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Underwater Photography in Primary School

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Abstract: *Underwater photography is one of the most demanding types of photography. An underwater photographer must be a good diver and photographer. Because the physical properties of water are different from aerial ones, it is very difficult to make a technically good image underwater. It takes a lot of patience and time for a technically and compositionally good shot to become a good photo. However, the work of an underwater photographer does not end with coming out of the water, because even on dry land he has a lot of work to do with maintaining fitness, equipment and documenting shots. Modern pedagogy treats photography as an artistic technical science. Underwater photography is a very interesting experience for children. Children are very receptive to novelties and quickly learn new things. Elementary school students acquire certain skills in the photo club. Very rarely, however, do they have the opportunity to gain new experience and knowledge about underwater photography in practice, therefore also underwater. In the research, I wanted to find out if underwater photography could be feasible with students outside of school. The research proved to be very successful. The students achieved positive results despite the more difficult conditions of underwater creation. The influence of the environment (Pristan swimming pool) has obviously contributed to exceptional motivation and a relaxed working atmosphere. Therefore, I do not see any obstacle to conducting a photo circle even outside of school.*

Keywords — **primary school; photography; underwater photography; photo circles; water; swimming pool; research.**

1. INTRODUCTION

As a diver and photographer, I was very impressed by underwater photography. In my research, I tried to present it as best I could as a combination of sport and art.

It is necessary to have photographic knowledge. Above all, a photographer must be an excellent diver with experience, as the mistakes of an inexperienced diver are unpleasantly retaliated against. I must emphasize that the natural environment here is only more dangerous. From this I can conclude that only a good diver can also be a good underwater photographer.

The underwater photographer encounters many of the problems I have presented in the theoretical part (Section 2). Since the underwater photographer encounters physical problems, I have described most of the causes (physical properties of water) that make this type of photography significantly different and unfortunately also technically much more demanding than terrestrial photography. The physical properties of water affect the construction of underwater chambers (hydrostatic pressure, water density, corrosion properties of salty seawater) and cause special optical problems (selective spectral absorption, diffusion, refraction or refraction and reflection or light reflection in water).

In the third practical part of the research, I conducted an underwater photography lesson with the students of the Slava Klavora Maribor Primary School as part of a photo circle. I wanted to find out what form of photo-circle is feasible, how students create and respond. The research was carried out in the Pristan swimming pool (Maribor).

2. THEORY OF PHYSICAL BASES

The underwater photographer encounters many physical problems that make this type of photography significantly different, so unfortunately also technically much more difficult than terrestrial photography. The causes lie in the physical properties of water. These properties can be divided into two types: those that affect the construction of underwater cameras (hydrostatic pressure, water density and its corrosion properties - salt sea water) and those that cause specific optical problems (selective spectral absorption, diffusion, refraction or refraction and reflection of light in water).

Of course, the physical properties of water also affect the diver-photographer himself, and because he encounters a different environment than the land, he must also prepare for it properly. This means following the rules of safe diving, that is, only with a co-diver whom he trusts. Before diving, he must, if necessary, choose the appropriate equipment, depending on the water (hot or cold seas, lakes, rivers…) into which the diver is going.

2.1. Water density and hydrostatic pressure

Density is the mass of a body per unit volume. The density of distilled water at 4°C is exactly 1,000 kg/dm3 (The density depends on the temperature due to the thermal expansion of the bodies. It is usually given at 20°C, but in water it is highest at 4°C). Sea water, which is a solution of various salts, has a slightly higher density (approximately 1.025 kg/dm^3, depending on the amount of dissolved salts - salinity).

Water with its density causes hydrostatic pressure (water pressure per unit area). Pressure is the force acting on a surface unit. The unit of pressure most widely used in diving and underwater photography is Bar (1 Bar is 10 N/cm^2 or 100,000 Pa (Pascals)). The hydrostatic pressure is therefore the pressure of water per unit area. The water causes a hydrostatic pressure of about 1 Bar (depending on salinity and temperature) at a depth of 10m, 20 Bar below the surface of 2

Bar and so on linearly. The hydrostatic pressure at a depth of 100m is therefore 10 Bar.

The hydrostatic pressure works the same in all directions. A force due to pressure acts on the body immersed in water from all sides. The larger the surface area of a submerged body, the greater the force acting on it. The force increases linearly with increasing depth and with increasing body surface area. On an underwater camera with a surface e.g. 2000 cm^2 at a depth of 50 m acts a force of 100.000 N.[1] However, since this force acts from all sides and is evenly distributed, this is significantly more favorable than if it were to act from only one side (for example, if a 10-tonne vehicle were parked on the camera). Nevertheless, this is a very high mechanical load, which underwater camera designers must take into account (Furlan, 1994, p. 27).

2.1.1. Form of underwater cameras and housings

In addition to the thickness and strength of the material, the shape is also very important in underwater constructions. Angularly shaped bodies (eg a cube) tolerate pressure the worst. Surfaces under pressure tend to bend inward, which is a large load for corners.

Cylindrical and spherical bodies work much better (Figure 1). The pressure is most evenly distributed across the sphere and is therefore more difficult to deform. A spherical body can therefore have significantly thinner walls than a cubic one at the same compressive load and the same construction material.

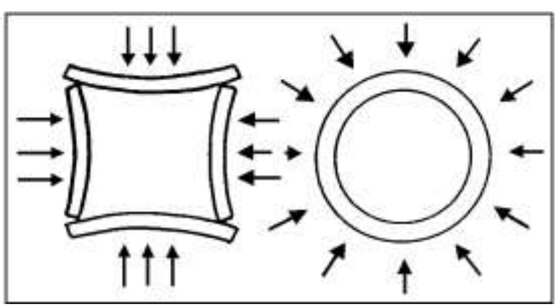

Fig. 1 *At the same underwater pressure, angular bodies (left) deform much more than spherical ones (right).*

Due to its density, water also causes the occurrence of buoyancy. Bodies with the same density as water float in water (neutral buoyancy), sink with higher density (negative buoyancy) and float with lower density (positive buoyancy). When constructing cameras, it is necessary to take into account their weight under water. Ideally, they should almost float, or have slightly negative buoyancy. Too heavy cameras are uncomfortable to use, and too light (floating) ones are completely unacceptable and need to be weighed properly (Furlan, 1994, p. 27-28).

2.1.2. Water resistance

Water resistance or sealing is one of the major problems in the construction of underwater cameras and housings. Gluing, different materials usually does not work underwater. Under the influence of hydrostatic pressure, microdeformations of individual components occur, which are different for different materials. Therefore, the glued surface may crack. This often occurs only after prolonged use (Furlan, 1994, p. 28).

2.2. Water corrosivity

Seawater contains various dissolved inorganic salts. It is mostly sodium chloride (about 78%). The concentration of all salts in the sea (salinity) is on average 3.5%.

Salts are electrolytes and their solutions (sea) conduct electrical current. In the construction of underwater cameras, it is therefore necessary to take care not to cause the appearance of micro galvanic cells - this is a unit of two different metals, between which is the electrolyte. This occurs e.g. with a screw screwed into another material. An electric potential is created between the metals and an electric current flows between them due to the electrolyte. The process of electrolysis begins. A metal with a lower electric potential (positive, anode) emits electrons and passes into the ionic (cationic) state, which is soluble in water. The metal therefore dissolves.

Underwater cameras (also underwater housings) are constructed mainly of aluminum. Aluminum becomes an anode and corrodes electrochemically if combined e.g. with brass. If chrome-plated brass or even better stainless steel is used instead of brass, this process is significantly slower and the combination is acceptable for construction. Nevertheless, the camera must be thoroughly rinsed with fresh water after each immersion in seawater (do not shower, but immerse in fresh water for several hours to remove all traces of salt from all cracks and grooves by permeating it).

Underwater housings constructed of plastics such as plexiglass (polymethylmethacrylate) or lexan (polycarbonate) are unaware of these problems, but are mechanically less solid. Diving in fresh water also does not cause corrosion problems, or they are significantly smaller. Corrosion is also temperature dependent. Cameras are more susceptible to corrosion in tropical seas than in cold seas (Furlan, 1994, p. 29).

2.3. Selective spectral absorption

Clean water is about a thousand times less clear than air. Therefore, light is absorbed on the way through the water. In the purest sea water, about 10% of light penetrates to a depth of 50 m, a little over 1% to a depth of 100 m and less than 0.1% to a depth of 200m.

When shooting with ambient light only, it is necessary to extend the exposure time according to the increasing depth. A

[1] By the term "underwater camera" is meant in this composition also the underwater housings for conventional land cameras.

rapid drop of light in the transition from air to water occurs because part of the light is reflected. With turbulent water and a lower angle of the sun, this leap is even greater.

Not all wavelengths of light (color) are absorbed equally. The phenomenon is called selective spectral absorption. The red light is absorbed the fastest, visually disappearing at a depth of about 5m, followed by orange (up to about 20m), yellow and purple (up to about 30m), green (up to about 40m) and finally blue. The stated depths only roughly show how a color photographic film or digital sensor perceives colors in medium-clear water (Figure 2).

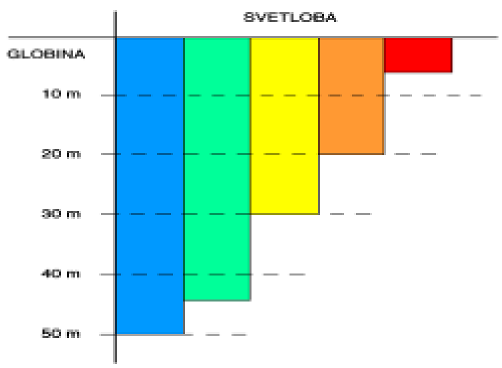

Fig.2 *Display of visual color fading with increasing depth*

When shooting at a depth of 10m, you would almost completely lose the red color, and other colors would get a distinct blue hue. It should be noted that it is not only the depth that matters, but the entire path of light through the water: from the light source (surface) to the object and from the object to the camera (Figure 3).

Fig. 3
(foto: Marko Šebrek, 2003)

The photo was taken in the strong afternoon sun, at a depth of 1m underwater. The sea level was slightly choppy. I did not use any additional light sources. I photographed with Fujicolor Superia X-tra color film (ISO 800) and a focal length of 28mm (Canon Eos 300).

The visual disappearance of the red color on the film is nicely visible with the increasing distance of the person from the camera.
The path of light, in the foreground model, is a total of 2m. Warm colors are still normally visible. For the person in the background, the light has traveled a total of 5m. In this part of the shot, the warm colors almost completely disappear. Blue and green are the predominant colors.

Photographing the same subject at a depth of 4m from a distance of 1m gives color exactly the same results as photographing at a depth of 1m from a distance of 4m. In both cases, the light travels a distance of 5 meters (Figure 4).

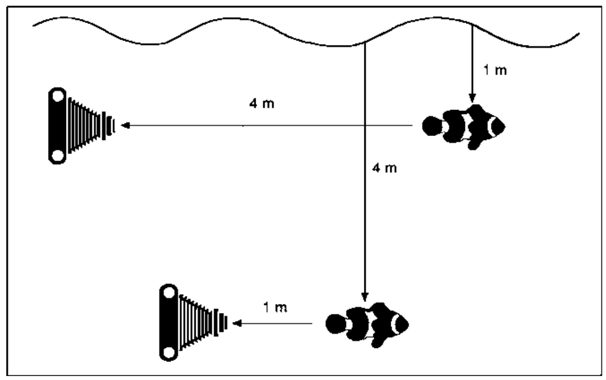

Fig. 4 *The loss of colors is the same in both cases, as it depends on the entire path of light (level - object - camera).*

The problem is avoided in two ways: by using filters or artificial light. Of the filters, red Kodak CC correction filters are the most widely used. The use is awkward (you would need a filter of a certain density for each distance, and changing under water is practically impossible) and unsatisfactory because the missing (red) color is not added, but the excess complementary (blue-green) is removed. The best solution is to add artificial light, which in practice is most easily (and recently almost exclusively) achieved by using underwater electronic flashes. The electronic flash gives a short and intense flash of white light (Furlan, 2003a, p. 23-24).

2.4. Light diffusion in water

Diffusion or the scattering of light in water is the reflection of rays from microparticles distributed in water (Figure 5). These particles can be inorganic (sediment, sand,) or organic (plankton). Light is reflected from these particles on all sides and becomes diffused (Figure 6). The phenomenon increases with depth and depends on the length of the path of light through the water. This reduces the contrast of light, the shadows become less and less pronounced and disappear completely at depth. Distant objects look out of focus and are also blurred by the camera. The phenomenon can be mitigated

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by using artificial light, if we place the flash too close to the subject, we can even get the opposite, equally undesirable phenomenon: too much contrast and too strong shadows (Furlan, 2003a, p. 24).

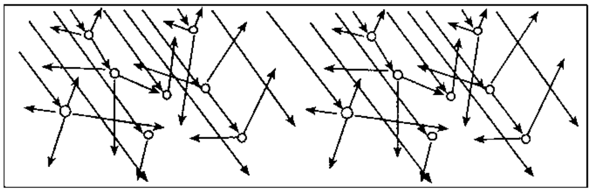


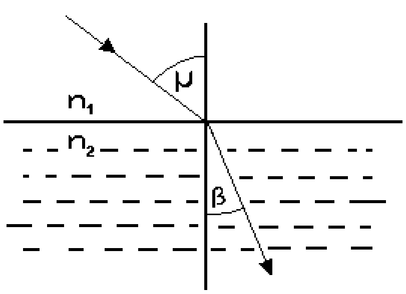
Fig. 5 *Light reflection on floating microparticles*

Fig. 6 *An example of the reflection of light from floating particles in seawater. (photo: Marko Šebrek, 2003)*

2.5. Refraction and reflection

2.5.1. Refraction

It is a phenomenon that occurs when light passes from one medium to another, whereby light is refracted. Namely: against the inlet, if it passes from an optically rarer medium (eg air) to an optically denser one (eg water). That is, away from the entrance at the reverse passage. The ratio of the sine angles of the incident and refracted beam angles is inversely proportional to the ratio of the refractive indices of both media (Figure 7).



$\sin \mu / \sin ß = n_2 / n_1 = n$

Fig. 7 *The angle μ is the angle of incidence, ß is the angle of refraction, the refractive indices of air and water and ˝n˝ are their ratio. This ratio determines the refraction of light at the boundary (air - water). The union is called the law of refraction.*

The refractive index for air is almost 1,00. The refractive index for water is about 1,33. It depends somewhat on temperature, density (salinity) and wavelength of light. When light passes from water to air, the light is refracted away from the incident rectangle (Figure 8) and at a sufficiently large angle of incidence, the refracted angle is equal to 90 °. We calculate from the law of refraction that this angle is equal to: ß tot = arc sin (n1 / n2 × sin μ) = 48 ° 45 '.

The consequences of fracture are described in Chapter 2.6 and its subsections (Furlan, 2003a, p. 24).

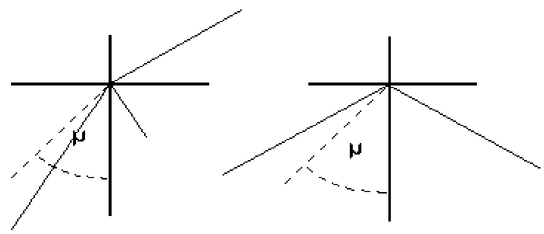


Fig. 8 *Display of the refraction of light in the water-air direction if the angle of incidence is less than sin μ (left) and if the angle of incidence is greater than sin μ (right)*

2.5.2. Reflection

This is a phenomenon when all or part of the light is reflected at the boundary of two media with different optical densities (Figure 9). The proportion of reflection depends on the difference between the refractive indices of the two media (the greater the difference, the more light will bounce off and less refractory) and the angle of incidence, the greater the angle of incidence, the greater the proportion of light reflected; reflections all light is reflected).

Fig. 9 *Example of light reflection at the boundary of two media (water-air). (photo: Marko Šebrek, 2003)*

2.5.3. Microrefraction

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It is a phenomenon where water is mixed with different temperature or density and thus different refractive index. It occurs at strong currents, e.g. on capes that cause mixing of deeper cold water and surface hot water or e.g. when the diver "breaks" the thermocline, again mixing the waters of different temperatures. Another mass phenomenon of microrefraction is the mixing of fresh and salt water: at the outflow of the river into the sea or at underwater freshwater springs (springs). In all cases, it is seen through such water very vaguely and flickering (similar to through air just above hot objects) (Furlan, 2003a, p. 24).

2.6. Transition of light through flat glass

Each optical system (lens) is designed so that there is air between each lens. If any other medium came into the lens, e.g. water, the precisely calculated optical system would be completely destroyed and the lens would not give correct results.

So we need some kind of barrier that separates our optical system from water. The simplest barrier is optically clear, plane-parallel glass (both outer surfaces are parallel to each other). When dealing with the problems that arise in relation to planparal glass, such as the boundary between air and water, it is important to know that we are dealing with three materials that have three different refractions: air, glass, and water. To simplify the problems, I assumed that the glass was infinitely thin and so I was basically dealing with an ideal flat boundary between water and air. All the problems I will list, the glass with its thickness (in practice over 5mm) expresses even more.

2.6.1. Apparent magnification

Due to the refraction, the angle of view of the lens under water is reduced. This phenomenon is also called the apparent lengthening of the focal length of the lens (Figure 10). Apparently, the focal length of the lens increases by a factor of 1,33 (or 4/3). Objects in the water look just as close and therefore bigger. The same phenomenon is observed when looking underwater with a diving mask, which also has a plane-parallel pane.

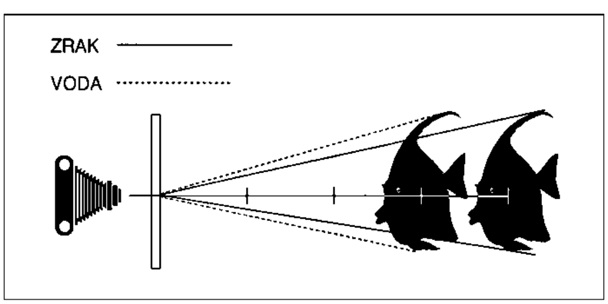

Fig. 10 *Example of apparent focal length extension*

The new angle can be expressed as a function of the old land angle: μ = 2 × arc sin (1 / 1.33 × sin / 2)

The maximum possible angle that can be achieved when photographing underwater, through planparallel glass, is the double limit angle of total reflection (97° 30') (Furlan, 2003b, p. 23).

2.6.2. Geometric distortion

Geometric distortion is due to a decrease in the angle of view under water. The larger the angle, the greater the ratio between the original air angle and the new underwater angle. Example: with an original 60° aerial viewing angle, an underwater viewing angle of 44,03 ° is obtained. The ratio between the angles is 1,33, which is called magnification. At the original air angle of 92 °, we get a new underwater angle of view of 65,18 °. The ratio between the angles and thus the magnification is therefore already 1,41. The previously mentioned magnification (1,33) actually applies only to very small angles, ie to objects in the middle of the image (Figure 11). The further we move away from the center, the greater the magnification (Figure 12).

As a result, the square is not mapped into a square but into a distorted quadrangular figure with concave parabolic sides (Figure 13). This phenomenon is called geometric distortion or pincushion distortion (Furlan, 2003b, p. 23).[2]

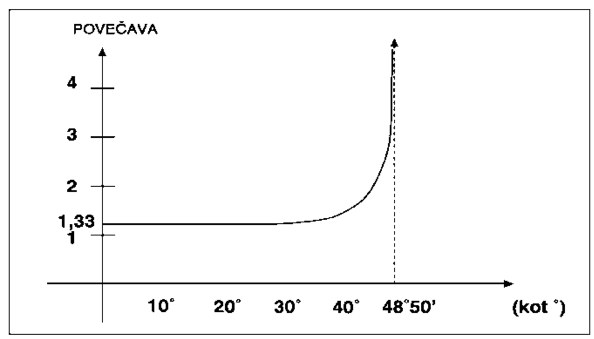

Fig. 11 *Geometric distortion*

[2] Pincushion is a pin pad that has a similar shape

Fig. 12 *Geometric distortion (photo: Marko Šebrek, 2003)*

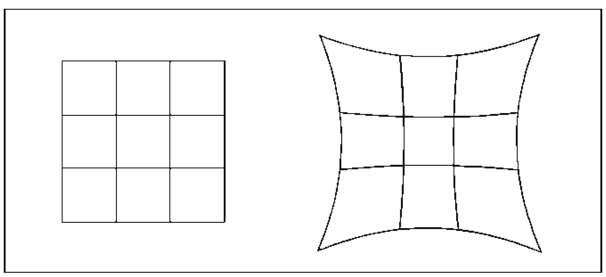

Fig. 13 *The square is mapped into a distorted rectangular figure with concave parabolic sides*

2.6.3. Chromatic aberration

Chromatic or color aberration is a physical consequence of differences in refraction for different colors. The refractive index of blue light (400nm) is 1,343, green (550nm) 1,334 and red light (700nm) 1,330. As a result, the white light at the water-air transition splits. The result is a spectral split (rainbow) on the outer (away from the center of the image) edges of objects, especially white, which contain all colors. As the lens rotates the image, red is on the inside of the rainbow, closer to the center of the image, and blue on the outside (Figure 14).

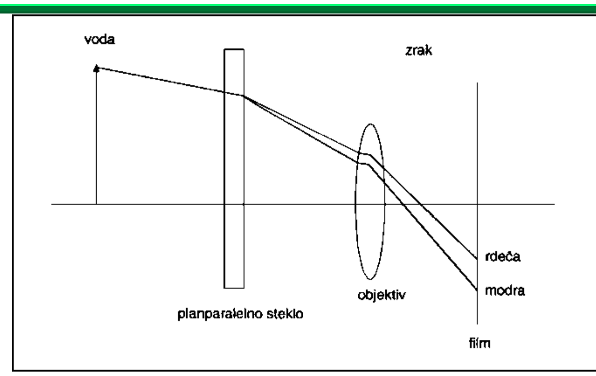

Fig. 14 *Chromatic aberration*

Chromatic aberration is still acceptable at small angles and completely unacceptable at very large ones. Example: at a viewing angle of 20 degrees (from the center), the difference in magnification between blue and red light is 1%, and at a viewing angle of 45 degrees, as much as 7,2% (Furlan, 1994, p. 34-35).

2.6.4. Usability of planparallel glass

Chromatic aberration and distortion limit the use of planparallel glass in wide-angle lenses. Images photographed with wide angles through plane-parallel glass are sharp in the middle, the sharpness drops sharply towards the corners, and the shapes of the objects are distorted outwards. These defects apply to a very thin planparallel pane. At normal thickness, however, they are even more pronounced. Plane-parallel lenses are used for lenses from at least 35mm upwards (for small format) in the tele area. With macro lenses, however, its magnification properties are even desirable, as the photographer does not need to get so close to the subject to get the desired image ratio.

For shooting with wide-angle lenses, it is necessary to use various correction systems that eliminate planeparallel glass errors at large angles. Correction systems also maintain the original angle of view of the lens.

2.7. The dome

The dome is by far the most common correction system for underwater wide-angle photography and also the only one known to many underwater photographers.

The basic idea of the dome is to bring light rays into the lens so that they do not refract anywhere at the water-glass-air transition. As a result, there would be no chromatic aberration, distortion, and magnification. This is possible if the rays cut the glass at right angles everywhere. Since all the lines going through the center of the sphere intersect the spherical surface at a right angle, they came up with the idea of using a spherical glass dome instead of a planparal glass, where the lens would be placed in its center.

The dome is therefore a spherically shaped glass body. It is bounded by two spherical surfaces, outer and inner, whose curve center (the center of the sphere) must be completely identical (concentric dome). The difference between the curvature radii of the two surfaces is the thickness of the dome, which must be perfectly uniform. The optical axis of the lens must coincide perfectly with the optical axis of the dome. The curved center of the dome must fall exactly into the optical pupil of the lens. This is actually the point where we see the aperture and not where it actually is. Because focusing moves the lens back and forth (a wide-angle lens very little), we place this point in the center position of the lens (when the lens is set in the middle between the shortest distance and infinity).

From all of the above, it is clear that one dome cannot be used for several different lenses because each needs very precise centering. Although the dome removes aberrations of planparallel glass well, it introduces new defects on its own. Together with the water, the dome forms a strong negative lens. The result is two new, essential errors of the dome: a change in the field of focus and a curvature of the field (Furlan, 2003b, p. 24).

2.7.1. Changing the focus field

The change in the focus field of the lens is due to the focality of the dome. Objects viewed through the dome look much closer than they really are. An infinitely distant object looks as if it lies in the back focus of the dome. The smaller the curvature of the dome, the closer its rear focus is and the closer the image of an infinitely distant object lies (objects closer than infinity seemingly lie between the rear focus and the dome itself.) The image of this object therefore does not fall into the same focal plane, as if photographed in the air, but for this plane the field of focus changes. The difference between the two foci is roughly given by the formula:

$D = F^2 / R \times (n - 1)$

″F″ is the focal length of the base lens, ″R″ is the radius of the outer surface of the dome and ″n″ is the refractive index of water. The formula is valid under the hypothesis that the thickness of the dome is much smaller than its curvature radius.

It can be seen from the formula: the larger the curvature of the dome, or its ratio to the focal length of the basic lens, the smaller the change in the field of focus. Therefore, a pre-lens with a lower diopter is also needed or is no longer needed at all (which is desirable because the image with a pre-lens is of lower quality).

The good side of dome photography: since all objects lie seemingly compressed at a short distance, we don't need much focus. With the aperture closed enough, we can sometimes forget about focusing (Furlan, 2003b, p. 24).

2.7.2. The curvature of the field

An infinitely distant surface with objects does not lie in a plane, but on a spherical surface concentric with the curved center of the dome. Therefore, even the image drawn by the base lens does not lie on a plane, but on a spherical surface that touches the plane of the new focus of the lens with the vertex. The spherical surface has its center behind the film, so in the corners the effect of field distortion sums up by changing the field of focus, which further worsens the results. By closing the aperture and thus increasing the depth of field, both errors can be slightly mitigated. Therefore, dome imaging gives us better results with small apertures. This error is also less pronounced in large curved radii of the dome.

In general, both errors fall below the allowable limits if the curvature radius of the dome is 10 times the focal length of the base lens and if the walls of the dome are thin (Planinc, 2001, p. 20).

3. EMPIRIC PART

3.1. Problem definition and research goals

Compared to other art forms, photography is a relatively young science. With the development of technology and thus photographic equipment, photography has gained new expressive possibilities. Modern pedagogy treats photography as an artistic technical science. Elementary school students acquire certain skills in the photo club. Very rarely, however, do they have the opportunity to gain new experience and knowledge of underwater photography in practice, and therefore also underwater.

I designed the empirical part from a survey we conducted with elementary school students. We explored the possibilities of conducting a photo club outside the school. We started from the assumption that the vast majority of primary schools in Slovenia do not have their own swimming pool. In the research, we empirically determined the response of students and their ability to create art in a different (new) environment than they are used to (school).

3.2. Research methodology

With the case study, we systematically analyze in detail and present an individual case or. event. We distinguish several types of case studies. For the research, I chose a case study in action research, where the contractor is also a researcher.

The main phases of case studies are generally: 1. the formation of a basic idea of the case, the purpose; 2. case selection (more definitive) and provision of access to relevant institutions, groups of persons, individuals, etc. (inquiry); 3. field work, data collection (first action step, second if necessary, etc.); 4. organization (design) of the collected material into a snapshot of the case - case documentation and 5. preparation of the final study - report. The phases are interconnected, transcending and interfering with each other (Sagadin, 1991, p. 465-468).

In the first action step, the findings and findings may show that the initial plan of the entire research needs to be changed (improved, refined, to determine in more detail what to add, what to take away). We will then amend the plan accordingly and prepare a detailed operational plan for the second action step based on it (Sagadin, 1989, p. 387).

The purpose of action research is to connect the objective and subjective perspective of the participants (performer, observer and students). This is mainly reflected in the triangulation technique, which we also used in our research, among other things (Marentič-Požarnik, 1987, p. 46).

3.2.1. Methods

As we were interested in a holistic view of the issue of underwater photography in the case study, we used the methods of qualitative research (Sagadin, 1993a, p. 115-123).

Qualitative research is characterized by an inductive path, in which it is more prevalent, the less we know about the research in advance. The less is known about the phenomena we are tackling, the less precisely we can determine and plan in advance which research questions we will look for answers to, and the less opportunities there are for the advance formulation and theoretical verification of research hypotheses. (Sagadin, 1993b, p. 217-223).

3.2.2. Involved persons

Pupils of 8th grade, aged between 12 and 13, from the Slava Klavor Primary School in Maribor (Slovenia) were included. There were six students in all, of whom three were girls and three were boys.

3.2.3. Data collection techniques

Data were collected using various techniques. These were: video and photo observation; triangulation technique; informal interviews with all survey participants, and children's product analysis and results.

The informal interview technique was used in all three other techniques for practical reasons.

As part of the action research, a triangulation technique was developed, based on the assumption that each representative of the "triangle" (performer, observer and students) sees only one part of the real happenings at a particular event. We want to connect the objective and subjective perspective of all three representatives with triangulation. The observer has the role of mediator of information and data between the provider and the students and vice versa. If necessary, the roles of performer and observer are intertwined. (Marentič-Požarnik, 1987, p. 46).

3.2.4. Data processing

Data were processed by qualitative analysis (Mesec, 1998).

3.2.5. Results and interpretation of data

3.2.5.1. Video and photo analysis and results

On Monday, November 24, 2003, we gathered with the students (13:00) in the lobby of the Slava Klavor Elementary School. All selected candidates, swimmers who had parental approval, were present. These were three boys and three girls of 8.d grade (12 and 13 years). They were accompanied by three pedagogues (Maja Slavec, Marko Šebrek and Prof. Tanja Šimek).

Together we took the bus on the way to the Pristan swimming pool, which passed without complications. The students were initially reserved and shy but relaxed and empathetic when we reached the finish line (13:45).

In the dressing room, we changed clothes and gathered at a pre-arranged place (14:00) where we talked about the work itself, the novelties and ambiguities of underwater photography. We also agreed on discipline in the swimming pool. Due to the complexity of the task, the introductory part lasted about twenty minutes, which is enough for them to understand the goals of the task (to photograph a classmate underwater). Together, we put together the order of the students. The first one on the list takes photos, while the others take turns posing for him, then the second one starts taking photos, and so on. However, before we started the practical part of the photo shoot, we introduced the students to a camera (Canon Eos 300) in an underwater case (Ewa-marine polyethylene bag) (Figure 15). Together, we repeated the laws of a successful composition on examples, looked at the props brought and quickly presented the ideas that had hardened to them. We analyzed the role, work and coordination of the photographer with the model and vice versa. Underwater communication is not verbal, but symbolic (body mimic).

Fig. 15 *Theoretical preparations for work*

We enthusiastically went to the pool (1,8m) at 14:20. In addition to us teachers, two other rescuers were present by the water. We did not choose the adjacent children's pool (1,5m) due to poor lighting conditions. In the water, the children tested the aforementioned theory (looking underwater with and without underwater goggles, holding your breath, leveling the pressure in your ears, photographer-model coordination, diving with the help of diving weights around your waist) (Figure 16). The student who was first on the list started the work, where I helped him with instructions, and the other students took turns posing. The will, enthusiasm, enthusiasm and inventiveness of the children were largely present.

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Fig. 16 *Practical work preparations*

The problems that arose were of a practical, technical nature. The first student-photographer could not decide between scuba diving and breathing through a tube. Due to the variable depth, scuba diving proved to be a better choice. Some also had weight problems because they were not used to them. All this is shown in the photographs; eg: out-of-focus (Figure 17), poorly framed (Figure 18) or time-inconsistent shot (Figure 19).

Fig. 17 *Blurred shot*

Fig. 18 *Poorly framed shot*

Fig. 19 *Timing mismatch of model and photographer*

Each took between five and fifteen minutes to make one shot. For this reason, we decided to reduce the number of five shots to three. We also used two additional underwater lights (Vega 2) to highlight warm colors, stars, and other props (Figure 20). Some of the students got colder, so we all took a break in between and warmed up for ten minutes in the warmer pool next door. The entire time of the photo shoot took us about two hours and thirty minutes (16:50). The resulting color shots of the children were largely successful, as each made at least two successful shots.

Fig. 20 *Extra illuminated star with underwater lamp*

After the work was done, we cleaned up after ourselves, took a shower, dried our hair and got dressed and waited in the lobby of the swimming pool. There we indulged in a small snack that we brought with us.

Full of new knowledge, we set off (17:20) from the swimming pool to the bus and arrived in Tezno at 18:00. Along the way, we discussed the experience, exchanged opinions and views. The whole event lasted five hours.

3.2.5.2. Analysis and results of triangulation

Participants in the research with the technique of triangulation were: Marko Šebrek (performer, researcher), Maja Slavec (assistant performer and observer), art pedagogue Stanko Rijavec (observer), Tanja Šimek

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(observer) and six students of the 8th grade of Slava Klavor Elementary School in Maribor.

The research was a novelty for all participants, but especially for children. The task therefore required thorough preparations that meet the rules for preparation and implementation when processing new content. The process is binary and involves the preparation of students and the practitioner. Direct involvement of students in the process of preparation for the task that followed, expands the boundaries of student activity and strengthens the positive attitude of the student to the task. Of course, preparations for introducing new content vary from subject to subject, but the basic steps remain the same. (Prodanović, Ničković, 1974, p. 164-165)

Basically, the preparation is divided into mental and technical preparations. Psychological preparations include motivating and directing students to the task. Therefore, an interview is needed, which must be open enough to trigger students 'mental activity during incubation. I informed the children that I expect products from them that will present their photo-circle activity outside of school. Since everyone attends the photo club, they already knew the theoretical side and had practical experience with photography (photographic optics, camera operation, photography). Technical preparation takes place outside the preparation of students and is performed by a pedagogue (or contractor). If the preparations are led by a pedagogue-contractor, they are also the most rational and professionally most appropriate. Both preparations are just components of this education system and we need to implement them at the same time (Prodanović, Ničković, 1974, p. 166).

I performed the research with the triangulation technique at the Slava Klavora Primary School and at the Pristan swimming pool in Maribor (Slovenia). I proceeded from the findings that the creative process can take place in stages:

1) Preparation for the process.

I informed the principal of the Slava klavora Primary School and Mr. Bojan Hernah from the Pristan swimming pool about the purpose of the research. I got a positive response from both. Therefore, I visited the students of the 8th grade on November 21, 2003 and informed them extensively about the task that they will perform in three hours of art classes at the photo club in the afternoon (Pristan swimming pool). From among the many enthusiasts, Professor Tanja Šimek and I chose the six most artistically active students who attend the photo club and are swimmers. I advised them to think about artistic solutions on the topic of a portrait of a classmate, and about the possibilities of using props underwater. Each student had to obtain written parental permission by November 24 at the latest. All were also given a short list of work progress and a list of equipment. In the interview, I found that they imagine underwater photography as something simple.

2) The dormancy and incubation period was between 21 and 23 November 2003.

3) Illumination.

We completed the task with the students of the 8th grade on November 24, 2003. We performed it as part of a photo circle in the Pristan swimming pool (Maribor). I gave instructions to the students in the swimming pool to carry out the art task. The theme was a portrait of a classmate underwater. The whole process, including the route, lasted five hours (300 minutes), of which three hours (180 minutes) were the introduction, implementation and a break in between. The practical work lasted 150 minutes (from 14.20 to 16.50). The students expressed themselves in the photographic technique of underwater photography. For their artistic expression, they used an SLR (mirror-reflex), an analog camera (Canon Eos 300) in an underwater polyethylene bag (Ewa-marine).

Equipment and props (Figure 21):
• camera (Canon Eos 300)
• underwater bag (Ewa-marine) for the camera
• photographic slide film (Fujichrome Sensia, ISO 400)
• two night underwater lights (Vega 2 rech.)
• three diving belts with weights (14kg in total)
• swimming equipment: swimwear, goggles, towel
• props: sequins on ribbons, various red fabrics, striped T-shirt, bench, umbrella, artificial rose, large plastic glasses, sunglasses, styrofoam stars…

Fig. 21 *Work environment with equipment and props*

First, we introduced the students to the peculiarities of underwater photography and introduced them to the operation of the camera. I then gave them instructions for carrying out the art task. Each took three shots underwater. The students who posed used the props they brought as needed. During the pedagogical process, we guided the students and gave them additional explanations.

4) Verification.

I did the verification with Stanko Rijavec, a professor of fine arts. If students were graded, four students would get a grade of excellent (5) and two very good (4). It should be noted that this was a study on the possibilities of conducting a photo club outside the school, in which, however, students are not usually evaluated.

5) Conclusion.

We researched students' response to a new and hitherto unknown artistic technique of expression. In preparation for the process, I only suggested that they think about artistic solutions, they did not know the techniques until the beginning of the process in the swimming pool. In the beginning, the novelty caused them practical and technical problems. The biggest problem was capturing the right moment for successful photography. The models and the photographer had to be underwater at the desired positions at the same time, and the photographer was then trying to consider the composition and background. Furthermore, many did not have a real feel for the trigger on the camera as the camera was in a polyethylene bag. I myself helped the students with ongoing corrections and instructions, which proved to be very effective. Expressed as a percentage: 66% of students were very successful, which is very good for the first action step. If the task is repeated in the second action step, the percentage of the highest grade would be reliably higher.

3.2.5.3. Analysis and results of children's works

The underwater photos of the students were viewed by all participants in the research. Using the technique of informal conversation, we exchanged our opinions and thus analyzed the resulting photos.

Students took photos: with an analog AF TTL camera Canon Eos 300, with a Canon zoom lens in an underwater housing (Ewa-marine polyethylene bag). The camera had an aperture setting of 4, autofocus and a focal length of 28mm. We used Fujichrome Sensia photographic film, ISO 400. In addition to natural ambient light (sunny day), artificial light sources were used: spotlights on the ceiling of the building, and two hand-held rechargeable night underwater lamps (Vega 2).

The evaluation criteria were: consideration of motive, captured moment, composition, framing, consideration of background and creativity. The works were evaluated in order to make it easier to understand the performance of children and, indirectly, the success of the research. Above all, the work of the photographer was evaluated, as the success of the shot depended on him. Of course, we should not neglect the creativity of the models who contributed their share to the making of the shots. It is important to note that this is the first time students have encountered such challenges underwater.
Of all the possible shots (18 photos), 17 were successful, which is as much as 94 percent success in terms of the number of all works created (Figure 22-24). If they were graded (1 to 5), thirteen works would be graded excellent (5), three works very good (4), one work good (3) and one work insufficient (1). Thus, four students would get a grade of excellent (5) and two very good (4). Negatively or poorly rated photos were taken mainly at the beginning of the process and due to more difficult working conditions. Most often, students accidentally pressed the camera shutter button.

Fig. 22 *The most interesting portraits of children 1*

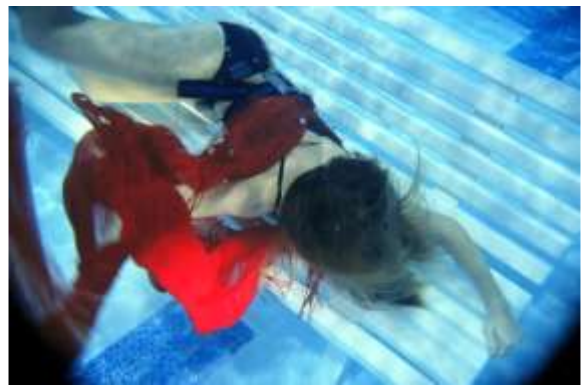

Fig. 23 *The most interesting portraits of children 2*

Fig. 24 *The most interesting portraits of children 3*

4. CONCLUSION

We researched the possibilities of conducting a photo club outside the school, as the vast majority of primary schools in Slovenia do not have their own swimming pool. In the research, we empirically determined the response of students and their ability to create art in a different environment than they are used to. We limited ourselves to children of both sexes, aged between twelve and thirteen, attending a photo club.

The research proved to be very successful. Despite the difficult conditions of underwater creation, the students achieved positive results. The influences of the environment (Pristan swimming pool) have obviously contributed to exceptional motivation and a relaxed working atmosphere. This, of course, facilitates the work of the teacher, who nevertheless needs the help of another educator. It turned out that the work is successful in small groups (up to six children), as it is necessary to include each individual. For a larger number of students, we would need a new, smaller group and thus two teachers to lead it. The planned time of five hours was sufficient for the course of the whole process.

The problems that arose were of a technical-practical nature and are in fact negligible. The students were perfectly able to work underwater (scuba diving) with a camera and other aids (weights, props).

Due to the place of implementation, the planning of the process required a certain organization: permission of the children's parents, permission of the swimming pool to perform, coordination of children's time with the appropriate time in the swimming pool, purchase of props, technical preparations, tickets for the swimming pool and bus. Nevertheless, the effort put into looking at the children’s underwater photos was immediately forgotten.

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