adaptação visual subaquática pode contribuir para o desenvolvimento de comportamentos mais seguros no meio líquido, ampliando a autonomia do praticante durante atividades aquáticas.

Palavras-chave: Segurança Aquática. Adaptação Visual. Aquacidade. Natação. Afogamento.

RESUMEN
Para nadar, es necesario desarrollar la visión subacuática, lo cual se logra mediante actividades que estimulan la relajación facial, la apertura gradual de los ojos y la inmersión cómoda. Se cree que las expresiones faciales, la apertura de los ojos y el comportamiento exploratorio pueden funcionar como indicadores observables de la adaptación visual subacuática. El objetivo de este estudio fue presentar una herramienta pedagógica capaz de proporcionar una medida práctica y observacional de la adaptación visual al medio subacuático, contribuyendo a la enseñanza de la natación, la adaptación al medio acuático y la prevención de ahogamientos, a través de la observación de las expresiones faciales, la apertura de los ojos, la comodidad durante la inmersión y la interacción con el medio

acuático. La muestra estuvo compuesta por 80 estudiantes distribuidos en ocho clases, con un promedio de 10 estudiantes por clase y edades comprendidas entre los 10 y los 13 años. Las evaluaciones de la capacidad de visión subacuática se realizaron utilizando la herramienta de evaluación denominada Índice de Adaptación Visual Subacuática (IAVS), en dos momentos: el primer día de clase, durante la aplicación de la Prueba de Acuaticidad, y después de 12 semanas de intervención, durante la reevaluación. La evaluación completa con el Índice de Adaptación Visual Subacuática (IAVS) se basó en diez regiones corporales: ojos, cejas, boca, frente, mejillas, cara, cuello, hombros, respiración y cuerpo. Cada elemento se considera con 1 punto correspondiente al signo conductual de adaptación. Con 10 elementos evaluados, la puntuación oscila entre 0 y 10 puntos. El evaluador asigna un punto por cada elemento registrado correctamente, de acuerdo con los comportamientos observados, y compara al estudiante con los estándares de referencia visual de la escala. Cuando la característica observada correspondía a signos de mala adaptación, se asignaban 0 puntos. Al final de la evaluación, se sumaron los puntos para determinar el nivel de adaptación visual subacuática del estudiante. Cuanto mayor sea el número de respuestas correctas, mejor será el nivel de adaptación del estudiante a la visión subacuática. Los resultados indican que el Índice de Adaptación Visual Subacuática tiene una aplicación pedagógica potencial en la enseñanza de la natación, ya que permite el monitoreo visual de la evolución de la adaptación subacuática de los estudiantes a través de indicadores simples, observables y fáciles de interpretar. Además de facilitar el seguimiento del proceso de aprendizaje, el instrumento puede contribuir a la planificación de actividades individualizadas, respetando el ritmo de adaptación de cada participante y favoreciendo el desarrollo de habilidades acuáticas esenciales relacionadas con la seguridad en el agua. Si bien el IAVS no fue diseñado para predecir el riesgo de ahogamiento, la evolución de la adaptación visual subacuática puede contribuir al desarrollo de comportamientos más seguros en el agua, aumentando la autonomía del participante durante las actividades acuáticas.

Palabras clave: Seguridad Acuática. Adaptación Visual. Actividades Acuáticas. Natación. Ahogamiento.

1 INTRODUCTION

According to the Ministry of Health, vision is one of the most important senses for the human body and a primary means of interacting with the environment, as approximately 80% of the information an individual receives is obtained through it. Furthermore, it plays an essential role in how a person interacts with the world around them. The eyes capture light and transform it into signals interpreted by the brain, enabling the perception of shapes, colors, movement, and depth. This capability not only helps humans understand their environment but also directly influences learning and safety in daily activities, such as performing tasks, walking, and swimming.

Swimming requires the development of underwater vision, a process fostered by activities that encourage facial relaxation, the gradual opening of the eyes, and the ability to remain submerged comfortably. For many beginners, this is a progressive adaptation process. Being able to keep one's eyes open without intense discomfort or the frequent urge to rub one's face is a significant indicator of progress. Moreover, calmly submerging the face promotes greater comfort, confidence, and familiarity with the aquatic environment (Vasconcellos, 2024).

Keeping one's eyes open—without goggles—to retrieve objects from the pool floor or move through the water has been used by researchers in Spain (Morgado *et al.*, 2020) as a way to assess the practitioner's level of adaptation to the aquatic environment (Vasconcellos, 2015).

The ability to see underwater is a key skill in the process of adapting to the aquatic environment and is part of the Aquacity Test (Vasconcellos *et al.*, 2017), used by Brazilian researchers at the Rio de Janeiro State University (UERJ) (Vasconcellos & Caloiero, 2025). The ability to swim without goggles is considered an essential aquatic skill in both sports (Rejman *et al.*, 2024) and recreational activities—such as horizontal underwater breath-hold swimming, where the competitive goal is to cover the greatest possible distance on a single breath with eyes open (Vinetti *et al.*, 2025). In a sports context, whenever possible, swimming instruction should begin without the use of goggles; this is not intended to hinder learning but rather serves as a pedagogical strategy aimed at developing water confidence and visual adaptation to the underwater environment.

According to Rejman *et al.* (2024), the habit of constantly swimming with goggles eliminates some of the physical and psychological discomfort associated with direct eye contact with the water. Consequently, the swimmer may become dependent on this

equipment, compromising their ability to adapt to unexpected situations where they might be in the water without goggles. This dependency can pose a risk, particularly in aquatic emergencies.

During initial lessons, activities requiring swimmers to submerge and retrieve objects are common (Duijn *et al.*, 2022). However, many swimmers still show reluctance to open their eyes underwater, reporting discomfort or a burning sensation caused by chlorine. This discomfort is relatively common during the early stages of learning to swim and is part of the process of visual adaptation to the aquatic environment (Vasconcellos & Viana, 2024), especially in pools treated with chemicals that can cause eye irritation. Furthermore, improper concentrations of chlorine and its by-products can also cause eye and nasal discomfort (Vasconcellos & Nascimento, 2023).

Rejman *et al.* (2024) warn that reliance on swimming goggles can be dangerous; therefore, they recommend that swimming without goggles be addressed as an independent component of aquatic competence from the early stages of learning. Thus, visual adaptation to the aquatic environment should be incorporated into the process of developing water confidence from the very beginning.

The development of this adaptation may occur at different rates among individuals, sometimes requiring personalized pedagogical strategies.

For this to occur effectively, pedagogical patience and—often—shifts in teaching perspective are required, as developing visual adaptation may take longer for some students. The use of goggles should be considered only in situations where initial learning without this aid poses a significant limitation for the swimmer (Rejman *et al.*, 2024).

During the intermediate and advanced stages of learning, careful observation is recommended to determine the right moment to introduce goggles without fostering dependency. According to Rejman *et al.* (2024), the most appropriate time to use them is when the student no longer perceives significant differences between swimming with and without goggles, particularly regarding the maintenance of rhythmic breathing and comfort during the activity.

In this context, conducting initial lessons with a pedagogical approach focused on familiarization with the aquatic environment is important (Criel *et al.*, 2025); lessons without goggles can facilitate visual adaptation to the water. Following this initial phase—the duration of which varies based on the methodology used and the students' individual characteristics—the use of goggles is recommended to minimize discomfort during practice. This process

should be gradual, progressive, and individualized, respecting each swimmer's pace of adaptation (Vasconcellos & Nascimento, 2023).

The ability to see underwater is a fundamental skill for learning to swim and for adapting to the aquatic environment. When properly developed, it improves spatial awareness, aids body orientation while moving through the water, and contributes to a greater sense of security (Vasconcellos, 2024). Conversely, when a student is unable to open their eyes naturally while submerged, difficulties may arise regarding breath control and the sensation of the “underwater (in)visible”—characterized by the perceived inability to see underwater (Vasconcellos, 2024). This condition can heighten insecurity and hinder exploration of the aquatic environment. When a student avoids looking around, seeks to surface quickly, and displays insecurity, they likely exhibit poor adaptation to underwater vision.

It is believed that facial expressions, eye-opening, and exploratory behavior can serve as observable indicators of underwater visual adaptation (Vasconcellos, 2026).

To date, there is no known specific visual index of underwater adaptation designed to assess swimmers. Thus, the aim of this study was to present a pedagogical tool capable of providing a practical, observational measure of visual adaptation to the underwater environment, thereby contributing to swimming instruction, aquatic adaptation, and drowning prevention through the observation of facial expressions, eye-opening, comfort during submersion, and interaction with the aquatic environment.

2 METHODOLOGY

This cross-sectional study aimed to develop an observational instrument for assessing underwater visual adaptation. It was conducted between 2022 and 2026 with adolescents enrolled in the 6th and 7th grades of elementary/middle school at the Instituto de Aplicação Fernando Rodrigues da Silveira (CAp-UERJ), part of the Rio de Janeiro State University (UERJ), Brazil.

CAp-UERJ has approximately 1,140 enrolled students, distributed across grades ranging from the 1st year of elementary school to the 3rd year of high school, totaling 48 classes. After reviewing class schedules for each grade level, the 6th and 7th-grade classes were selected because they were available during the afternoon shift, which coincided with the scheduled use of the pool at UERJ's Maracanã Campus.

The sample consisted of 80 students distributed across eight classes, with an average of 10 students per class and ages ranging from 10 to 13 years. The selection also took into account that this age group is at higher risk of drowning due to lower perception and awareness of risks associated with the aquatic environment (Xie *et al.*, 2022). Most drownings are preventable, and prevention remains the most effective intervention (Gianfrancesco & Sternard, 2025), especially when implemented by health professionals (Harries, 2025).

The classes followed the methodology of the “Natação + Segura” (Safer + Swimming) program (Vasconcellos & Massaud, 2022), which consists of a three-month program totaling 12 weeks, with one 60-minute class per week.

The pool used in the study measured 18 meters in length by 8 meters in width, with a depth ranging from 1.20 m in the shallow end to 1.80 m in the deep end. The facility featured handrails along the sides of the pool, providing support for students during activities, as well as the constant presence of lifeguards monitoring every class.

Activities took place predominantly in the shallow end of the pool. In specific instances, students were guided to the deep end to carry out pre-planned pedagogical activities.

Inclusion criteria were as follows: being a 6th or 7th-grade student at CAp-UERJ; having a guardian available to transport the student to and from swimming classes at the UERJ Maracanã Campus (located 3.3 km from CAp-UERJ); completing a health history assessment (Vasconcellos, 2023a); filling out the medical clearance form (Vasconcellos, 2023b); completing the Drowning Prevention Knowledge Level test (Vasconcellos *et al.*, 2025); and signing the image usage consent form. Accumulating three absences during the 12-week course served as an exclusion criterion.

Underwater visual capability was assessed using the Underwater Adaptation Visual Index tool at two points in time: on the first day of class during the administration of the Water Familiarity Test, and after the 12-week intervention during the re-evaluation.

Following the administration of the Water Familiarity Test to students across the eight swimming classes, the underwater photographs taken between 2022 and 2026 were compiled. A GoPro Hero 10 Black underwater camera was used to capture the images.

The Underwater Adaptation Visual Index assessment was conducted while students were voluntarily submerged and not wearing swimming goggles, focusing on the following behavioral indicators: a) eye opening; b) facial relaxation; c) duration of submersion; d) spatial orientation; and e) interaction with the aquatic environment. When fully assessed, the evaluation using the Underwater Adaptation Visual Index was based on ten body regions

(eyes, eyebrows, mouth, forehead, cheeks, face, neck, shoulders, breathing, and body), with each item assigned 1 point corresponding to the behavioral sign of adaptation as shown in Table 1.

With 10 items assessed, the score ranges from 0 to 10 points. The evaluator assigns one point for each item correctly recorded based on observed behaviors and compares the student against the scale's visual reference standards. A score of 0 points is assigned when the observed characteristic corresponds to signs of maladaptation. At the end of the assessment, the points are summed to determine the student's level of underwater visual adaptation. The higher the score, the better the student's level of underwater visual adaptation.

Based on the score distribution, the Underwater Adaptation Visual Index is organized into five classification levels: 0 to 2 points (very poor underwater visual adaptation); 3 to 4 points (poor); 5 to 6 points (moderate); 7 to 8 points (good); and 9 to 10 points (excellent).

In a summarized assessment, students exhibiting the following behaviors can be considered adapted to underwater vision: (1) spontaneously keeping their eyes open while submerged; (2) facial and body relaxation; (3) visual exploration of the aquatic environment; (4) facial expressions associated with joy, curiosity, or satisfaction; and (5) natural retrieval of submerged objects.

Conversely, students exhibiting one or more of the following behaviors are considered maladapted to underwater vision: (1) avoiding opening their eyes or keeping them closed while submerged; (2) facial and body tension; (3) evident fear or discomfort while submerged; (4) difficulty with underwater spatial orientation; and (5) avoiding visual exploration or the retrieval of submerged objects.

The established levels allow for comparing the student's progress between the initial assessment and the re-assessment conducted after 12 weeks of classes, in addition to enabling the identification of the current stage of underwater visual adaptation. The predominant indicators for each level were summarized as follows: at Level 1, the student is unable to use vision to explore the aquatic environment; at Level 2, the student tolerates opening their eyes but still shows signs of insecurity; at Level 3, vision begins to aid in body orientation during submersion; at Level 4, vision is used functionally and comfortably in the aquatic environment; and at Level 5, underwater vision is fully integrated into aquatic behavior, enabling safe, efficient, and enjoyable exploration, spatial orientation, and interaction with the environment.

2.1 INSTRUMENT

Table 1 presents the main facial and body signs used as a reference for classifying participants according to the Underwater Adaptation Visual Index.

The total score corresponds to the sum of the ten indicators, ranging from 0 to 10 points. Higher scores indicate better adaptation to underwater vision. Thus, the Underwater Adaptation Visual Index was classified as follows: 0 to 2 points, very poor; 3 to 4 points, poor; 5 to 6 points, moderate; 7 to 8 points, good; and 9 to 10 points, excellent, as shown in Table 2.

Table 1

Observational indicators used to construct the Underwater Adaptation Visual Index

Body indicator	Underwater Vision Adaptation Characteristic	Points
1. Eyes	Open, stable, and oriented towards the aquatic environment.	1 point
2. Eyebrows	Relaxed, in a neutral position	1 point
3. Mouth	Relaxed, smiling, or exhaling naturally.	1 point
4. Forehead	Smooth or with few wrinkles	1 point
5. Cheeks	Lifted by a smile or relaxed	1 point
6. Face	An expression of comfort, fun, or tranquility.	1 point
7. Neck	Relaxed, aligned with body movement	1 point
8. Shoulders	Relaxed, following the body's natural movement.	1 point
9. Breathing	Controlled exhalation during submersion	1 point
10. Body	Fluid and natural movements	1 point
Total Score: Underwater Adaptation Visual Index		**0–10 Points**

Source: The Authors.

Table 2

Summary classification of Underwater Adaptation Visual Levels

Level	Points	Visual Adaptation Category	Predominant indicator	Main Action
1	0–2	Very Weak	Muscle tension and fear	Immediate escape to the surface
2	3–4	Weak	Moderate discomfort	Opens their eyes very quickly
3	5–6	Moderate	Neutral expression	Start of visual exploration
4	7–8	Good	Relaxed and comfortable	Orientation and object recovery
5	9–10	Excellent	Spontaneous smile and fun	Water interaction and total confidence

Source: The Authors.

Similarly, the Visual Index of Underwater Maladaptation was characterized by ten observational indicators: (1) eyes closed, half-closed, or frequently blinking; (2) eyebrows raised or contracted, indicating tension; (3) mouth excessively open, tense, or biting the lips; (4) forehead furrowed or with pronounced wrinkles; (5) cheeks retracted or tense; (6) face

grimacing or showing an expression of discomfort, worry, or fear; (7) neck rigid or excessively extended; (8) shoulders raised, contracted, or hunched; (9) breathing involving breath-holding or excessive air retention; and (10) body exhibiting rigidity and abrupt movements.

Presented below is a series of photographs illustrating students with varying levels of underwater visual adaptation—based on the Underwater Adaptation Visual Index which were used to categorize the students.

Figure 1

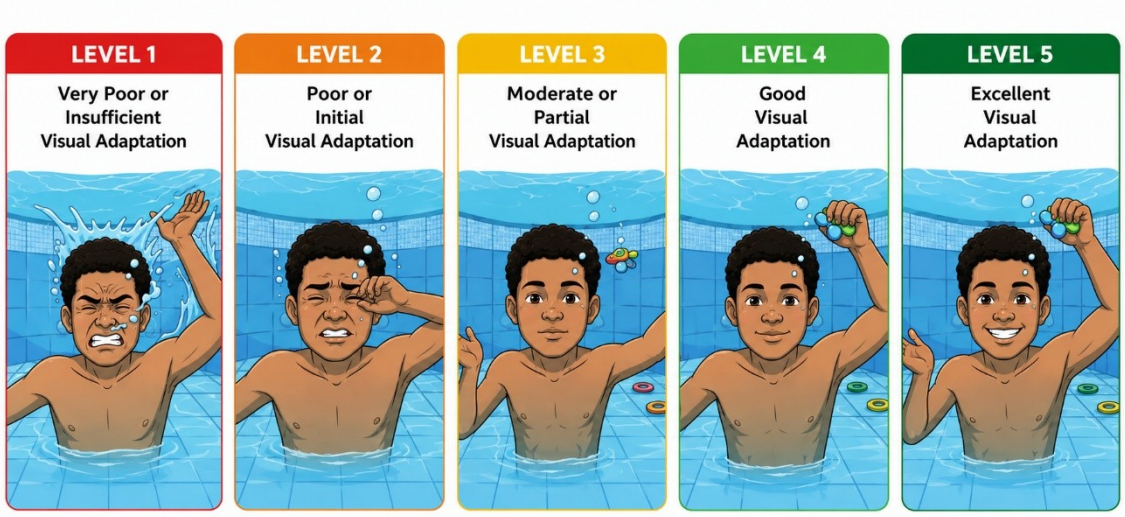
Example of five students used to create the Underwater Adaptation Visual Index

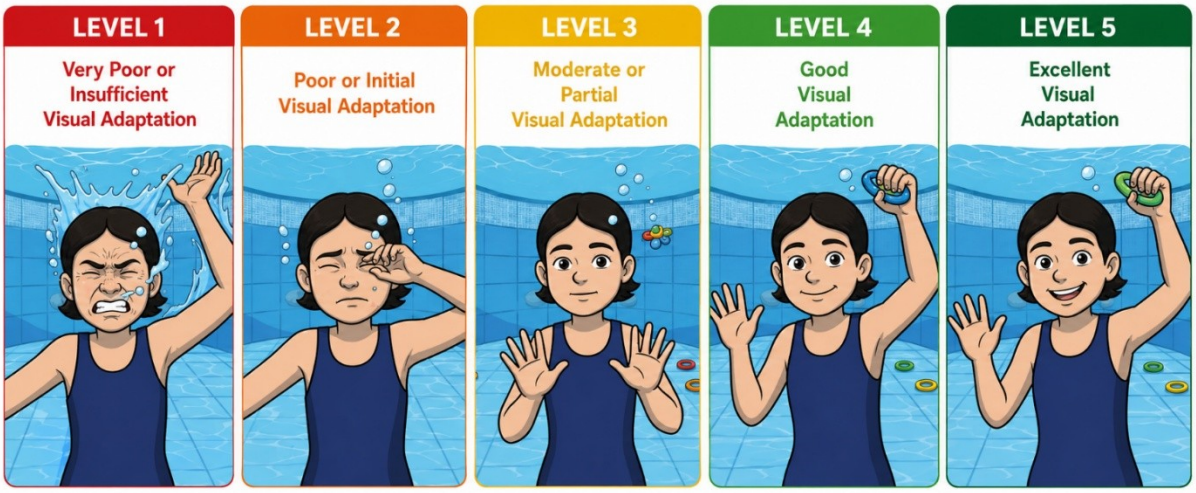


Source: The Authors.

Figure 2

Scale of Underwater Visual Adaptation Levels for boys and girls





Source: The Authors.

To use the assessment tool, the teacher must focus on four actions. The first involves observing behavior during submersion; the second, analyzing facial, visual, and behavioral cues; the third, identifying the level that best represents the predominant behavior; and finally—no less importantly—using the result to monitor the progression of visual adaptation throughout the lessons.

At Level 1, designated as Very Weak or Insufficient Visual Adaptation, the student's observable characteristics are: 1) eyes closed during submersion; 2) facial expression of fear or discomfort; 3) evident facial muscle tension; 4) immediate attempts to return to the surface; and 5) avoidance of looking at the underwater environment. At this level, the teacher will observe that the student exhibits high sensitivity to visual contact with the water and demonstrates low tolerance for submersion.

At Level 2, designated as Weak or Initial Visual Adaptation, the student's observable characteristics are: 1) opens eyes for very short periods; 2) blinks excessively after surfacing; 3) demonstrates moderate visual discomfort; 4) focuses attention on exiting the water; and 5) engages in little visual exploration of the environment. At this level, the teacher will observe initial contact with the underwater environment, albeit still accompanied by discomfort and limited visual exploration.

At Level 3, designated as Moderate or Partial Visual Adaptation, the student's observable characteristics are: 1) keeps eyes open during part of the submersion; 2) is able to observe nearby objects; 3) displays a neutral facial expression; 4) tolerates remaining submerged for a few seconds; and 5) begins visual exploration of the environment. At this

level, the teacher will observe that the student demonstrates intermediate adaptation, being capable of using underwater vision for simple tasks.

At Level 4, designated as Good Visual Adaptation, the student's observable characteristics are: 1) keeps eyes open throughout the entire submersion; 2) demonstrates visual comfort; 3) orients themselves adequately in the pool; 4) retrieves objects without difficulty; and 5) displays a relaxed facial expression. At this level, the instructor will observe that the student uses underwater vision functionally for spatial orientation and task performance.

At Level 5, designated as Excellent Visual Adaptation, the student's observable characteristics are: 1) eyes completely open and relaxed; 2) spontaneous smile or expression of enjoyment; 3) demonstrates confidence and ease; 4) interacts with the camera or makes voluntary gestures; and 5) maintains efficient spatial orientation to explore the aquatic environment. At this level, the instructor will observe that the student has mastered underwater visual adaptation, using their vision with confidence, comfort, and autonomy.

The teacher can use the Underwater Adaptation Visual Level Scale in three ways. The first and simplest method involves using only the images from Levels 1 and 5 to represent, in a dichotomous manner, whether or not students exhibit underwater visual adaptation. In this case, very poor or insufficient visual adaptation is represented by Level 1 (no visual adaptation), while excellent visual adaptation is represented by the characteristics of Level 5 (visual adaptation present).

The second method involves categorizing the student into three levels: unadapted, in the process of adapting, and adapted. To do this, the teacher uses the images and characteristics presented in Level 1 to classify a student as having very poor or insufficient visual adaptation; Level 3 for average or partial visual adaptation; and Level 5 for excellent visual adaptation.

The third and most comprehensive method involves categorizing the student into five levels: Very Poor Visual Adaptation, Poor Visual Adaptation, Average Visual Adaptation, Good Visual Adaptation, and Excellent Visual Adaptation. For this, the teacher uses the five images corresponding to levels 1 through 5, as shown in Figure 2.

Using all five levels offers an advantage for teachers who wish to track gradual changes in visual adaptation to the aquatic environment—changes that would not be identified by a dichotomous classification limited to “adapted” and “unadapted” categories. Between these two extremes lies a developmental continuum that can be explored in greater

detail, allowing for the monitoring of small improvements in student behavior throughout the learning process. Thus, it is up to the teacher to choose the strategy for using the tool that best suits the assessment objectives and the characteristics of their pedagogical practice.

3 DISCUSSION

Primary prevention of drowning (Pajares *et al.*, 2025) requires the adoption of multiple strategies, including participation in swimming lessons (Farrell & Shenoi, 2025), which teach safe behaviors, attitudes, and procedures in the aquatic environment (Vasconcellos & Blant, 2026). These lessons can equip children with skills to enhance their water safety (Blazovic *et al.*, 2023), anticipate risky situations (Ortiz & Moreno, 2024), and reduce the risk of morbidity and mortality (Gianfrancesco & Sternard, 2025). Above all, they allow for the identification of students with lower levels of aquatic adaptation—a condition that may warrant increased pedagogical attention during the teaching process.

Swimming instruction and the development of a curriculum to guide the integration of water safety education from kindergarten through high school should be a universal recommendation (Pressley & McDonald, 2026).

Beyond being ubiquitous, swimming requires constant monitoring (Vasconcellos *et al.*, 2026). In this regard, researchers have been developing assessment tools for beginner swimmers within the “Safer Swimming” (Natação + Segura) methodology to make student progress more measurable, tangible, and objective (Vasconcellos, 2025). One such proposal is the development of the Underwater Adaptation Visual Index test.

An analysis of images of beginner swimmers who struggled to open their eyes while submerged revealed a striking resemblance in the gestures, facial expressions, and body postures of participants at similar stages of visual adaptation to the aquatic environment.

It was also observed that as the level of underwater visual adaptation improved, there were progressive changes in the facial and body expressions captured in the photographs. By the end of the 12-week course, many students who were already naturally opening their eyes underwater displayed expressions associated with comfort, tranquility, curiosity, and joy during submersion.

A systematic analysis of hundreds of photographs and videos made it possible to identify ten body regions where observable changes occurred that were potentially linked to the process of adapting to underwater vision. These regions served as the basis for developing the Underwater Adaptation Visual Index.

The ten body regions were selected through an observational analysis of the photographic records and discussions among the researchers, focusing on the body segments that showed the most frequent changes distinguishing students who had adapted to underwater vision from those who had not.

Five photographs representing different submerged students were selected to cover the main levels of visual adaptation observed during the study. The images predominantly displayed signs associated with underwater visual adaptation, such as open eyes, a relaxed facial expression, raised cheeks (indicating a smile), an absence of neck tension, and relaxed shoulders.

Only the most frequently observed signs were retained for the scale. Subsequently, these photographs were converted into illustrations (cartoons) to visually represent the five levels of the Underwater Adaptation Visual Scale in a playful manner.

Figure 3

Examples of cartoons used to visually represent the five levels of the adaptation scale



Source: The Authors.

To classify the level of underwater visual adaptation, the evaluator transferred the photographs to a computer and compared each image obtained at the start of the program with the one obtained after 12 weeks of intervention, using the reference visual standards from the Underwater Adaptation Visual Scale. Ten body regions were analyzed: eyes, eyebrows, mouth, forehead, cheeks, face, neck, shoulders, breathing, and body.

When a student visually explores the aquatic environment, observes submerged objects, and demonstrates confidence during immersion, it can be inferred that they possess good or excellent underwater visual adaptation. These behaviors indicate that vision is being used functionally for spatial orientation, environmental exploration, and the execution of tasks underwater (Vasconcellos, 2026).

Evidence suggests that better visual capability is associated with superior swimming performance (Fortin *et al.*, 2022). During lessons, the instructor can use observations of students' facial expressions and behaviors as key indicators of their level of adaptation to the aquatic environment. Adapted individuals typically display physical signs associated with joy, fun, satisfaction, curiosity, and muscle relaxation. Conversely, students who are not yet adapted tend to show expressions linked to worry, nervousness, or fear, revealing heightened facial and bodily tension.

Thus, systematically observing these manifestations can assist the instructor in identifying individual student needs, enabling more appropriate pedagogical interventions and fostering a safe, enjoyable, and progressive adaptation to the aquatic environment.

In unexpected submersion situations, the ability to open one's eyes and orient oneself visually within the aquatic environment can contribute to more effective responses, increasing the swimmer's autonomy and reinforcing self-protection behaviors in the water.

Another skill that relies on underwater vision is the retrieval of submerged objects. This activity contributes not only to stimulating visual adaptation but also to the development of the student's autonomy, confidence, and body and spatial awareness. Safely exploring the pool floor allows for a better understanding of the limits of one's own body and the characteristics of the environment in which the participant is immersed.

Thus, retrieving objects from the bottom of the pool without goggles represents a crucial stage in the process of adapting to the aquatic environment and is directly linked to the development of underwater vision. This activity simultaneously stimulates underwater vision, breath control, spatial orientation, and safety during submersion. Gradual and controlled exposure to such exercises fosters the practitioner's visual and emotional adaptation, reducing fear, discomfort, and disorientation in unexpected aquatic situations.

By successfully locating and retrieving submerged objects without goggles, the student demonstrates progress in aquatic adaptation, greater composure during submersion, and improved underwater spatial perception, thereby developing safer behaviors during aquatic activities.

The Underwater Adaptation Visual Index offers potential pedagogical applications in swimming instruction, as it allows for the visual monitoring of students' underwater adaptation progress using simple, observable, and easily interpretable indicators. In addition to aiding in the tracking of the learning process, the tool can assist in planning individualized activities that respect each practitioner's pace of adaptation and foster the development of essential aquatic skills related to safety in the water.

The next stage in the development of the Underwater Adaptation Visual Index tool involves completing the application, which compiles images representing the facial expressions characteristic of each level of underwater visual adaptation. Upon inputting a photograph of a new student during submersion, the system will use artificial intelligence techniques to automatically analyze the image and classify the corresponding level of underwater visual adaptation based on Underwater Adaptation Visual Index criteria.

Although the Underwater Adaptation Visual Index was not designed to predict drowning risk, the ability to open one's eyes, orient oneself spatially, and explore the underwater environment is a key component of adapting to the aquatic environment. Consequently, developing underwater vision can indirectly contribute to safer behaviors in unexpected aquatic situations, enhancing the practitioner's autonomy and responsiveness. A limitation of the study was the development of the UAVI using examples of facial expressions from adolescents. Although the instrument can be used with other age groups, it is expected that future studies will develop versions of the UAVI featuring facial expressions from children, adults, and older adults of both sexes.

4 CONCLUSION

The Underwater Adaptation Visual Index (UAVI) has proven to be an assessment tool with the potential to assist swimming instructors in monitoring the underwater visual adaptation process of beginner students. Based on the observation of facial and bodily indicators recorded during submersion, the instrument allows for the classification of the level of visual adaptation in a simple, objective manner that is easy to apply within a pedagogical context.

Using the UAVI makes it possible to monitor the progression of water confidence throughout the learning process, facilitating the identification of individual student needs and supporting the planning of more appropriate pedagogical interventions. Furthermore, the

instrument expands the scope of swimming assessment by addressing an aspect that has received little attention in the literature: visual adaptation to the underwater environment.

Although the UAVI was not developed to predict drowning risk, progress in underwater visual adaptation can contribute to the development of safer behaviors in the water, thereby increasing the swimmer's autonomy during aquatic activities.

Regarding limitations, it should be noted that the scale was developed based on photographic records of adolescents; future studies are needed to investigate its application across different age groups, skill levels, and teaching contexts, as well as to evaluate its validity, reliability, reproducibility, and sensitivity to change. Strengthening this evidence base could establish the UAVI as a benchmark tool for assessing underwater visual adaptation in swimming instruction.

This study presents a novel approach to assessing underwater visual adaptation, offering swimming instructors a practical tool to monitor a skill fundamental to the development of water confidence and safety in the aquatic environment.

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ANNEXES

ANNEX I – UNDERWATER ADAPTATION VISUAL INDEX (UAVI)

Swimming + Safety Project developed by Dr. Marcelo Barros de Vasconcellos

LEVEL 1 – VERY POOR OR INSUFFICIENT VISUAL ADAPTATION

Observable characteristics

- Eyes closed during submersion.
- Facial expression of fear or discomfort.
- Visible facial muscle tension.
- Immediate attempts to return to the surface.
- Avoids looking at the underwater environment.

LEVEL 2 – POOR OR INITIAL VISUAL ADAPTATION

Observable characteristics

- Opens eyes for very short periods.
- Blinks excessively after surfacing.
- Shows moderate visual discomfort.
- Focuses on exiting the water.
- Minimal visual exploration of the environment.

LEVEL 3 – MODERATE OR PARTIAL VISUAL ADAPTATION

Observable characteristics

- Keeps eyes open during part of the submersion.
- Able to observe nearby objects.
- Displays a neutral facial expression.
- Tolerates remaining submerged for a few seconds.
- Begins visual exploration of the environment.

LEVEL 4 – GOOD VISUAL ADAPTATION

Observable characteristics

- Keeps eyes open throughout the entire submersion.
- Shows visual comfort.
- Orients self adequately in the pool.
- Retrieves objects without difficulty.
- Displays a relaxed facial expression.

LEVEL 5 – EXCELLENT VISUAL ADAPTATION

Observable characteristics

- Eyes completely open and relaxed.
- Spontaneous smile or expression of enjoyment.
- Demonstrates confidence and ease.
- Interacts with the camera or makes voluntary gestures.
- Maintains efficient spatial orientation to explore the aquatic environment.