Instituto Universitário de Ciências Psicológicas, Sociais e da Vida

Discover the ocean with Kids dive: Impact of a digital ocean education program during COVID-19 pandemic

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Resumo

O programa Kids Dive é um programa prático de literacia do oceano que inclui atividades subaquáticas. Durante a pandemia da Covid-19, foi totalmente substituído por um programa virtual para fazer face às restrições sociais impostas na altura. O novo programa envolveu escolas-alvo em atividades como: uma experiência de mergulho com máscaras de realidade virtual em cartão (VR360); sessões de campo ao vivo a partir de margens rochosas intertidais locais, e visitas virtuais guiadas ao Oceanário e ao Jardim Zoológico de Lisboa. O impacto deste programa virtual foi avaliado através de inquéritos ao nível de literacia do oceano, das atitudes e comportamento dos estudantes em relação à proteção marinha, e avaliando também a curiosidade para continuar a explorar o oceano com mergulho autónomo. Os 201 inquéritos válidos de pré e pós-programa foram distribuídos igualmente entre géneros e incluíram estudantes do 8º ao 11º ano de diferentes regiões de Portugal Continental. Foi observado um efeito positivo e significativo relativamente ao aumento geral da literacia do oceano, com impacto sobretudo nos alunos do 8º e 10º ano, realçando o importante papel da educação informal nas escolas. Este programa não trouxe mudanças significativas nas atitudes ambientais dos estudantes, mas considera-se que as mudanças comportamentais foram limitadas durante o tempo de confinamento social. Foram encontradas diferenças notáveis relativas à curiosidade de continuar a explorar o oceano com ferramentas virtuais. No futuro, a junção de atividades práticas e virtuais poderá aumentar o impacto dos programas de educação, adaptável a situações de confinamento pandémico.

Palavras-chave: Educação Ambiental, Aprendizagem Digital, Impacto, Literacia do oceano, Atitudes

Abstract

Kids Dive is a hands-on practical ocean literacy program that includes specially designed underwater educational activities. During the Covid-19 pandemic it was fully replaced by a virtual program, to cope with the social restrictions imposed at the time. The new program involved target schools in activities such as: a scuba diving experience with cardboard virtual reality masks (VR360); live field sessions from local intertidal rocky shores to nearby target schools and virtual guided visits to Lisbon Oceanarium and Lisbon Zoo. To evaluate the impact this virtual program, inquiries were designed to measure different levels of ocean literacy; evaluate students' attitudes and behavior towards marine protection and assess the overall curiosity to continue exploring the ocean with scuba diving. The 201 valid pre and post program inquiries where equally distributed between both genders and included students from the 8th to 11th grade from different regions of Continental Portugal. A significant positive effect regarding the general increase in ocean literacy was observed, impacting mostly 8th and 10th grade students, highlights the important role of informal education in schools. This program brought no significant changes in students' attitudes and behavior towards marine protection, but behavioral changes were severely limited during social confinement. Striking differences were found considering the overall curiosity to continue exploring the ocean and the potential use of virtual tools in ocean literacy programs. In the future, coupling practical and virtual activities will probably increase the impact of ocean literacy programs and adapt educational programs to future pandemic confinements.

Keywords: Environmental Education, Digital learning, Impact, Ocean literacy, attitudes

Table of contents

LIST OF TABLES

LIST OF FIGURES

Introduction

The ocean represents the most defining feature of our planet with its massive water mass that makes the Earth habitable. It covers 70% of Earth's surface, providing more than half of the oxygen in the atmosphere, regulating the weather and climate and providing complex and dynamic food webs for all living organisms in the planet. Never in history humans had such a profound impact on the natural world. We now know the depth of these interactions with the marine ecosystems, ultimately converging into environmental, social, and economic problems (Bailly et al., 2015). To mitigate these problems, the United Nations (2017) declared the Decade of Ocean Science for Sustainable Development and set the Agenda for Sustainable Development until 2030, with 17 sustainable development goals (SDGs). This framework was a significant accomplishment for the global ocean communities(Santoro et al., 2018). Within this line of work, the United Nations organized a high-level conference, "Our Ocean," in 2017 to help implement SDG 14. The meeting produced an inter-governmental accepted declaration, "Call to action", whose article 13a states that the United Nations supports plans to foster ocean education. Ocean literacy programs will be critical to accomplishing such societal goals.

With this notion in mind, organizations worldwide set many goals to improve participants' environmental literacy and address critical environmental problems. Generally, literacy is the set of knowledge, attitudes, dispositions, and skills necessary to create a well-informed, responsible, and sustainable society (Hollweg et al., 2011; Stern et al., 2014). Engaging society and raising awareness about the effect of our lifestyle on ocean health is crucial to achieve sustainability goals. SDG14 is known to be more challenging to accomplish in marine environmental programs than in those that target their terrestrial counterparts' programs. It's easier to create empathy and connect students with habitats that they can have direct contact with and raise awareness towards issues that we can directly observe on a day-to-day basis. Marine ecosystems are harder to observe/interact and, subsequently, it's harder to create empathy with organisms that are mostly considered food items. In this sense, Portugal in particular has a great responsibility to reverse this paradigm. It's been currently negotieted in the UN the extension of the continental shelf. Upon acceptance by the UN committee, Portugal will hold the tenth-largest maritime area worldwide, corresponding to 97% of its territory. This proposition raises strategic importance in the economic, scientific, social, and cultural sectors, making imperative to promote individual and group awareness of ocean conservancy and sustainability. The increase in ocean literacy in different sectors like the public, industry and governance sectors is essential to increase sustainability and reduce the impact on economic resources and human health (Ashley et al., 2019). Today we are all will be responsible for setting a new path, "fixing" the environmental mistakes as current and future scientists, policymakers, consumers, and voters. Today's youth must be persuaded to adopt and pay the costs of future environmental policies. As a result, it appears that effective environmental education for school-age children is critical and urgent. Children are significant social agents because, besides altering their behavior, they can trigger a change in attitudes and behaviors within their families, and of peers in a wider community (Hartley et al., 2015). In this sense, environmental education is a key component in the conservation effort to increase scientific knowledge, change mentalities and, hopefully, change long-term behaviors (Damerell et al., 2013). Over the years, there has been a need to define a baseline for ocean-related knowledge. Seven main ocean literacy principles were created to fill this void aiming for a way to measure an ocean literate society (Santoro et al., 2018):

#1: The Earth has one big ocean with many features;

#2: The ocean and life in the ocean shape the features of Earth;

#3: The ocean is a major influence on weather and climate;

#4: The ocean made the Earth habitable;

#5: The ocean supports a great diversity of life and ecosystems;

#6: The ocean and humans are inextricably interconnected;

#7: The ocean is largely unexplored;

Knowledge is a critical factor in environmental literacy, resulting in more positive attitudes towards the environment (Bradley et al., 1999;McMillan et al., 2004)). However, alone it is not sufficient to actually change the individual's behavior (Hungerford & Volk, 1990). In addition to knowledge, affections and attitudes are crucial for developing pro-environmental behavior (Hsu & Chiu, 2004; Pe'er et al., 2007), even though the connection between cognitive, affective and behavior domains are complex and not yet clear. However, there is a clear connection between knowledge about marine issues and environmental behavior change (Chen & Tsai, 2016). There is a need for a standard and effective tool to assess environmental education programs successfully. These methods are essential to ensure the objectives of the environmental program are met, increasing awareness and knowledge, and possibly triggering behavior change (Ashley et al., 2019).

Furthermore, informal programs are more successful, particularly those promoting a sense of empowerment (Novosadova, 2015). As the Covid-19 pandemic outbreak hit the world in 2020-2021, the technologies became highly relevant in recent years and, in some cases, the only way to connect socially. So much that most educational programs had to be delayed cause of the of the intrinsic need for direct contact with students. The Kids dive program, a hands-on project on ocean literacy that involves scuba diving and field activities, had to be restructured to cope with the social restrictions imposed at the time. The solutions included the use of cardboard virtual reality masks to provide a virtual diving experience and live field trips transmitted online from coastal areas nearby local schools. Virtual reality (VR) experiences are proven effective educational tools for ocean-related topics (Chang & Tien, 2019) even when using less immersive VR headsets like the Google Cardboard (Vishwanath et al., 2017). The objectives with this work included the implementation of this virtual science outreach program to as many students as possible, given the social constraints in effect during the pandemic outbreak. Upon success on this first phase the following objective was to measure the effectiveness of the virtual Kids dive program applied to the 8th, 9th, 10th and 11th grade students by assessing their level of ocean literacy, attitudes and curiosity to explore the ocean.

Methods

The Kids Dive project

Kids dive is an educational project developed by researchers in the marine biology field that intends to bring ocean literacy to a broad audience of children (8-17 years). The project's approach is a hands-on program including a first diving experience, workshops, and a field trip with the goal to restore the natural bond and curiosity towards the ocean, simultaneously acquiring knowledge to make responsible decisions in the future.

Due to the pandemic outbreak, this practical Kids dive program had to be fully adapted to a virtual program. During those times the activities included were:

1) The virtual dive webinar

The Virtual Kids dive includes a ZOOM webinar with two "dives" using cardboard VR360º goggles. During this session, the students can interact with researchers and experience the virtual reality technology with 360º scuba dive videos from two different marine ecosystems, the first filmed in the polar region by National Geographic 360 Video (National Geographic, 2018) and the second one inshore near the Sesimbra region (Pais, 2021).

The three-hour event was conducted at ISPA from 10:00h to 13:00h on 18/01/2021, the session is available in the ISPA YouTube platform[1]. Prior to this session, the VR Cardboard masks were sent to schools and offered to the students and teachers, as they were encouraged to use them as a complement for other educational activities in their formal school curriculum (Figure 1).

Figure 1. (A) Students assembling the 360º VR masks; (B) Visual of the assembled 360º VR google; (C) Students participating in the Live session from their school.

[1]The complete session: https://www.youtube.com/watch?v=gXGzFZwNY_8

1) Live session on Instagram from nearby intertidal rocky platform

The program included an Instagram live session to show the complexity of intertidal habitats, species richness and take the opportunity to perform story-telling activities about the inhabitants of tide pools and crevices in rocky coastal areas. The location of this activity was purposefully chosen to be nearby the school's involved in this activity. The time and location of these sessions were previously discussed with the teachers, combining the low tide period and the school's schedules. Detailed information regarding the locations of the live sessions, number of participants and respective students' school year are available in table 1.

Tabela 1. Detailed information on the valid survey's student's school, year and respective location where the Live Instagram stream was presented.

Municipality	School's	School year	Nº of Students	**Beach location of Live Instagram**
Sintra	A	8º	19	Praia do Magoito
	B	9º	14	
	C	10º	27	
	D	11º	21	
	E	11º	21	
Oeiras	F	8º	17	Oeiras Yatch harbour
	G	10º	22	
Viana do castelo	H	9ºA+9ºB	15	Praia Norte
Setúbal	I	8º	19	Praia de Alpertuche
Olhão	J	10º	26	Praia dos Arrifes (Albufeira)

The topics of these story-telling activities were details on the behavior, reproduction, ecology, and evolutionary relationships of intertidal organisms and also the marine problems affecting their wellbeing (see Figure 2.) In total, eight sessions were accomplished, with an average duration of 90 minutes each.

Figure 2. Live streaming of the field trip on Instagram IGTV at Magoito beach rocky platform.

2) Virtual trip to Jardim zoológico de Lisboa and Oceanário de Lisboa

To conclude the project's program, the students engaged in a virtual visit into the *Oceanario de Lisboa* and *the Jardim zoológico de Lisboa*, leaded by a marine biologist and mediated by Teams and Zoom calls (Figure 3). This event included sixty minutes talks, with the discussion of topics on animal biology, ecology and general curiosities about the behavior and life habits of some marine organisms that we can usually see in these facilities when there are no social constraints due to an ongoing pandemic.

In general, virtual Kids dive addressed most of the topics in the seven principles of ocean literacy and the threats to marine ecosystems, such as climate change and marine litter, empowering the participants to adopt a sustainable lifestyle. The possible solutions for the ocean crises are motioned, particularly the creation of marine protected areas and a circular economy followed by tips on individual change into sustainable behaviors.

Figure 3.(A) Live stream of the virtual trip to the Lisbon Oceanarium via Zoom; (B) Live stream of the virtual trip to the Lisbon Zoo via Zoom.

Questionnaire design

A structured questionnaire was used to evaluate the Kids dive program impact on students. The survey was created in Portuguese as it was the common language among the participants and later translated into English. The survey consisted of four parts. The first part dealt with the general students' data concerning their demographic profiles, including: registration number, date, age, gender, school's name, birth country, area of residence. The remaining three parts were focused on the modules corresponding to each activity set. On this survey, twelve questions were aligned with the 'Ocean Literacy Principles', six questions were related to attitudes, and six questions focused on assessing the student's curiosity to explore the ocean. From a total of 60 questions, the ones used in this work were selected based on their relevance to answer the thesis objectives.

The questions were rated on a 5 points Likert-type scale (Croasmun & Ostrom, 2011), Yes/No, percentage range and open-type questions. Two questions were formulated in a negative sense to control accuracy, congruence and to quickly identify students who answered the survey in a non-rigorous way. At the beginning of each section part is a control question to ensure the students participating were present in all activities. The analyzed questions of the survey is available in Appendix III.

Participants

For the school year of 2020/2021, twenty-three schools attended the virtual dive event in total. Due to the virtual nature of this program, it was possible to have more students attending this event. Students were posteriorly separated into two groups; the participants in the complete program and the ones who just attended this event being therefore categorized as having an incomplete program.

Inquiries from grades that did not meet a representative number of participants for being selected (e.g. 6th, 7th and 12th grades) were excluded from the analysis.

Thirteen public schools participated in the complete program and 11 schools had students with valid surveys from the 8th to 11th grade.

Due to the significant number of submitted and valid surveys, the focus group in this study was the eighth, ninth, tenth, and eleventh grades. The number of students in each school cycle and the number of valid individual inquiries are described in table 2.

Tabela 2.Comparison with the number of the total submitted surveys in "Before" and "After "sampling times with the number of the final valid surveys per school year.

Nº survey/grade	**8th**	**9th**	**10th**	**11th**	**12th**	**Total**
Submitted	145	114	356	134	37	786
Before	78	80	223	85	35	501
After	67	34	133	49	2	285
Valid	55	29	75	42	0	201

Data collection

Data was collected between November 2020 and June 2021 in Google Forms (online). The sampling was conducted in two distinct moments before the beginning of the program and immediately after completing all Kids dive activities, to evaluate the individual progression of the participants. For this purpose, the teacher provided each student with a unique number. This number was registered in a document that was previously provided to each teacher (see Annex IIa.), with the list of students' full names and school year. Each teacher was briefed and kept this information to himself to ensure students' personal information was private and also necessary to ensure the same students responded to both surveys. In addition to this, and to guarantee this document were filled correctly a support document was delivered to the teachers with all information necessary to this process (see Annex IIa.). All participants were previously authorized by their parents to contribute to the project and the survey (Annex IIb.), as well as the school principal (see Annex IIc.). In all valid surveys, the time between the first and the second sampling was approximately four months. The surveys are considered valid when:

1. Students participating in the complete program with matched pre and post-survey numbers.
2. Regarding the pre-surveys, the date marked on the datasheet was not after the 10:00h on the 18th of January.
3. Teachers reported students having too many doubts regarding the formulation of the questions.

Data analysis

The students' answers were converted in a matrix of 1, 2, 3, 4 and 5, with higher numbers being directly proportional to the level of correctness of each answer within the likert scale (corresponding to "Completely agree", "Agree", "Neither agree nor disagree", "Disagree", and "Completely disagree"). Likewise, only one question was not in a normal Likert scale format. The 12th question had five percentage response option categories: 81-100%, 61-80%, 41-60%, 21-40%, 0-20%. Nevertheless, to fit with the 5-point Likert scale as well as all the other questions, the answers were converted in a 1 to 5 scale according to the level of closeness to the correct answer.

A total of 24 questions was classified as answering to different categories:

- Ocean literacy;
- Attitudes;
- Curiosity to explore the sea.

Ocean literacy was further sub-classified with different questions addressing different ocean literacy principles (question categorization is presented in Annex IIIa.).

All statistical tests were conducted using IBM SPSS© Statistics 28.0 for Mac. The Cronbach alfa test was conducted to determine if the questions could be analyzed as a set, testing the reliability between the questions in each category(Gliem & Gliem, 2003). Normality and homogeneity were tested with Kolmogorov-Smirnov test and Levene test, respectively. Despite the data did not fit a normal distribution, parametric analysis has been shown to produce reliable and robust results under the assumptions of a normal mean distribution through the Central Limit Theorem (skewness ranged from – 0,656 to −0,430; kurtosis ranged from – 0,148 to 0,078) (le Cessie et al., 2020).Therefore repeated measures ANOVA test was applied to the *ocean literacy* and *attitudes* category. The "impact" was tested by combining the "Before" and "After" results in a 2-level factor. The Bonferroni post-hoc test was used to evaluate differences between school years and gender.

The curiosity to explore the ocean category analysis was different. The positive input was created by adding the "Totally agree" and "Agree" responses, and the negative was by adding the "Totally disagree" and "Disagree" responses. The neutral responses were discarded in this category, and some students' responses were discarded altogether by incoherent responses. This further categorization into 2 type responses (positive and negative) permitted to submit the questions to a qui-square test. This simpler approach in this category allowed me to determine if there were differences in the Before and After responses, not involving variables like school year and gender.

Results

In this work, 201 valid surveys were obtained from the 8th to the 11th grade. The results showed a geographical distribution with Sintra schools conducting 51% of total surveys, 19% were from Oeiras, 13% from Olhão, 9% from Setúbal, and 8% from Viana do Castelo schools. Analyses of the socio-demographic variables showed that participants were aged 12-18 years old (M ± SD: 15,08 ± 1.40). The gender split was almost 50%, with 100 female and 101 males' students responses. Further data from the subjects age in relation to the gender and school year are available in the Annex IV. In this section there is also available a table regarding the student's gender split in all school years. The detailed information about the gender distribution within each district is shown in figure 4. In the annex IV section, there is complementary data on the number of students in each district sampled.

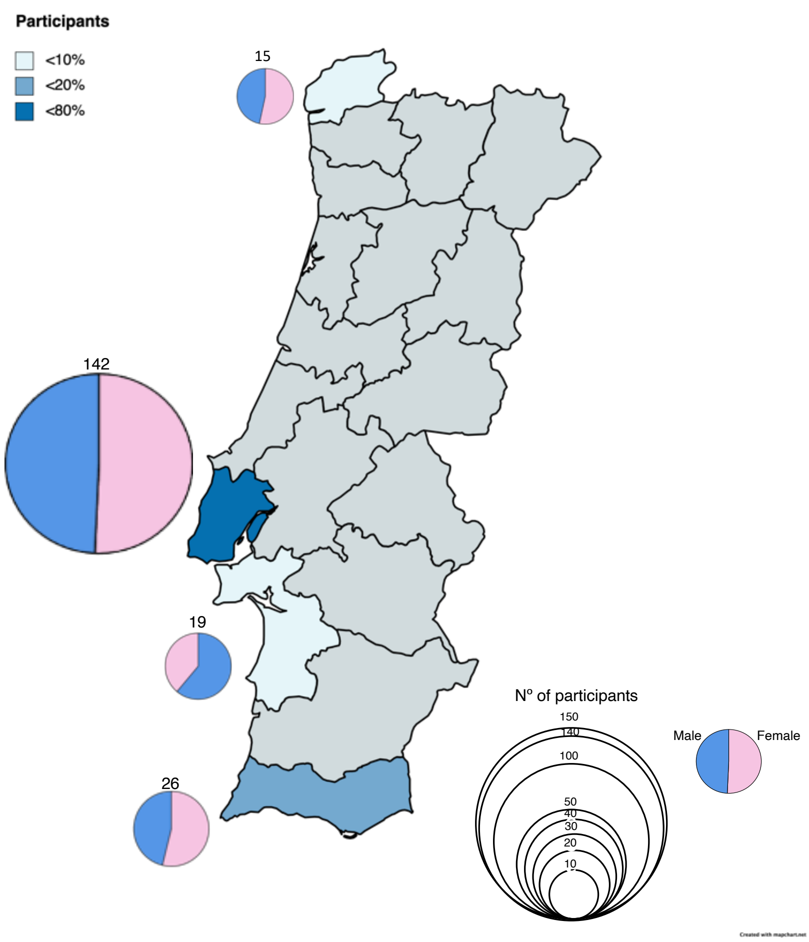


Figure 4. Demographic distribution map of participant's schools and their respective gender split in Portugal. Edited ®Microsoft PowerPoint 16; © 2022 Map Chart.

The Cronbach teste revealed a sufficient consistency between the questions in the ocean literacy category (0,542) and a considered good reliability for the attitudes category (0,795). According to Davis, (1964) in (Peterson, 1994) this alfa is considered acceptable due to the social study nature of this thesis with over 50 subjects.

Ocean literacy

In this section, only the questions related to the category "Ocean literacy" will be analyzed (available in annex IIIa.). The ANOVA repeated measures showed a significant positive effect regarding the general increase in the level of ocean literacy in the students before and after participating in Kids dive program (F (1, 2401) = 45,39; $P < 0,001$). There are also significant differences between school years (F (3, 1,489)= 46,44; $P<0,001$) but not between genders. Despite being significant, this growth (Before*After) has no linear relationship between the four years (Figure 5).

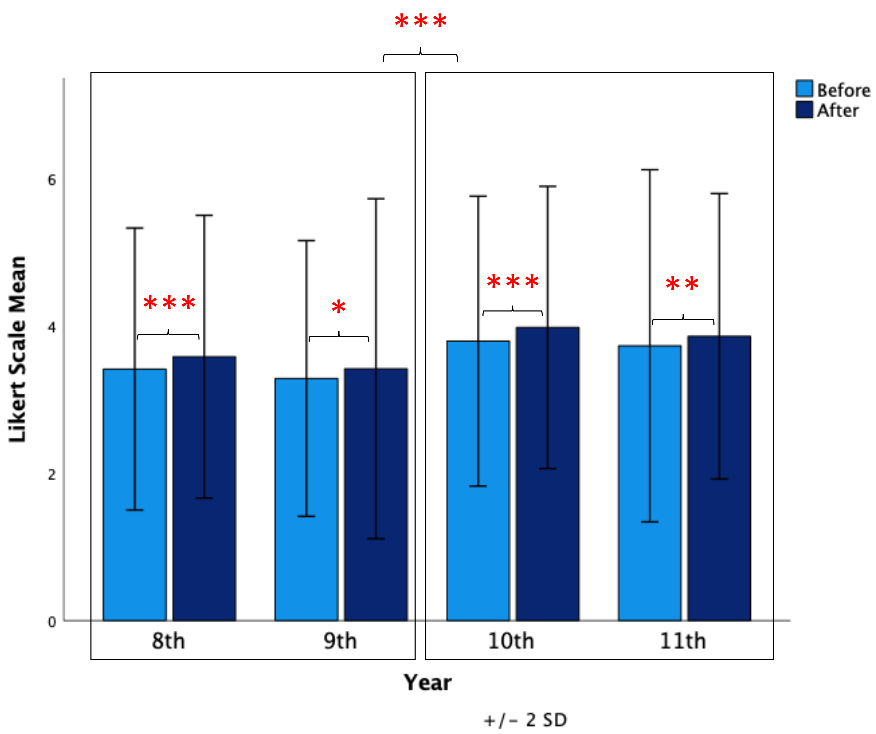


Figure 5. Graph illustrating the comparison of the Ocean Literacy category mean values (± standard deviation) in a 5-point Likert scale between the "Before" sampling time (light blue bars) and "After" (dark blue) per school year. The squares represent the lack of significant differences between the responses of the 8th - 9th grade and 10th -11th grade, separating the third cycle and secondary. (n = 201).

Figure 5 shows a clear separation between school cycles, namely, between the 3rd Cycle (8th and 9th grades) and the secondary school (10th and 11th grades) ($P<0.001$). No significant differences were observed within each cycle, suggesting that there are in fact uniform results according to the age of the students with a shift from the 9th to the 10th grade.

Unexpectedly, comparing the improvement (before vs. after) in each school cycle it becomes clear that younger participants (8th grade in 3rd Cycle and 10th grade in Secondary school) show better results than the older counterparts (Table 3). Although all scores were significantly improved, meaning that the program impacted the students' knowledge of ocean affairs, the grade level was a relevant factor in the acquisition of contents, with the 8th and 10th grades improving more ($P<0.001$) than their Cycle counterparts.

Tabela 3.Mean results from the Ocean literacy category recurring from the Bonferroni post hoc test in the "Before" and "After" sampling time per school year. This table also shows the mean Difference between After and Before moments, representing the student's growth between the sampling times and the respective significance level.

Year	Mean Before	Mean After	Mean Difference
8th	3,41	3,58	0,17***
9th	3,30	3,41	0,12*
10th	3,8	3,98	0,18***
11th	3,73	3,86	0,13**

No differences were found between genders F (1, 1,489)= 0,43; P =0,514. As expected from previous results, both genders significantly improved their ocean literacy marks with Kids dive program (female students $P<0.001$; male students $P<0.01$).

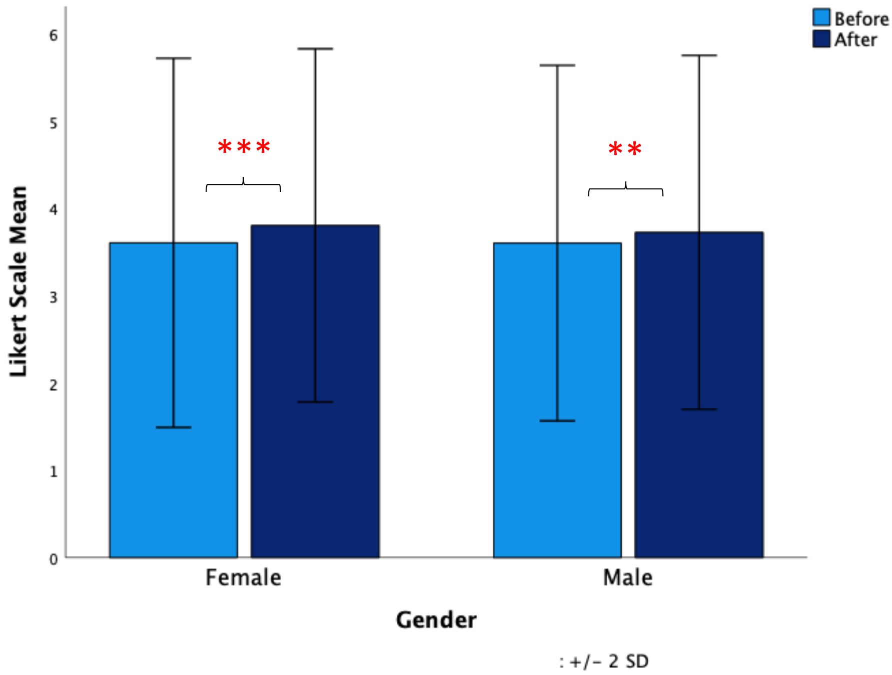


Figure 6. Graph illustrating the differences in the Ocean Literacy category mean values (± standard deviation) responses in a 5-point Likert scale between the "Before" sampling time (light blue bars) and "After" (dark blue) between gender (n= 201).

Comparing levels of significance (figure 6) and the overall average growth the results were most prominent in female students (MD=0,21) compared to male students (MD=0.09) regarding the level of ocean knowledge acquired (Table 4).

Tabela 4. Mean results from the Ocean Literacy category recurring from the Bonferroni post hoc test in the "Before" and "After" sampling time per gender. This table also shows the mean Difference between After and Before moments, representing the student's growth between the sampling times and respective significance levels.

Gender	Mean Before	Mean After	*Mean Diference
Female	3,54	3,75	0,21***
Male	3,57	3,67	0,09**

The data analyses showed a lack of significant interaction between year and gender, but pairwise with the before and after responses, the gender and year together had a significant effect F (3, 2401)= 3,240; p= 0,021. Here, it's important that all female students have been positively impacted by the project resulting in significant positive responses in all years tested (Table 5). In this group, the highest results were from the 9th grade (MD= 0,28) and the lowest from the 10th grade (MD= 0,15). Only 8th and 10th grade students in the male group showed significant results (Table 5). The highest growth from the male students was in the 10th grade (MD= 0,21) and the lowest scores resulted in students from the 8th grade (MD=0,13).

Tabela 5. Mean results from the Ocean Literacy category recurring from the Bonferroni post hoc test in the "Before" and "After" sampling time with the year and gender variables interaction. This table also shows the mean difference between After and Before moments, representing the student's growth between the sampling times and respective levels of significance.

Gender	Year	Mean Before	Mean After	Mean Difference
Female	8th	3,39	3,594	0,20***
	9th	3,209	3,487	0,28***
	10th	3,892	4,047	0,15***
	11th	3,675	3,885	0,21***
Male	8th	3,44	3,575	0,13**
	9th	3,385	3,34	-0,04
	10th	3,702	3,916	0,21***
	11th	3,79	3,837	0,05

Attitudes

This section analyses the questions in the category "Attitudes" (available in annex IIIb.). In general terms, in this category, the students were not impacted by the project as there was no significant difference between the sampling before and after the implementation of Kids dive program (F (1, 0,46)= 0,12; *P*= 0,725).

The analyses showed no significant differences between school years F (3, 1,18)= 2,18; *P*= 0,089. However significant differences were found comparing responses before and after Kids dive surveys in the 9th and 10th grade (F (3, 0,46)= 3,50; P<0,05).

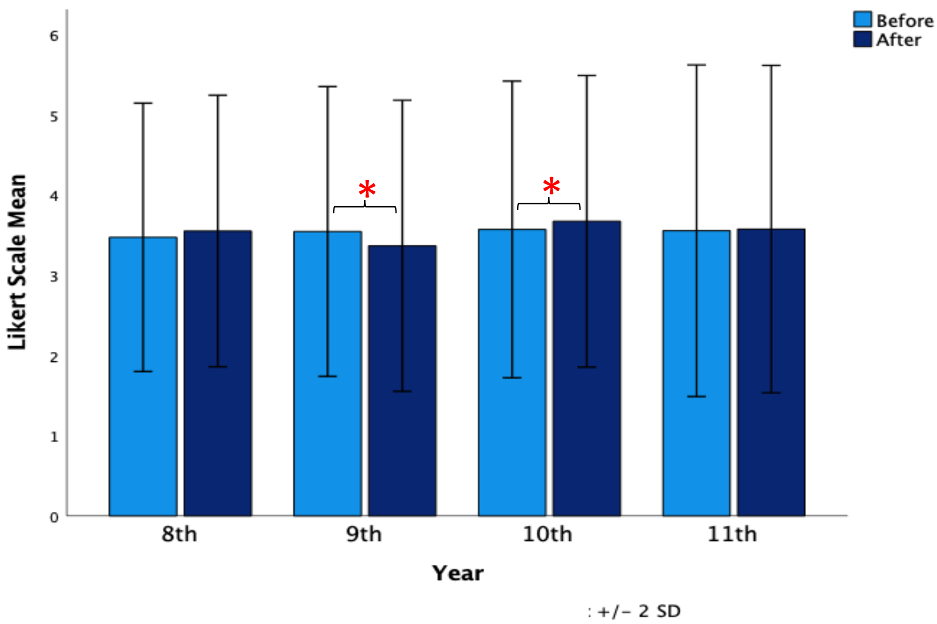


Figure 7. Graph illustrating the differences in the Attitudes category mean values (± standard deviation) responses in a 5-point Likert scale between the "Before" sampling time (light blue bars) and "After" (dark blue) between school years (n=201).

Unexpectedly, we observe a significant decrease in the 9th grade responses in terms of attitudes towards ocean conservation (MD= - 0,16; *P*<0,05;). In contrast, the 10th grade had been positively impacted by the project as the responses significantly improved after Kids dive (MD = 0,10; *P*< 0,05).

Tabela 6. Mean results from the Attitudes category recurring from the Bonferroni post hoc test in the "Before" and "After" sampling time per school year. This table also shows the mean Difference between After and Before moments, representing the significance level.

Year	Mean Before	Mean After	Mean Difference
8th	3,48	3,56	0,08
9th	3,55	3,39	-0,16*
10th	3,57	3,68	0,10*
11th	3,56	3,57	0,02

In contrast with ocean literacy, significant differences were detected between male and female students (F (1, 1,18) = 15,430; *P*<0,001) (Figure 8).

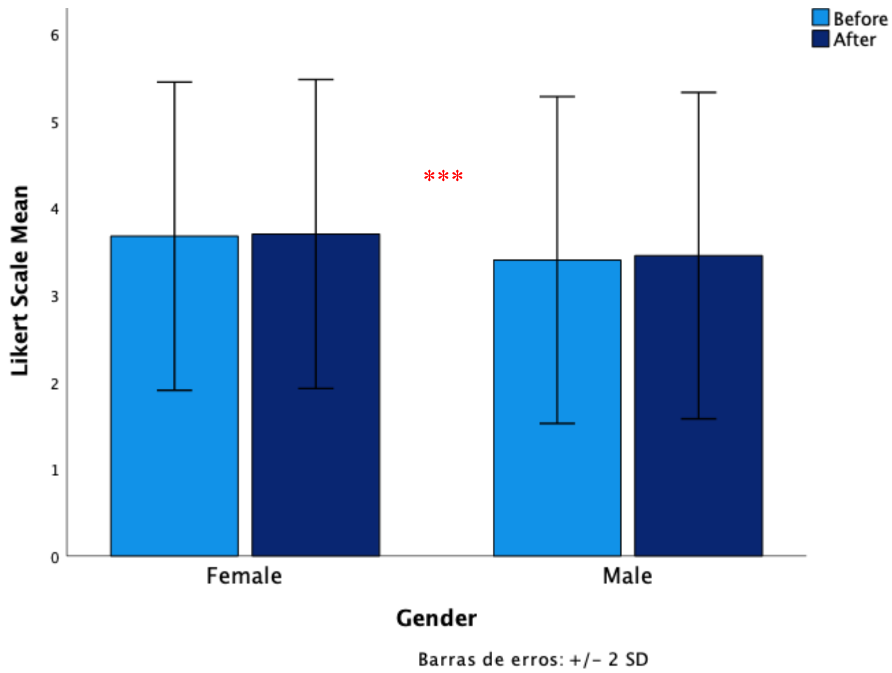


Figure 8.Graph illustrating the differences i[...]ry mean values (± standard deviation) responses in a 5-point Likert scale between the "Before" sampling time (light blue bars) and "After" (dark blue) between gender (n= 201).

Also in contrast with ocean literacy, female students had higher scores than the males and Kids dive program did not change this relationship with identical results, within each gender in both before and after program inquiries (F (1, 0,46) = 0,47; p= 0,495) (Table 7).

Tabela 7. Mean results from the Ocean Literacy category recurring from the Bonferroni post hoc test in the "Before" and "After" sampling time per gender. This table also shows the mean Difference between After and Before moments, representing the student's growth between the sampling times.

Gender	Mean Before	Mean After	Mean Difference
Female	3,64	3,63	-0,01
Male	3,44	3,47	0,03

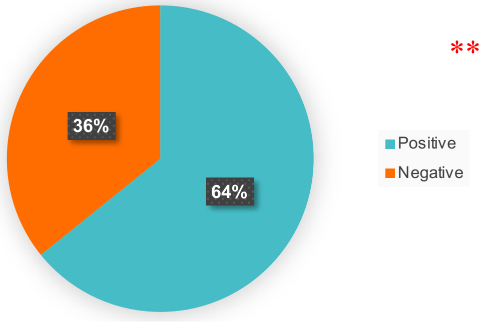
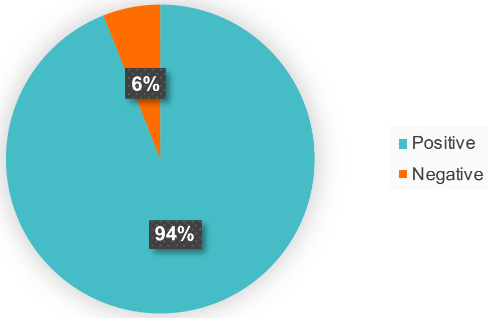
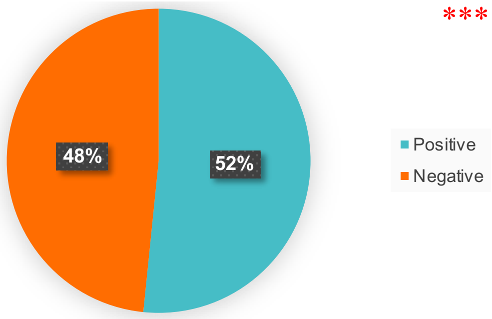
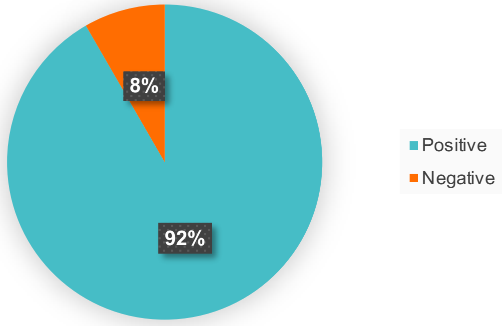
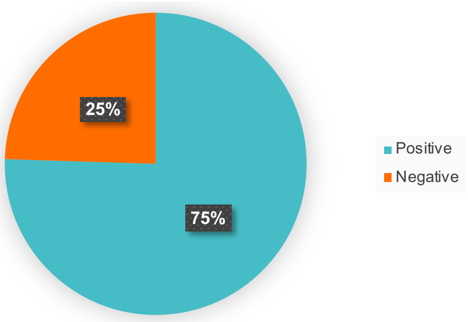
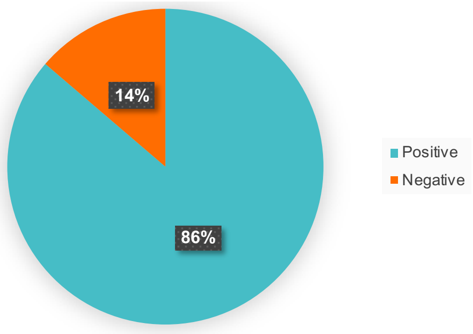
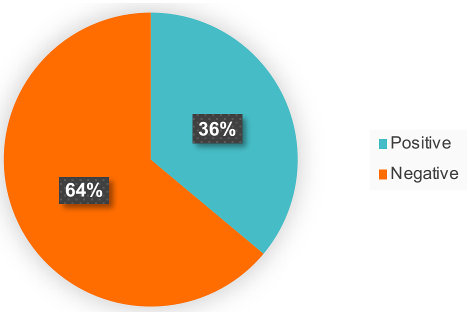
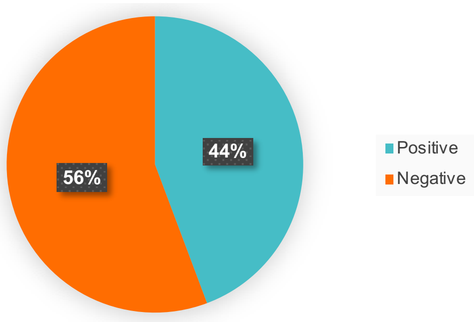
As expected, the interaction between the gender and year variables was found to be significant (F (3, 1,18) = 8,22; P<0,001), but when pairwised with the impact on students this interaction was non-significant (F (3, 0,46) = 2,44; P= 0,063).

Curiosity to explore the ocean

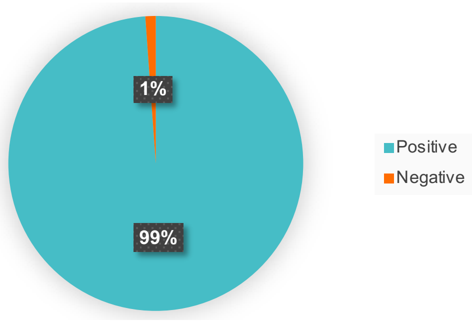
In this section, students were asked questions to evaluate if the virtual project influenced the participant's desire to explore de ocean (see annex IIIc.). Most students (94%) never went diving, and only 2% felt the urge to dive between the before and after sampling period.

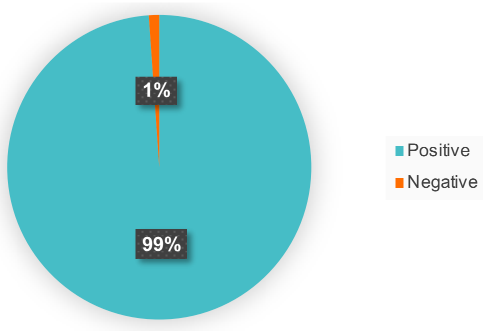
The student's perception in this category indicates that virtual tools, particularly virtual reality masks (VR360), have a striking effect increasing the curiosity to have a scuba diving experience in the future (Chi-squared test, P<0,01) (Table 8). Also, VR360 masks are regarded as effective educational tools useful to reinforce the understanding of contents being communicated to students (Chi-squared test, P<0,01). Contrary to expectations, direct contact with nature was not considered a priority and these virtual activities did not highlight the need to create a direct connection with nature to awake the interest in its conservation. No significant changes occurred regarding the level of fear with scuba diving activities, an expectable result considering the fact that this was a virtual program.
Most students' perceptions about diving activities were already positive as fun and considered related to many professional opportunities linked to the ocean

Tabela 8. Series of pie charts in the curiosity to explore the ocean category depicting the "Before" and "After" positive (blue) and negative (orange) responses, per question and the respective level of significance between sampling times.

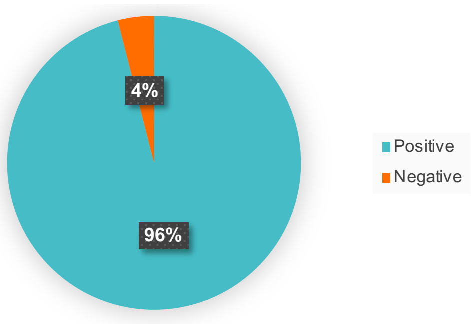
Question	Before		After
19)The virtual reality experience has awakened in me the desire to dive "for real" as soon as I have the availability.	 	***	
20) I found that the virtual reality masks helped me to understand the content that was being communicated to me.	 	***	
21) For me it is important to have the opportunity to interact directly and personally with something, so I want to protect it."	 		
22) Diving with full equipment (tank, suit, etc.) is an activity that scares me.	 		

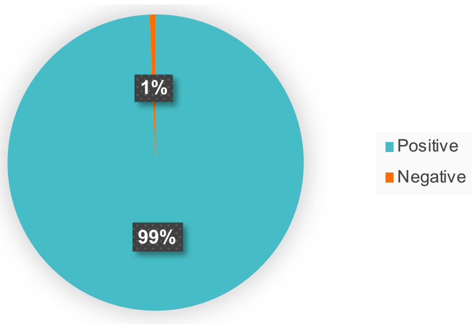
23) Diving can be a leisure and fun activity that I can practice with family/friends.





24) There are many professions associated with the practice of diving.





Discussion

The results of this study are clear, and the virtual Kids dive program significantly increased the level of knowledge in ocean literacy principles of 201 Portuguese participants on this study. The project impacted the student's knowledge on ocean affairs, and the grade level was a relevant factor in the acquisition of contents. However, we must take these promising results with a note of caution. This increase, although significant, falls on absolute values located in the neutral part of the Likert scale, suggesting a not-so-strong comprehension of overall ocean-related concepts. This trend has been recorded and extensively evaluated in many countries worldwide, both with middle and high school students (Koulouri et al., 2022; Sakurai et al., 2019; Tsai et al., 2019).

The differences between Cycles (3rd Cycle and Secondary school) could be related to the fact that this program was designed and is currently implemented by university professors and researchers. The positive results obtained with secondary school students (e.g., on ocean literacy), may be related with the scientific background of the KIDS DIVE team. Although it is intrinsically good to have scientists disseminating scientific contents, their communication style may not reach younger audiences with the same effectiveness (Bickford et al., 2012).

The result of this thesis demonstrates a clear strong impact of this project in ocean literacy in female students. This finding is quite controversial, and it contradicts most studies regarding gender differences in acquiring knowledge in ocean literacy. Some research points out that males usually have higher quiz scores in ocean literacy topics as it mostly fits the "scientific knowledge" category (Meinhold & Malkus, 2005). However, there is no evidence that differences in intelligence between genders can define the success in the science carrier (Spelke, 2005; Handelsman et al., 2005). The argument used in these studies is mainly centered on the gender gaps in math and science achievement rooted in socio-cultural factors and stereotypes (Nosek et al., 2009). These findings are perhaps a good indicator of the awareness efforts in supporting and empowering women in science-related jobs that are making an impact on young female students. The results also indicate that, within each school cycle, the 8th and 10th grades had better scores overall. This finding may be justified by the structure of the formal curricular educational system in Portuguese schools. In Portugal, ocean-related topics remain disregarded as they do not have a central role in the essential learning work frame defined in the K-12 program. Instead, the Portuguese formal school system focuses on achieving high grades in national exams at the end of secondary school. Superior grades enhance the chance of being accepted into more prestigious universities. This educational structure strains teachers and students mainly in 9th, 11th and 12th grades, resulting in a constant prioritization in preparing for the final exams. This fact may have affected the results, as the 9th and 11th-grade students were focused on preparing for the exams rather than learning scientific facts about the ocean. The 9th grade's results were most likely due to lack of continuous work on ocean-related topics in the Natural sciences course, mainly focusing on human anatomy (Ministério da Educação, 2018). This way, the students only have the opportunity to work on ocean-related topics in another courses. This problem can significantly affect students' interests as other subject teachers are not always equipped to communicate science in a correct and meaningful way (Ramadhan et al., 2019). Nevertheless, this remains a controversial topic that must be further evaluated in the future, since many Geography and History teachers, had an enthusiastic approach to Kids dive program on ocean conservation. This can be especially important in Blue Schools that already have an intrinsic propensity to include ocean related issues in their regular programs.

Some countries, like the USA, India, and Malaysia, have taken a step forward and included ocean science in their formal education on a national scale (Chang et al., 2021; Mustam & Daniel, 2016). However, this kind of formal progress does not always mean a better understanding of ocean literacy topics. The prime example of this matter is Canada, as the ocean is taught the 8th grade curricula and has even an optional course in this subject the 11th grade. Nevertheless, in this case, is the way these topics are presented in the formal curricula is not considered effective in communicating meaningfully to the students (Guest et al., 2015). In conclusion, it is not enough to legislate or otherwise decide to include Ocean related topics in formal curricula. One must find the most effective way to pass on those scientific topics to the students and that is not always easy. The ideal situation, according to Knapp, (2000) is the combination of formal and non-formal partnerships. To fulfil the lack of ocean literacy in formal education, the "Blue schools" have access to a network of partners who can complement the curricular program with ocean topics. According to Costa et al. (2021), the Blue School programme was created as a strategy to "promote a project and problem-based approach in schools, with a stronger emphasis on interdisciplinarity and on developing students' critical thinking, behavior and action towards the ocean." Kids dive is therefore one among many programs available in Blue School, that can complement formal school programs. The main achievement with this work is that it shows for the first time that even the virtual version of Kids dive is an effective tool to tackle current constraints of formal school curricula on ocean literacy. In a natural and normal school progression setting, we expect older students to be more knowledgeable and engaged depending on several reasons. Some examples include: 1) the age of the students and the adaptation of the non-formal program to a specific age class; 2) the inclusion of Ocean related topics in the formal curricula allowing students and teachers to deepen some topics; 3) exam pressure that may lead to worse results when the attention at school must be focused on other middle-term objectives; 4) the contribution of each teacher to use both formal and non-formal education programs synergistically, developing additional discussions and activities along the year.

At first, we may be persuaded that 4) is included in 2), however the practical experience along different editions of Kids dive led us to suspect that the enthusiasm of each teacher and the way it can be conveyed to their students is probably of paramount importance. Although this was not measured in the inquiries, the preparation of group reports, exhibitions, posters and even actions towards school administrations and municipalities, led us to assume that the endeavor of each teacher plays a fundamental role in students' responses. This should not come as a surprise, because the simple inclusion of ocean conservation topics is not a synonym of a synergistic effect between formal and non-formal education. But the commitment of teachers (and students) taking ocean literacy/science related topics one step further throughout the whole school year is.

As Barracosa et al. (2019) mentions teachers and schools require scientific support to comprehend ocean issues and meet the challenges of disseminating ocean literacy. Thus, current projects like KIDS DIVE involving scientists are required to fill that gap by accessing specialist resources, experts and communicators that would otherwise not be available within formal education (Fidler, 2008)

Teachers agree that it is essential to integrate environmental education in the learning process, but, despite the recognized importance, time and educational resources for teaching are the major problems when it comes to implementing these programs (Ham & Sewing, 1988). Fortunately, Portugal officially approved in 2018 the "Project for Autonomy and Curriculum Flexibility" (PACF) for the 1st, 5th, 7th and 10th grades. PACF provides schools with the necessary time and conditions to adjust the national curricular program with local content. This new program is considered an essential step to including ocean literacy, among other important societal pillars, in formal curricular programs in a way that does not add additional pressure on other components of the educational system. Nevertheless, it relies only on the teacher's motivation to include ocean-related topics in this subject. Motivated teachers and their teaching background are critical to a successful informal educational program (Walker, 1997). Since this phenomenon was observed first-hand by Kids dive team, in the future it is important to also measure as the contribution of teachers 'motivation to the awareness of students on ocean-related topics.

Guest et al. (2015) suggest that the student's interests must be considered when conducting ocean literacy programs. Environmental education programs should evolve accordingly, both in terms of including rewarding activities and in terms of digital communication, under very fast development. This media component may be redirected to increase curiosity and excitement on ocean literacy. Marrero (2010), found that animal life is the most exciting topic among young students. This digital "hook" can be a powerful tool to introduce poorly or misunderstood subjects such as current dynamics, tides and food webs (Ballantyne, 2004). They can be used to introduce urgent topics such as climate change, over-fishing and ocean acidification.

Marrero, (2010) discovered that school, television, and previous experiences are the significant sources of information among students at this time. Today, with the advance in technology, the sources have shifted, and the internet has become the leading resource for information about the ocean (Realdon et al., 2019). Digital technologies have the potential to overcome these challenges to some extent by, virtually, bringing humans and the ocean closer by making some of the complex interactions visible to the human eye. Students with developed personal interest in marine affairs are more likely to have a higher knowledge and be more active in protecting the ocean (Guest et al., 2015). Therefore, educational programs such as Kids dive, can reach out to different students by using different tools that meet different students' interests. Scuba diving (in non-pandemic contexts) and VR360 technology (both in pandemic and non-pandemic contexts) are examples of such tools.

Virtual reality can play a significant role on ocean literacy, attracting students with no major interest in marine sciences and attracting them by the technological novelty (Huang et al., 2019). One study reported a greater level of motivation, interest and engagement in students who had the VR experience than in the traditional slideshow class (Parong & Mayer, 2018; Boel et al., 2021). This educational tool can solve problems associated with implementing environmental education, for instance, experiments too challenging to run in a classroom due to safety, time, or budget constraints. It can also be the solution for populations living away from the coastline or far from an aquarium and play a significant role in demonstrating invisible phenomenon that otherwise would be beyond most people's reach. Similarly with social media, virtual reality can be an effective way to bring the ocean closer to students. The VR immersive experience is best known in the entertainment industry but, over time, has been recognized as a powerful educational tool, becoming a way to incite curiosity and motivation in students and, consequently, affecting their knowledge retention (Huang et al., 2019; Pirker & Dengel, 2021). Scuba diving VR360 videos can be a great way to show the local marine biodiversity or the one that thrives away from shore. This technology likewise provides the opportunity for students with fear or not have the ability to dive, to witness the underwater scenery being more inclusive (Wibowo et al., 2021). Additionally, students living in rural areas can experience and connect to the ocean because although they do not realize that they in fact interact with the ocean. This ocean connection is crucial to engage populations in marine citizenship. In short, it is imperative to integrate environmental education programs and conservation efforts (Jefferson et al., 2014) Fortner & Mayer (1983), reported that students in coastal areas have higher ocean literacy levels. The problem is that citizens often cannot look at what is hidden under the surface or know what is happening in the open ocean. This can lead to a situation where only a tiny portion of the marine diversity and processes can be experienced directly. Despite not being tested in this thesis, Kids dive team's personal experience with the students felt the use of compelling stories about the behavior, ecology and curiosities about the local marine life made them more curios and compelled to visit and protect the coastal region closer to home/school region.

On the other hand, the technical problems that comes with this virtual setting can trigger a loss of patience and interest. Applying this technology in the classroom can also decrease direct contact with nature (Guest et al., 2015). Immersive VR experiences can be overwhelming and lead to individuals paying more attention to the experience *per se* then the content of the video(Rupp et al., 2016). So, the Kids dive option for a less immersive version of VR using cardboard headsets has a number of advantages because they: 1) are portable; 2) less expensive, meaning thar they can be sent to individual students at schools even during a pandemic outbreak sheep; 3) are composed mostly by recyclable materials; 4) can be re-used in different education contexts besides Kids dive depending on the available video contents (e.g. historical reconstructions, microbiology, astronomy, etc.); 5) less immersive than gaming VR360 headsets. This kind of VR experience's effects on environmental education is still poorly documented and needs more attention. VR and social media can potentially increase ocean connection and aligned with hands-on activities, can result in a more active and informed marine citizenship.

Despite the student's interest in alternative use of technologies in education, it was not enough to change their attitudes towards a more active citizen towards ocean conservation. Studies have shown that low levels of ocean literacy led to a poor engagement responsible behavior (Guest et al., 2015), but as previously suggested, knowledge alone is not sufficient (Chen & Tsai, 2016). We can argue that the COVID-19 pandemic had a significant effect in this category tackling all our efforts in a virtual ocean conservation program. As experienced by almost all communities worldwide, the restrictions imposed by the Covid-19 pandemic constrained all aspects of social behavior, making sustainable development to stagnate or even to recede. So, this could affect the perception of empowerment and self-efficiency, which is essential to trigger environmental behavior change. In addition, surveys that only include inquiries are not considered to be the best approach to evaluate human behavior. Best practices combine pre and post survey interviews with participants' self-reported behavior and objective observational data (Ashley et al., 2019). In future studies, it could be more effective to have a more concise approach regarding the number of questions in the survey to avoid fatigue and promote more reliable answers.

An additional conclusion, with potential striking effects on a post pandemic context, was the curiosity to further explore the ocean after a first VR360 experience. Curiosity is key to promote future engagement with the ocean. The proneness to get involved in scuba diving activities, even if it is not fulfilled in the future, led all participants in this program to realize that the ocean is much more than its surface or its shoreline. Almost all participants (97%) never experienced scuba diving before (neither literally or virtually) and probably never thought about it before. Now they are aware that the visible part of the ocean from where we stand, usually on land, represents only a fraction of our Ocean planet that its urgent to protect. This willingness to get involved in scuba diving activities in a post-pandemic context has the potential to raise a generation more informed, present, and demanding on future challenges related to ocean conservation.

In conclusion, the virtual version of Kids dive program has proven effective, more inclusive and remains an educational option for the future. Students' age and probably, teachers' involvement and individual interests, play an important role in the effectiveness of this educational program towards ocean conservation. However, direct contact with nature will probably be more efficient in creating a solid connection with the Ocean. In the future, it would be interesting to conduct a comparative study with the original Kids dive program to determine what kind of program is more effective, with control and experimental groups. This new study would be helpful to determine the strengths and weakness in each program. Though ideally, in my view, an environmental education program must have the combination of the two approaches to maximize its potential impact on students with different backgrounds and skills.

APPENDICES

I. REVIEW OF LITERATURE

All aspects of life are deeply connected to the ocean, no matter where we live. As so, every citizen has the moral duty to act to the detriment of the human impact on the terrestrial, freshwater, and marine environments. In this respect, education play's a key role in communicating the fundamental importance of our ocean to create awareness and responsibility for its protection (Dupont & Fauville, 2017). According to Santoro et al., 2018 ocean literacy is fundamental to accomplish "economic stability and national security and to allow society to understand critical issues associated with important ocean-related topics spanning ecology, trade, energy exploration, climate change, biodiversity, the ocean, human health, and developing a sustainable future". Ocean literacy is often described as the understanding of the ocean's influence on us and our influence on the ocean. Carley et al. (2013) considered an ocean literate "someone who understands the essential principles and fundamental concepts about the functioning of the ocean, can communicate about the ocean in meaningful ways and can make informed and responsible decisions regarding the ocean and its resources". In this regard, according to the Tbilisi conference (Hoffmann, 1977) the individual needs to have a set of competencies to be considered an environmentally responsible citizen: (1) sense of awareness and sensitivity to the environment and its problems; (2) basic understanding of the environment; (3) concern for the environment and motivation for actively engage in environmental protection; (4) skills for proper identification the environmental problems and (5) active involvement at all levels in working toward a solution of environmental problems (Hungerford & Volk, 1990). To fully comprehend what makes an ocean literate, there is a need to determine what triggers pro-environmental behavior to engage the public in ocean affairs more effectively. The commonly accepted definition of pro-environmental behavior is purposeful action that can help to reduce a negative impact on the environment (Stern, 2000; Kollmuss & Agyeman, 2002). Pro-environmental behavior includes recycling, transport use, waste management, energy consumption, and acquiring green products and electrical appliances (Li et al., 2019). While the various types of pro-environmental behavior are well defined, the determinants are less appreciated. Over the years, some authors have developed different theories and models to predict and explain pro-environmental behavior: Theory of Planned Behaviour (Fishbein et al., 1980); Models of Responsible Environmental Behavior (Hines et al., 2010; Hungerford & Volk, 1990); Models of altruism, empathy and pro-social behavior (Allen & Ferrand, 1999) and

Value-Belief-Norm (VBN) theory (Stern et al., 1999) are some examples. One of the first models to predict behavior was formulated by a multi-disciplinary group Hines et al (1987) who started a meta-analysis to study what variables have the most impact on responsible environmental behavior. Hines et al. (1987) categorized the significant psychosocial variables into attitudes, personal responsibility, and locus of control and how the external factors influence behavior (consult Annex V). Later, the author defined what are the major and minor variables defining marine citizenship (consult Annex VI).

Attitudes reflect the level at which the performance of the behavior is favorable to the individual, specific feelings towards ecology and the environment, and finally, acting on general or specific environmental issues. Personal responsibility represents the individual's sense of obligation towards the environment, either in general or to a specific aspect. Locus of control represents an individual's perception of their ability to change the environment, either attributing it through personal behavioral effort (Hungerford & Volk, 1990; Chiang et al., 2019 ;Pe'er et al., 2010) Those with more positive attitudes are more likely to engage in pro-environmental behavior, especially recycling and waste management (Tonglet et al., 2004; Roxas & Coetzer, 2012). Later, Fishbein & Ajzen, (2010) proposed that learning about a person's intentions is the best way of predicting behavior. According to the author, intentions are determined by the person's attitudes, perceived norms, and perception control regarding the behavior.

Improved ocean literacy can enhance marine citizenship and has economic benefits (Guest et al., 2015). This definition has been evolving and according to Fauville et al. (2019) ocean literacy currently the ocean literacy definition has three essential dimensions:

1) Knowledge,
2) Communication
3) Decision-making.

Since 1998, environmental education has entered the political agenda and is considered a priority to achieve sustainability due to the growing international recognition of the connection between education and environmental problems (Sauvé et al., 2007). Since 2000, the UN has developed the Millennium Goals and Education of Sustainable Development program. The 14th SDG goal concerns the protection of the ocean and states the following: "Conserve and sustainably use the oceans, seas and marine resources for sustainable development". But there are other SDG's involved in ocean literacy and science outreach programs. Furthermore, in addition to the 14th goal, the Kids dive delivers on his framework program the 4th, 12th and 13th goal, working on quality education, responsible consumption and production and reenforcing the climate action, respectively. Environmental education is key to achieving these goals, especially when teaching current marine affairs, reassuring the importance of the ocean (Lin et al., 2020). The notion of environmental education is now a globalized concept in national educational policies, conservation strategies, and development initiatives (Rickinson, 2001). Despite that, research in several countries shows that citizens have limited ocean knowledge about the ocean (Brody, 2010; Fortner & Mayer, 1991; Steel et al., 2005; Guest et al., 2015).

Since 1996, there has been a need to define a baseline for ocean literacy in the United States, to effectively change the science education standards, especially in formal education (Cava et al., 2005). To mitigate this problem, the National Marine Educators Association (NMEA) compiled a document regarding ocean literacy's fundamental principles and concepts (National Oceanic and Atmospheric Administration, 2013). In the last decade, the focus has changed and now is a global reference in teaching multiple audiences, from business professionals to fishermen, by several means (e.g., Formal, informal, and blue growth strategies) (Marrero et al., 2019). The original framework was revised in 2013 and complemented by NMEA. The goal is to define what students must learn by the end of the 12th grade to be considered ocean literate. The lack of ocean literacy hinders society from engaging in sustainable behaviors (McCauley et al., 2019). Knowledge, one of the critical aspects of achieving proper levels of ocean literacy, appears to be lacking among the general public (Gelcich et al., 2014). The gap in knowledge in ocean-related affairs has been associated with poor inclusion in the formal science education curriculum (Hoffman & Barstow, 2007; McPherson et al., 2020; Gough, 2017). In fact, over the last decade, students have shown a significant lack of interest in science and mathematics (Rocard et al., 2007). They are leading to a decrease of science students in many parts of Europe (Gago et al., 2005). In addition, according to Lambert (2006), there is a lack of teacher training in marine science affairs, so efforts must be made to ensure teachers have the proper understanding of ocean literacy principles to pass them on to their students. There have been reports stating low levels of ocean literacy awareness between the adult and younger population in Canada (Cummins & Snively, 2000), the United States (Steel et al., 2005), the U.K. (Ward & Cowie, 2019), South Africa (Nyman, 2018) and New Zealand (Gough, 2017). There are still some misconceptions about marine-related phenomena among young students, especially regarding ocean acidification, dispersion of sea life in the ocean, and the concept of by-catch (Leitão et al., 2018; Ballantyne, 2004; Gelcich et al., 2014)

The ocean literacy concept is relatively new in Europe, although since the early 2000s, this concept has been growing in the United States, particularly by the National Marine Educators

Association (NMEA). The first conference on this matter was held in 2012 and marked a political priority to the EU. Despite that, according to European Marine Science Educators Association little has been done to develop and include in the formal education curriculum. Portugal was the pioneer European country to implement ocean literacy concepts into the teaching program. "Conhecer o Oceano", coordinated by Ciência Viva in 2011, was the first project aimed to change the level of knowledge of the ocean among Portuguese citizens with the concept of the North American Ocean Literacy initiative (Costa & Caldeira, 2018). The proposal initially was to integrate this concept into the existing school curricula in the History and geography subject. Since then, the "Essential Principles of Ocean Sciences for All Learners of All Ages" framework was successfully adapted and integrated into the Portuguese school's program. This NGO also provided a guidance chart to help teachers introduce the ocean literacy. principles into the various subjects' themes throughout the mandatory school years (1st to 12th grade). A few years later, the Blue school project was launched by the Portuguese Ministry of the Sea in coordination with the Directorate-General for Maritime Policy (DGPM), the Oceanario de Lisboa, and Ciência Viva. This project intends to highlight the schools committed to engaging the local community in promoting ocean literacy, giving them certification and resources to work on ocean-related topics within the school curriculum. In implementing the activities, a blue school fostered partnerships with a great variety of entities in the maritime industry, supporting the certified schools and connecting them to the ocean (Costa et al., 2021). This initiative has been considered a success story and received several mentions in the scientific community, as in the UNESCO Ocean Literacy Toolkit.

Since 2007 in Portugal there has have been a significant increase in new projects related to ocean literacy. According to Barracosa et al. (2019), eighteen projects were initiated in Portugal, ten of which are still active. Despite that, ocean literacy and environmental education in Portugal and other European and American countries continue to be overlooked in the formal K-12 curricular programs (Barracosa et al., 2019).

Since 1990, there has been a growing number of publications in the environmental literacy framework assessing knowledge, cognitive skill, affective disposition, and behavior components, including awareness and attitudes. Recently, efforts have been made to assess the ocean literacy level across communities worldwide with the International Ocean Literacy Survey (IOLS). This survey intends to serve as a community-based measurement tool to define the levels of ocean knowledge across time and location. However, the results of this survey are not yet published.

The evaluation of any environmental education program is a crucial step in assessing the impact on its participants and is essential to ensure the objectives are met. Also, this assessment is key to monitor initiatives within the ocean literacy program to elevate awareness and knowledge and, hopefully, to trigger a change in individual behavior (Robinson & Murray, 2019).What defines the educational program's success depends on the participants' commitment and motivation, affected chiefly by their social settings, as well as their awareness of their surroundings. There is some empirical evidence that programs with successful stories lead to self-criticism in their daily choices. In addition, programs that promote a sense of empowerment, personal responsibility, and perceptions of self-efficacy in natural settings, have more success in achieving the intended goals and be more effectiveness (Stern et al., 2014; Powell, and Hill, 2014; Hungerford & Volk, 1990; Hsu & Chiu, 2004; Athman & Monroe, 2001; Palmberg & Kuru, 2000).

The Kids dive program started in 2018, with the ambition to bring the ocean closer to the younger generation trough diving. In Portugal, this initiative was pioneer in linking education to a diving experience promoting a stronger ocean connection. The activities planned in the original program consists in four days in total. The day "zero" consists on a class introduction of the program giving the general context of this program. After that, students are invited to experience diving for the first time and workshops on the plastic problem and marine biodiversity. Furthermore, the students can have a guided visit the Lisbon oceanarium and to visit the local intertidal rocky shore with a marine biologist. To wrap the program up, the final day is a "summit" were the team invites local scientists to share their work and talk about their experience in the field. In this event, the students are encouraged to present what they have learned and share their personal experienced during the Kids dive program. This project was designed to be a 100% hands-on experience, giving students the opportunity to interact with scientists. Knowing that some students can be overwhelmed with the diving experience and allied with the pandemic outbreak the project had to be reinvented and the new virtual version emerged. Currently, we live in an era of rapid, and global information propagation, with the potential of reaching all kinds of audiences. In the recent decade technology has evolved into something we carry with us in our pockets, making information more accessible and faster. Thus, learning opportunities are becoming more fluid and mobile (Kumpulainen & Sefton-Green, 2014) making the line between in-school and out-of-school learning tinner (Bulfin et al., 2016). Although students still look for guidance in the school context on unfamiliar or complex aspects of technology use (Bulfin et al., 2016). This fact implies that schools no longer have a monopoly on information and knowledge. Digital technologies are a natural and integrated part of almost all activities for the younger generation, and as such are: "part of the taken for granted social and cultural fabric of learning, play, and social communication" (Deeson, 2014). As such, the potential has been explored for using technology for educational purposes, especially on social media. This fact gives teachers the opportunity to influence a broader audience, with different kinds of interests as young people tend to rely increasingly on social media to get information and be entertained. This can be a problem, as the information is often simplistic, lacks a deeper analysis of problems and broad perspective, and ultimately without recommendations on the significance of taking action. However, Guest et al., 2015 suggest that the student's interests must be considered when conducting ocean literacy programs. Environmental education programs must have this media component redirect the curiosity and excitement to increase ocean literacy. Marrero, (2010) found that animal life is the most exciting topic among young students. This "hook" can be a powerful tool to introduce poorly or misunderstood subjects such as currents, tides, and waves (Ballantyne, 2004) and can be used to introduce urgent topics such as climate change and ocean acidification.

II. Deliverables Documents

a. Support document for teachers

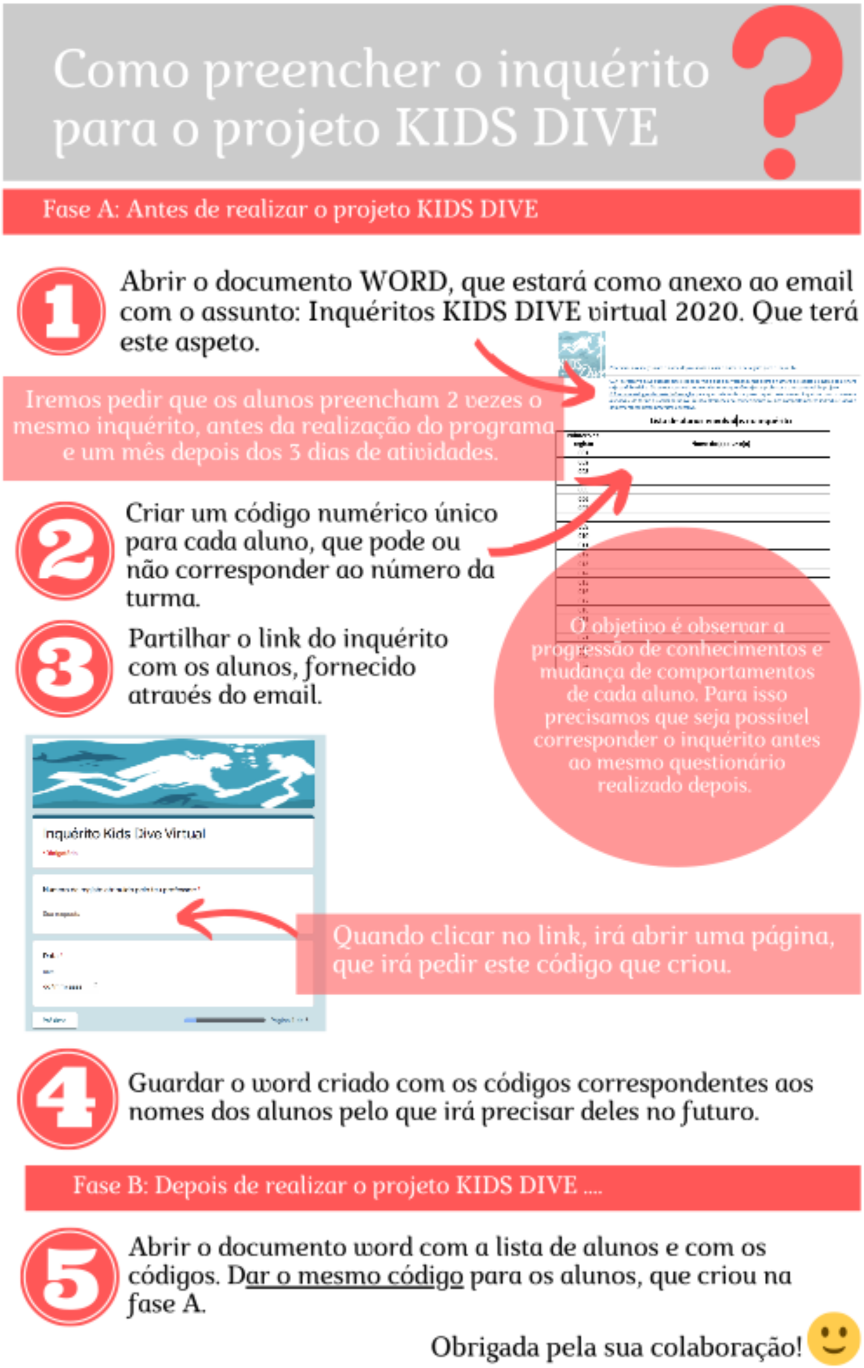


Figure 9. Guidance document for teachers to correctly submit the surveys.

O/A Professor/a deve guardar esta lista de forma a que a correspondência entre o número de registo e o nome do aluno/a seja **confidencial** e não esteja acessível a outros elementos que não sejam o professor e o responsável do projeto.
É fundamental guardar esta informação para que mais tarde se possa repetir este mesmo inquérito com os mesmos alunos/as, de forma a avaliar se houve ou não alterações no conhecimento ou nos comportamentos individuais após a implementação deste programa educativo.

Preencher os espaços com o nome do/a aluno/a e usar o número de registo para o inquérito

Lista de alunos envolvidos no inquérito

Número de registo	Nome do(a) aluno(a)
001	
002	
003	
004	
005	
006	
007	
008	
009	
010	
011	
012	
013	
014	
015	
016	
017	
018	
019	
020	
021	
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037	
038	

Figure 10. List document for teachers associete the student's number to their respective name.

b. Authorization document directed to the School Principal to acknowledge the student's participation on the Survey

ISPA
INSTITUTO UNIVERSITÁRIO

Compromisso de responsabilidade

A Direção da Escola____ foi informada e concorda na participação da escola no projeto KIDS DIVE.

A Direção da Escola:

____

__________________________, _____________
(Local) (Data)

c. Authorization document directed to the legal guardian to acknowledge the student's participation on the Survey

TERMO DE RESPONSABILIDADE

Eu,____, maior, titular do documento de identificação civil nº _______________, titular dos poderes parentais relativamente ao Aluno Participante ____ ______________________ titular do documento de identificação civil nº____________

declaro, para os devidos efeitos legais, aceitar expressamente os termos do presente Termo de Responsabilidade. Confirmo que a informação declarada corresponde à verdade e que não estou a omitir nenhum facto do qual tenha conhecimento.

Declaro que autorizo o meu educando acima identificado a participar na **atividade de introdução ao mergulho**, contemplada no programa educativo Kids Dive, que segue todas as recomendações e normas internacionais para atividades de mergulho com escafandro autónomo que envolvam menores entre os 8 e os 17 anos de idade.

Declaro que autorizo a **realização de inquéritos** com o objetivo de avaliar a eficácia do Kids Dive ao nível dos conhecimentos e da consciência ambiental dos alunos, no sentido de poder melhorar este programa no futuro. Os resultados destes inquéritos poderão ainda contribuir para a publicação de resultados científicos. Os inquéritos serão realizados de forma anónima e confidencial e na presença do Docente responsável pelo Aluno.

Mais declaro, que autorizo, a título gratuito, a utilização dos **direitos de imagem do aluno participante**, incluindo nome, retrato, fotografia, voz, vídeo ou outro diretamente obtidos e desde que relacionados com o Kids Dive e os seus objetivos, sem limitação quanto ao tempo ou meio de divulgação. Os mesmos poderão ser reproduzidos total ou parcialmente, em qualquer suporte (papel, digital, televisão (linear e não linear), magnético, tecido, plástico, etc.) e integradas em qualquer outro material (fotografia, desenho, ilustração, pintura, vídeo, animação, etc.) conhecido ou que venha a existir, nos meios nacionais ou internacionais, diretamente ou através de terceiros. As referidas imagens e fotografias poderão ser utilizadas no âmbito de iniciativas ou ações relacionadas com o Kids Dive pelo que renuncio desde já a quaisquer direitos ou compensação que desta utilização possa eventualmente resultar. Por outro lado, as entidades organizadoras do projeto Kids Dive garantem a adequada gestão das imagens, salvaguardando sempre os direitos da criança aqui referida.

Declaro ainda, eximir o ISPA, o MARE ou qualquer uma das entidades parceiras de qualquer queixa, responsabilidade, consequência, dano, coima, multa, penalização, custo e/ou despesa que incorra e que esteja relacionada, direta ou indiretamente, com a participação neste programa educativo.

Assinatura do Encarregado de Educação: ____________________________________

______________________________ (Local) _____________ (Data)

III. Survey Questions

a. Survey questions in the ocean literacy category

Table 1. Analyzed survey questions and respective ocean literacy principle.

Principle	Questions
Ocean literacy 1º Principle	1) What is your opinion of the following statement: "There is only one global ocean because all the oceans we know are interconnected with each other".
Ocean literacy 3º Principle	2) When the water evaporates from the ocean it leaves the water cycle.
Ocean literacy 3º Principle	3) About 70% of Planet Earth is covered by water so anything that changes the climate in the ocean can also influence the climate on land.
Ocean literacy 3º Principle	4) The absorption of carbon dioxide (CO2) by the ocean reduces the so-called "greenhouse effect".
Ocean literacy 4º Principle	5) Most of the oxygen in the atmosphere is produced by photosynthesis by marine organisms.
Ocean literacy 5º Principle	6) "The vast majority of marine species prefer to live near coastal areas rather than in the open sea. "
Ocean literacy 5º Principle	7) The living things that we can observe in Portuguese waters are identical to those that exist elsewhere in the Atlantic Ocean (Africa, Brazil, USA)
Ocean literacy 5º Principle	8) "All species in a region are in some way dependent on each other."
Ocean literacy 6º Principle	9) If the average sea level rises it will affect roads, railway lines, beaches even during your generation."
Ocean literacy 6º Principle	10) Can man's actions change the temperature of the water in the ocean?
Ocean literacy 7º Principle	11) "As I often go to the beach, I already know the sea very well."
Ocean literacy 7º Principle	12) "What percentage of all marine habitats have yet to be explored?"

b. Survey questions in the attitudes category

Table 2. Analyzed survey questions on the category "Attitudes".

Questions - Attitudes
13) I get involved in actions/initiatives with the aim of contributing to the resolution of environmental problems that concern me.
14) About the problems related to the environment, I think I have the power to influence my family members.
15) On the problems related to the environment, I think I have the power to influence my colleagues.
16) On problems related to the environment, I think I have the power to influence other citizens.
17) I consider it my duty to participate in activities/initiatives that contribute to solving problems on a global scale.
18) I consider that I have a duty to participate in activities/initiatives that contribute towards solving problems on a family scale.

c. Survey questions in the curiosity to explore the ocean category

Table 3. Analyzed survey questions in the category "Curiosity to explore the ocean".

Questions – Curiosity to explore the ocean
19) The virtual reality experience has awakened in me the desire to dive "for real" as soon as I have the availability.
20) I found that the virtual reality masks helped me to understand the content that was being conveyed to me.
21) For me it is important to have the opportunity to interact directly and personally with something, so I want to protect it."
22) Diving with full equipment (tank, suit, etc.) is an activity that scares me.
23) Diving can be a leisure and fun activity that I can practice with family/friends.
24) There are many professions associated with the practice of diving.

IV. Complementary tables and graphs

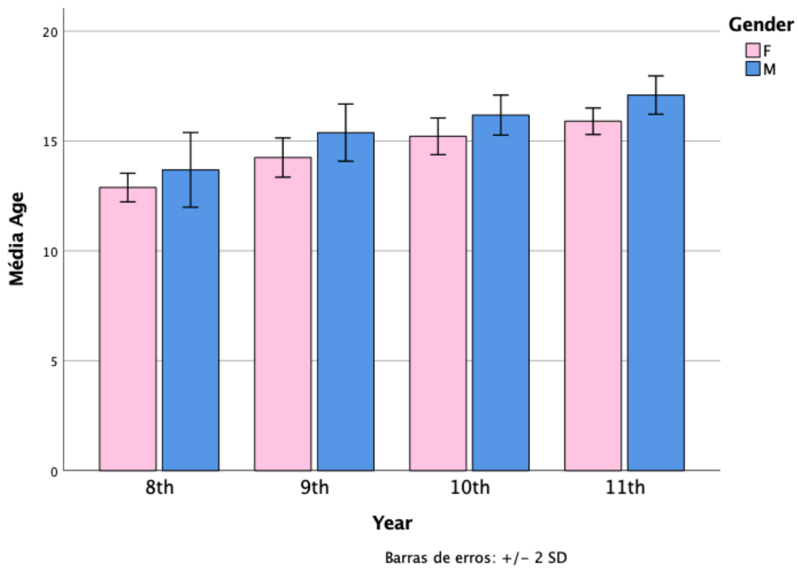


Figure 11. Graph illustrating students age in relation with grade and gender.

Table 4. Table illustrating the number of students by gender in relation of each school year.

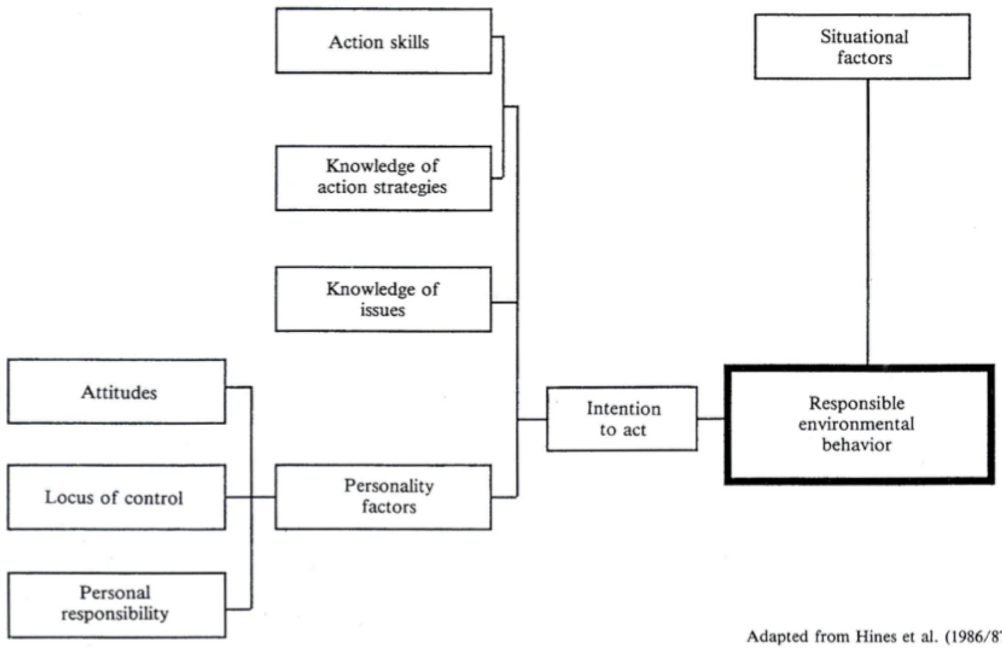
Gender	8th	9th	10th	11th	Total
Female	26	17	37	21	100
Male	29	12	38	21	101
	55	**29**	**75**	**42**	**201**

Table 5. Table illustrating the number of students by their school location.

Municipality	8th	9th	10th	11th	Total
Oeiras	17	0	22	0	39
Sintra	19	14	27	42	102
Setúbal	19	0	0	0	19
Olhão	0	0	26	0	26
Viana do castelo	0	15	0	0	15
	55	**29**	**75**	**42**	**201**

V. The Hines Model of Responsible Environmental Behavior

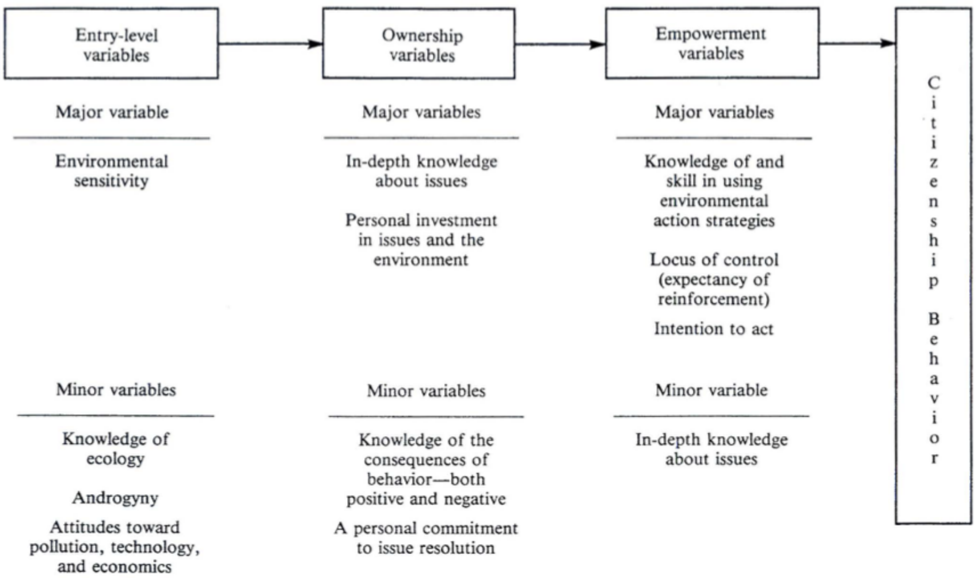
FIGURE 2.—The Hines Model of Responsible Environmental Behavior



Adapted from Hines et al. (1986/87).

VI. Behavior Flow Chart: Major and Minor Variables

FIGURE 3.—Behavior Flow Chart: Major and Minor Variables Involved in Environmental Citizenship Behavior



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