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Digital storytelling as an educational tool for scientific, environmental and sustainable development literacy on marine litter in informal education environments (Case study: Hellenic Center for Marine Research)

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Abstract

The modern era is characterised by the explosion of Information and Communication Technologies (ICT) and their multiple applications both in school communities and extracurricular activities. ICT enables the school community to engage in new educational storytelling approaches with educational and learning content, using multimedia applications. This article describes a study that took place at the headquarters of the Hellenic Center for Marine Research and involved a convenience sampling of 153 high school students (ages 13 to 15 years old). The study aims to investigate the use of digital storytelling, as an instructional tool for informal learning, to develop environmental and sustainability awareness, and enhance the scientific literacy of high school students around the topic of marine litter, a serious environmental and sub-regional issue of our times. A didactic intervention was applied which focused on digital storytelling and experiential hands-on activities covering concepts of marine pollution, to establish the acquisition of new knowledge and the strengthening of optimal behaviour towards the environment and development of sustainable attitudes towards the global problem of plastic marine pollution. The results of the study confirm the importance of digital storytelling for the cultivation of students' scientific and environmental literacy for oceans.

Keywords: DST; Non-formal education; science institute; education for environment and sustainable development; experiential activity; micro-plastics; pollution; science literacy; Information and Communication Technologies.

Introduction

The new era of globalisation and 21st century learning has brought many changes to all types of educational settings all around the world. Places such as zoos, museums, and other learning locations where this experience is often a one-time event, are classified as non-formal learning locations (Davidson *et al.*, 2010). Non-formal learning acts as a bridge between the formal and informal realms of learning. As Ainsworth & Eaton (2010) describe, non-formal learning usually involves some form of organization, but it can be extremely loose. In contrast to formal learning situations, there is no credit system established through non-formal learning. Therefore, the learning can be more genuine and realistic, as the focus is on building knowledge, without outside pressures or concerns. Compared to informal learning opportunities, which can be additive or transformative (Schugurensky, 2000), non-formal learning typically does have a defined location and time (Ainsworth & Eaton, 2010). In terms of non-formal, informal and lifelong learning, biosphere reserves, science museums, science centres, zoos, and aquariums constitute significant frameworks for public understanding and engagement of science and acquisition of scientific literacy (UNESCO, 2013) particularly on major challenges such as marine litter, connected to a wide range of research topics and welcoming large numbers of visitors. Furthermore, teaching science in science museums and science centres is strongly connected with the socio-cultural aspects of science education (Plakitsi,

2013). Science education plays an essential role in the development of science literacy, scientific methodology, scientific concepts, and science process skills of people in a technologically and scientifically advanced world. (Dewi *et al*., 2019).

Scientific literacy is one of the key competencies for 21st-century skills. It is considered essential for all citizens and is seen as the capacity to access, read and understand the global world from a scientific and/or technological perspective, in order to make a careful appraisal, and use that evaluation to make and inform everyday decisions. (Okada, 2013). Scientific and environmental literacy in modern societies, when provided throughout school learning environments (non-formal learning environments and informal learning) is a complex, demanding, issue, and full of challenges. Typically, this type of learning takes place in environments outside the classroom, which are aimed at the teaching of science to a heterogeneous audience in a pleasurable way (Maarschalk, 1988). Museums, zoos, science centres and other types of non-formal settings seem to be highly suitable to communicate science-related topics since they provide opportunities for a wide audience to see or experience scientific phenomena (Gibson & Chase, 2002). As these institutions are closely connected to the scientific community, they provide an ideal stage for communicating rapidly, and attractively, current scientific disciplines and important environmental issues to a broad audience. A variety of learning approaches are usually chosen in these environments, mainly from an experiential point of view such as observation, experiments, exploration, exhibitions, games, etc. (Scoullos & Malotidi, 2004). However, the use of activities in which students are actively engaged through hands-on experiential learning linked to real-world applications is more likely to produce more realistic experiences with the content that will be beneficial to student learning in multiple contexts (Clement, 2014; Digka *et al.,* 2018). According to a report of the US National Research Council for informal education (NRC, 2009), citizens choose to invest more time in out-of-school learning environments by attending programmes provided and implemented in various informal and non-formal educational settings. However, recent research showed that school visits to science museums and research centres do not seem to maximize the learning opportunities they could have offered to the students, due to the way they are conducted (Falk & Storksdieck, 2005).

Therefore, in the modern technological era, the use of digital tools for the implementation of scientific and environmental literacy in formal education and out-of-school learning (non-formal settings and informal learning) can be an effective pedagogical strategy. Alessi & Trollip (1991) point out that the capacity to improve science education is high when using technology as a didactic resource. Through various simulations, many abstract concepts can be comprehended more effectively. Furthermore, through these techniques, experiments that in real life would be dangerous, very costly or difficult to perform, can now be designed and executed successfully. According to Williams *et al*. (2000), the use of technology facilitates the construction of knowledge and allows the educator to provide more individualized attention. This is of paramount importance for new emerging or urgent issues where many educators may not have adequate knowledge and training. Such an issue is marine litter, where knowledge, fit for purpose data to support decision making, and help through positive public opinion of the implementation of the necessary measures, are scarce (Vlachogianni *et al.*, 2018, 2020). In addition, using multimedia and interactive materials favours the development of decision-making, communication, and problem-solving skills. (Whitworth & Berson, 2003; Robin, 2005). An innovative tool for enriching the learning and teaching approach of science education and raising environmental awareness is digital storytelling. Digital storytelling (DST) is characterized as the modern expression of the ancient art of storytelling and it is an application defined by the telling of stories through the use of multimedia technology (Duman & Göcen, 2015). DST helps students develop their creativity for solving problems and enhances their learning motivation. In addition, it gives them opportunities to express their thoughts and experience different perspectives (Ohler, 2008; Reijnders, 2010; Smeda *et al.*, 2014). Digital storytelling is an innovative approach that presents such opportunities as reflective learning, active learning, and learning by having fun (Bilen *et al.*, 2019). The approach allows learners to create unique relationships between their experience and academic content through active engagement in the teaching process (Lisenbee & Ford, 2018). According to Barrett (2005), digital storytelling facilitates the convergence of four student-centred learning strategies: student engagement, reflection for deep learning, project-based learning, and the effective integration of technology into instruction procedures. Based on results from the literature, educators at all levels and in most subjects/disciplines can use digital storytelling in many ways to support students' learning by encouraging them to organize and express their ideas and knowledge in an individual and meaningful way (Robin, 2008; Hur & Suh, 2012; Baki, 2015; Anderson *et al.*, 2018; Saritepeci, 2021). In addition, digital stories can open up a path to creativity and collaboration (Ranieri & Bruni, 2013; Lazar *et al.*, 2019). While it seems obvious that DST enhances knowledge in social sciences, humanities, languages and literacy education, it also works efficiently in science and technology classes according to the bibliography (Sadik, 2008; Wang & Zhan, 2010; Balaman, 2018). According to Bilen *et al.* (2019), the digital storytelling method can be used as a suitable teaching method for science subjects allowing them to be taught within a plot with the accompaniment of a story, and the method can be used as a successful means of concretizing and exemplifying abstract science concepts. The integration of non-formal teaching approaches within environmental-themed units as part of the science curriculum allows students the opportunity to make stronger personal connections with the material through the expression of the material in real-world applications. (Tan *et al.*, 2014; Bilen *et al.*, 2019). In the context of

environmental education and education for sustainable development, storytelling has been considered as an effective teaching strategy in cases where direct experience is impossible or unmediated, as well as in cases where the consequences of our experience are negative or undesirable (De Young & Monroe, 1996; Hadzigeorgiou *et al*., 2010). Furthermore, storytelling can be considered to be an effective strategy across the curriculum, especially when the educational goal is raising young students' awareness of the environment and sustainable development (Hadzigerorgiou *et al.*, 2010; Judson, 2010), and preparing students to further participate in science. Digital storytelling also seems to be a useful background for the planning and experience of museum exhibition visits, creating significant new challenges for their role in the educational process (Roussou *et al.*, 2015).

Purpose-Objectives-Research Questions

This study aims to assess DST as a teaching/learning strategy in a non-formal learning setting such as the Hellenic Center for Marine Research, for the promotion of positive attitudes among high school students towards plastic pollution and marine litter issues, particularly in the Mediterranean. Scoullos *et al*. (2017), have emphasised the importance of introducing critical issues such as marine litter in high schools, as well as in informal learning settings by utilising regional experiences. The research questions raised, concern the effectiveness and pedagogical value of DST in relation to the building of scientific and environmental literacy of high school students when this is combined with hands-on/or experiential activities. Analytically, the research questions are as follow:

1. According to the views of educators, could DST contribute to the improvement of students' science literacy in relation to major contemporary environmental issues?
2. Could DST contribute to student engagement and enjoyment of the learning experience in a research centre?
3. Could DST contribute to the popularisation of scientific knowledge when combined with experiential activities (e.g., laboratory experiments, etc.)?

Material and Methods

The teaching interventions took place from February 2019 until April 2019 in HCMR's premises in Attica under the supervision of HCMR's Education Unit. The Education Unit consists of a non-formal inquiry-based educational environment that promotes scientific and environmental literacy of students and the public through informal and non-formal educational approaches/methods. A convenience sampling consisting of 153 high school students was conducted, from various schools of the Attica region, of which 15% were first-grade students, 37.3% second-grade students and 47.7% third-grade students. Regarding the gender of the students, 58% were female and 42% were male.

The teaching/didactic intervention was entitled "Stephanie presents the history of plastics and their impact on marine life" and it was a non-formal intervention as it was based on student-centred teaching and learning approaches (e.g., participatory and learner-centred, process-oriented, close to real-life concerns, experiential and focus on learning by doing, etc.) (Council of Europe, 2001; Ainsworth & Eaton, 2010). The intervention included a digital narration and an experiential/hands-on activity and had a total duration of 1 hour and 50 minutes. As a pedagogical tool, the DST involved students in a story related to the given scientific issue of plastic marine pollution. The digital narrative was entitled "The history of plastics and their effects on the marine environment". The protagonist, and narrator, of the story, is Stephanie, a young chemical scientist descendant of the famous and renowned chemist Leo Beckeland. The heroine of the story works in a research centre that deals with marine research. Through the narrative, the heroine at first presents a brief historical background of the origin, production, and evolution of plastics as well as chemistry issues behind the creation of plastics (Fig. 1), emphasising their widespread and daily use through their multiple functions. Then the narrator refers to the impact of plastic marine waste in marine fauna and the marine ecosystem

Fig. 1: Presentation of the chemistry behind the plastics in the DST.

Fig. 2: Presentation of the impact of plastic waste in marine fauna.

Fig. 3: Presentation of the best practices to tackle the marine pollution issues.

Fig. 4: Hands-on experimental activity using stereoscopes.

in general (Fig. 2). The conclusion is that students have to adopt a responsible attitude and action in order to tackle this major environmental problem (Fig. 3). Through raising their awareness, the narrative aims to raise the children's interest in this serious environmental issue. The "Crazy talk animator" program was used to design the heroine of the narrative. The DST was presented via the Microsoft PowerPoint program, and the speaking parts of the narrative were recorded using the Audacity program.

Subsequently, the students participated in an authentic learning task such as a hands-on laboratory-experiential activity, for familiarisation with scientific methodologies and equipment. Students were provided with samples of sand, and they were asked to observe them with stereoscopes, to detect plastic and microplastic items in them (Fig. 4).

To evaluate the effectiveness of the intervention two different questionnaires (5-point Likert scale - and dichotomous questionnaires) were used with the students, aiming to investigate their awareness, performance, and attitudes towards marine litter and plastic pollution.

The option to provide two different questionnaires (pre-test and post-test) to students was chosen: a) to examine the cognitive status of students in relation to the environmental issue of marine litter/ plastic pollution (pre-test) and b) to investigate the impact, and effectiveness, of digital narration on both the improvement of their knowledge (students' final scores between 1st and 2nd questionnaire) and on their behaviour-attitudes axis. The post-test included several items related to the content of the digital narrative, the understanding/effect of which was a task that we wanted to assess.

The first questionnaire (pre-test) detected their perceptions and knowledge on plastics and marine pollution, while the second one (post-test), evaluated how their perceptions and knowledge were influenced by the intervention. The collected data were analysed through IBM SPSS Statistics.

Specifically, students completed the first questionnaire (pre-test) before participating in the intervention. The questionnaire consisted of 5 questions (Likert type and dichotomous questions) aiming to explore their knowledge and attitudes regarding the DST and the environmental issue of plastic marine pollution. The first question was a Likert type question related to students' familiarity with digital storytelling. The second one was a closed question (dichotomous question) referring to students' experience regarding the implementation of a DST. The third question (Likert type) investigated the frequency of students' recycling habits in their daily life. The fourth question (Likert type) assessed the students' awareness regarding the importance of the impact of plastic waste on the marine environment in relation to the aesthetical degradation, the damage of the ecosystem, and their impacts on human health. In the end, by answering the last questions students were asked to choose true or false for a series of cognitive items related to the use of plastics in our daily life and the effects of plastics on marine ecosystems. After the completion of the intervention and before their departure, the students completed a second questionnaire (post-test) aimed at investigating the understanding of the topics, terms/notions that were developed and presented in the teaching intervention and the evaluation of the pedagogical tool. Analytically three groups of questions were present in this questionnaire. The first group focused on the evaluation of digital storytelling (their views on the usability of the medium in science literacy and environmental literacy) and the satisfaction of the learning experience of students in the research centre. The second group referred to the understanding of the concepts presented in the DST and the experiential activity related to students' performance. Finally, the third group was concerned with students' attitudes towards the environmental issue of the impact of plastic pollution on marine life. Aiming to evaluate the intervention as a whole, a third questionnaire was handed to the educators (Educators questionnaire), at the very end of the programme. Educators from different schools who accompanied the students in their visit to the Center completed this last questionnaire, which consisted of seven questions. The first two were closed questions (dichotomous questions and referred to their familiarity with DST, while the remaining five (Likert type questions) aimed to reveal the educators' perceptions of using DST in science instruction and environmental education.

Table 1. Students' performance related to the results of pre-test and post-test.

Pre-test: Knowledge/Attitudes related questions	**% Correct answers**	**Mean**	**Std.D**
Plastics are widely used in our daily lives	97.4	1.03	.160
Plastics are not damaged.	58.8	1.41	.494
Plastics do not contribute to marine pollution.	81.7	1.82	.388
Many marine organisms eat plastic by choice	87.6	1.88	.331
Plastics break into smaller pieces called microplastics.	74.5	1.25	.437
Most likely, microplastics are a problem for our health.	85.6	1.14	.352
Plastic waste management is adequate.	66.0	1.34	.475
Disposable plastics, such as straws, cutlery, etc., cause great environmental damage.	83.7	1.16	.371
Recycling is a solution to the problem of plastic pollution.	89.5	1.10	.307
Changing people's habits is important for protecting the environment	92.8	1.07	.259
Post-test: Knowledge /Attitudes related questions	**% Correct answers**	**Mean**	**Std.D**
Plastics are widely used in our daily lives.	100	1.0	.000
Bakelite is a natural material	83.7	1.84	.371
Plastics are polymers	86.3	1.14	.345
Plastics are durable, malleable, and cheap.	92.1	1.08	.270
Plastics are stored for many years.	80.4	1.2	.398
A small percentage of marine pollution comes from the land.	51.6	1.52	.501
Plastics break down in the stomach of sea turtles	56.2	1.56	.498
Various marine organisms are trapped in plastic items	90.2	1.10	.298
Plastics break into smaller pieces called microplastics	94.1	1.06	.236
The microplastics are less than 5 mm in size	94,1	1.06	.236
Many marine organisms accidentally eat plastic.	96.1	1.04	.195
Most likely, microplastics are a problem for human health.	88,2	1.12	.323

Results

The analysis of the students' questionnaires including items on plastic marine pollution issues indicates quite significant changes in students' performance. (Table 1). Wilcoxon Signed Ranks Test showed that the students' performance concerning plastic pollution was statistically higher in the post-test ($Z = 4.949$ and $p < 0.001$ and effect size $r = 0.4$) than in the pre-test. The average score for the pre-test questionnaire was **76.8** while for the post-test was **84.4** (Table 2). This could be assessed as a positive result of such an intervention. Concerning the reliability and the validity of the questionnaires, the reliability value for the pre-test was calculated and its reliability coefficient was 0.613 (acceptable value for validity and reliability). Concerning the post-test, the Cronbach's alpha reliability coefficient was 0.764 which indicates quite strong reliability.

According to the results of the descriptive statistics, the students appeared to have little to moderate familiarity/experience with DST. Regarding their perceptions of the impact of plastics on ecosystem destruction, aesthetic

Table 2. Students' performance concerning plastic pollution according to Wilcoxon Signed Ranks Test.

Descriptive Statistics					
	N	Mean	Std. Deviation	Minimum	Maximum
Pre-test 100	153	76.7974	13.45820	20.00	100.00
Post-test 100	153	84.3682	11.40369	41.67	100.00
Test Statistics					
Z	-4.949[b]				
Asymp. Sig. (2 tailed)	.000				
a. Wilcoxon Signed Ranks test					

Table 3. Descriptive statistics of the students' perceptions as they emerge from the 1st questionnaire.

1st questionnaire (pre-test – Likert scale questions)	Median	Range	Mean	St. error	Std. Deviation
How familiar are you with the notion Digital Storytelling?	3.00	4	2.63	.111	1.376
Classify the impact/importance of plastic waste in the marine environment: Damage to the ecosystem	5.00	4	4.59	.063	.782
Classify the impact/importance of plastic waste in the marine environment: Aesthetic degradation of landscape	4.00	4	3.89	.076	.936
Classify the impact/importance of plastic waste in the marine environment: Deterioration of human health	5.00	4	4.65	.064	.797
How often do you recycle in your daily life?	4.00	4	3.87	.108	1.336

degradation and human health presented in Table 3, the findings indicate that the effect is quite significant. As far as recycling in everyday life is concerned, the results showed that the frequency of this practice varies between "every month" and "every week".

Additionally, perhaps as expected, the deterioration of human health is considered by the students as the major impact of plastics in comparison to the damage of the ecosystem and the aesthetic degradation of the landscape.

According to the results (Fig. 5), 79.08% of the students agreed that they should avoid buying disposable products (e.g., Single-Use Plastics / SUPs), while 78.43% of them agreed that recycling is a solution to tackle the problem of marine pollution (Fig. 6), and 94.12% of the respondents agreed that "we need to change our daily consumption habits and behaviours in order to protect the planet" (Fig. 7). The majority of the students (96.1%) expressed their belief that DST could advance education

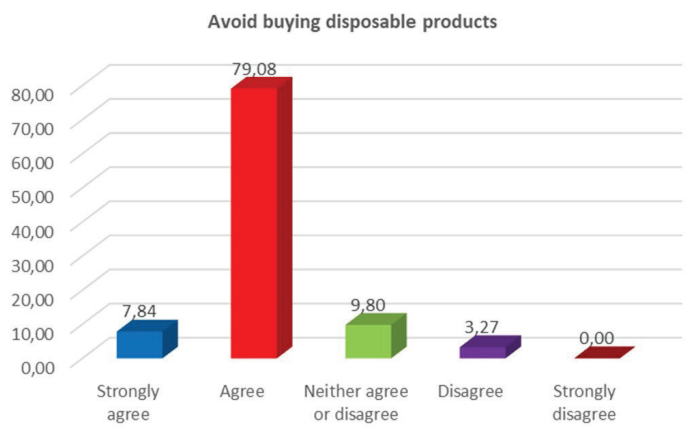

Fig. 5: Students' perceptions on avoiding disposable products.

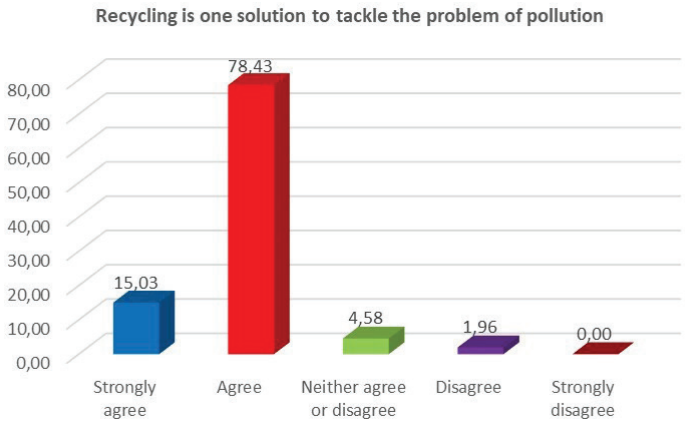

Fig. 6: Students' perceptions on recycling in our daily lives.

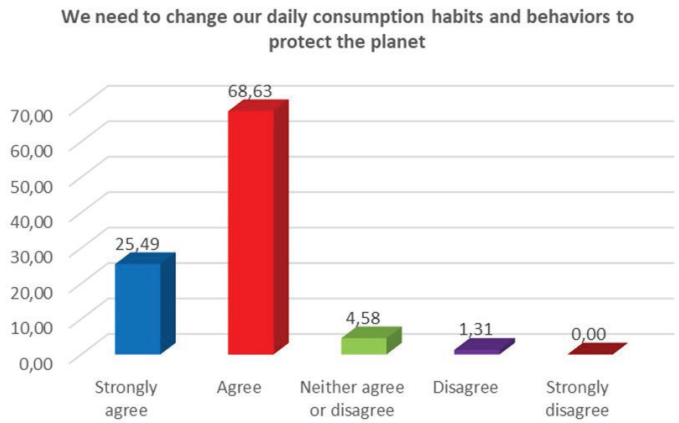

Fig. 7: Students' perceptions on changing our daily consumption habits.

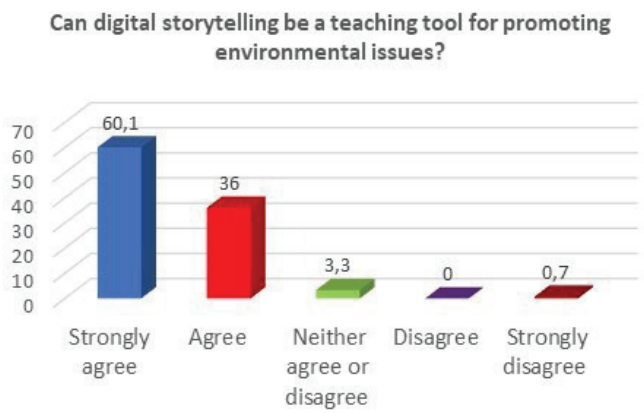

Fig. 8: Assessment of the suitability of DST in promoting environmental issues

concerning the environment and sustainable development issues, and could be used successfully as an instructional tool for environmental literacy (Fig. 8). Finally, most of the students expressed their satisfaction regarding the learning experience in the research centre with an emphasis on the experimental activity in which they had participated. (Fig. 9).

Concerning the data analysis of educators' responses, it appeared that most of them had previous experience with DST. The mean, standard deviation, median and range of their responses that are related to their experience with digital storytelling are given in Table 4. Furthermore, the reliability of the educators' questionnaire was also investigated. The reliability coefficient was 0.792 indicating quite strong reliability.

Moreover, educators responded positively towards the use of digital storytelling as an instructional and pedagogical tool for environmental/sustainable development and scientific literacy, as they consider that DST could contribute to students' engagement in a science centre (Fig. 10).

In conclusion, the results of a performed correlation analysis indicate that there is a strong positive and statistically significant relationship between the DST's contri-

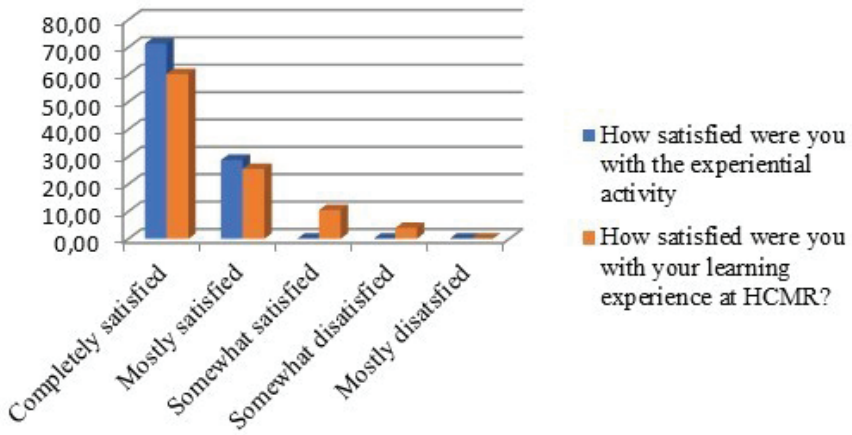

Fig. 9: Assessment of students' satisfaction from didactic intervention.

Table 4. Descriptive statistics of the educators' experience with digital storytelling.

Experience with DST	Median	Range	Mean	Std. Deviation
Are you familiar with the term DST?	1.00	1.00	1.21	.426
Have you ever viewed a Digital Story?	1.00	1.00	1.07	.267

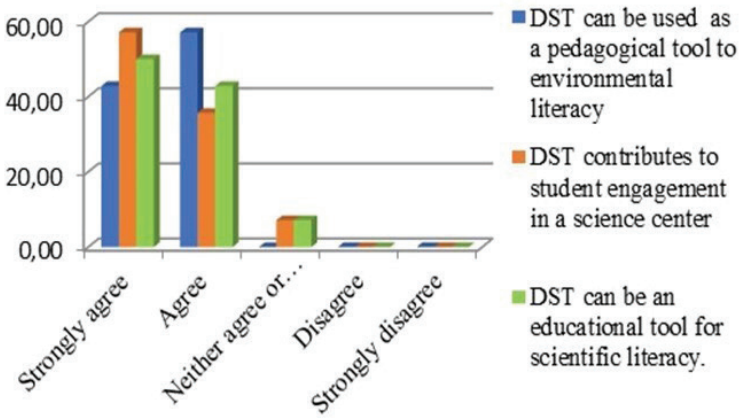

Fig. 10: Educators' perceptions of DST effectiveness in science education.

bution to students' engagement and the degree of active students' participation in the intervention ($\rho = 0.536$ and $p = 0.048$, <0.05).

Discussion

Education's role in behavioural change is indeed crucial, however, there is a lack of research regarding what has been developed towards plastic pollution and marine litter prevention and reduction. According to literature (Digka *et al.*, 2018; Bettencourt *et al.*, 2021), many interventions targeting marine litter issues and plastic pollution by using multimedia technologies to further attract youngsters, have been performed in the last 20 years. However, the use and implementation of a digital narrative as an initiative has not been recorded so far. Therefore, this specific case study could be characterised as pioneering, since it introduces digital storytelling as a useful and effective innovative initiative, able to adequately raise awareness and change attitudes towards marine litter issues.

To maximize the potential efficacy of the interventions, different skills, values and attitudes must be fostered, together with knowledge. For that, processes that rely on open-minded, reflexive and participative approaches must be explored as they will lead to better results (Tambovceva *et al.*, 2018). Similarly, the linkage between visual and experiential methods has been proved to produce positive results, as the participants can perceive reality and feel the necessity of changing behaviours (Anderson *et al.*, 2016).

In this study, we present a didactic intervention where digital storytelling and hands-on activities were combined to promote students' scientific literacy and environmental/sustainable development awareness in a science centre. Furthermore, we identify the degree of familiarity of students and educators with DST and their perceptions regarding the pedagogical value of DST in environmental and science literacy. Additionally, students' attitudes and perceptions on the environmental issue of plastic waste pollution were examined throughout this research. Based on our preliminary results some interesting conclusions emerged regarding the research questions that were investigated. In addition, our outcomes encompass not only knowledge acquisition but also changes in interest and attitudes.

The findings in this study showed that the majority of both students and educators (with a ratio of 7 out of 10) agreed on the usefulness of DST as an instructional tool for teaching science in non-formal educational environments. According to the literature (Gils, 2005; Sadik, 2008), the positive attitude of educators, and the effective use and implementation of DST by the school community, are both important factors for its successful integration into the learning process.

Moreover, all students and educators answered positively to the research question concerning the suitability of DST as a tool for the promotion of contemporary environmental issues, agreeing on the usefulness of its application in environmental literacy. According to the literature, storytelling is an appropriate education tool to persuade people and facilitate behavioural change (Anderson *et al.*, 2016; Pasupa & Pasupa 2017; Pahl *et al*., 2017). In addition, when educators were asked about the didactic value of DST in the science literacy of students, 9 out of 10 of them answered positively. As is indicated in the literature, the use of narratives to engage and stimulate changes in non-expert audiences has also been claimed as a powerful way to communicate science (Dahlstrom, 2014). Additionally, Bettencourt *et al.* (2021) emphasise the importance of developing hands-on and technologic-educational actions to foster participants' attitudes, perceptions, and behaviour changes, particularly among the younger generation.

Regarding the research question that referred to the engagement of students and the enjoyment of the learning experience in a science centre, the majority of the educators believe that it contributes positively. Additionally, most of the students stated that they were very satisfied with their experience at the research centre. The correlation analysis exhibited a positive and of high significance relationship between the DST's contribution to student engagement and the degree of active student participation. Concerning students' perceptions and behaviours on plastic pollution, it appears that the majority of them (7 out of 10 students) believe that plastic waste causes damage to the ecosystem, contributes to the aesthetic degradation of the landscape, and can threaten human life. Regarding recycling as a good environmental practice, a large percentage of students stated that they choose to recycle in their daily lives. More specifically, 4 out of 10 students stated that they recycle every day. In addition, 9 out of 10 students stated that changing our daily consumer habits and behaviours is important for the protection of the environment.

Summarising our results, we can conclude that the didactic intervention that was applied helped students to further familiarise themselves with digital storytelling and to further engage in marine pollution issues by the use of technologies as an ideal tool for scientific education and environmental literacy. In addition, it contributed to the cultivation of students' engagement in science and environmental literacy in a research centre by providing authentic experiences through hands-on interactions, which strengthened students' attitudes towards science and the environment. Furthermore, to maximize the potential efficacy of the interventions, skills, values and attitudes must be fostered, together with knowledge. For that, processes that rely on open-minded, reflexive and participative approaches must be explored as they will lead to better results (Tambovceva *et al.*, 2018).

Limitations and future research proposals

This research is a case study presenting early results that cannot be generalised, mainly due to the limited number of students trained. However, these results point to the need for further research on this topic. The repetition of similar interventions followed by surveys with a larger sample of participants (students and educators) in various non-formal/informal learning environments is strongly recommended for obtaining more reliable and generalised results. It is also suggested that for better development of the learning outcomes of the teaching intervention on the part of educators, there is a need for close and functional cooperation between teachers and educators from informal settings. Better preparation of both educators and students, before and after their visits to the non-formal learning centre, enhanced and complemented with appropriate material, toolkits, etc. is also needed (Alampei *et al.*, 2014). This cooperation would help teachers to acquire more in-depth knowledge about the connections between research centre resources and school science, to fully understand the importance of knowing the research centre resources before planning their school visit, in order to become a much more active participant during their own school visits (Faria & Changas, 2012). According to Anderson & Zhang (2003), the activities that will follow after a visit to a non-formal learning institution should be harmonized with the experiences and knowledge that students acquire during that visit but also with the use of pre-existing knowledge and experience in order to consolidate and/or expand the understanding of the issues related to the educational programs attended.

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