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Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Citizen Science practice around lake Pamvotis and the Ioannina Castle: Using iNaturalist to foster Connectedness to Nature in citizens and university students.

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ABSTRACT

Citizen science practice in Greece is in its early infancy, while crowdsourcing applications that can contribute to research are increasing in volume and provide excellent tools that can support in decision-making. The present article presents the design of a BioBlitz that took place in the castle of Ioannina and aims to complement the natural and cultural heritage assessment of the specific site through the participation of 116 citizens and university students. Basic tool for the biodiversity recording was iNaturalist mobile application and online social network that assisted in the identification process. Prior to the activity, basic training was provided through an introductory open course in Science Education under the auspices of the School of Early Childhood Education of the University of Ioannina, while the pre-questionnaire of Connectedness to Nature Scale (CNS) was administered to the participants. The results revealed that more than 26% of almost 1000 observations received a research grade, while 207 species were recorded, engaging 191 identifiers. The analysis of both the pre-questionnaires and the post-questionnaires that were collected a week after the BioBlitz, showed a statistically significant positive shift in the levels of CNS. However, low intensity and small scale of the activity should be considered, and multiple interventions or long-time programs could provide more robust findings.

Keywords

Citizen Science, Biodiversity, Connectedness to Nature, Education

1. INTRODUCTION

1.1. *Background*

It was in 1996 that the idea of Geoparks developed at the 30th International Geological Congress in Bejing and since June 2000 when the European Geoparks Network was established (McKeever & Zouros, 2005), the number of geoparks has a notable increase in volume especially in Europe an East Asia (Stoffelen, 2020). Greece already counts 7 geoparks according to the Geopark Map (www.globalgeopark.org) that continues to expand. The region of Epirus in the northwestern part of Greece is represented in the network by the Vikos Aoos Unesco Global Geopark. However, there are quite a few sites within the region, of outstanding

natural and cultural beauty that encompass geological, geomorphical, paleontological and geographical features with aesthetic appeal and educational value.

One of Europe's biodiversity "hot spots", Lake Pamvotis at the east part of the city of Ioannina, is considered one of the oldest lakes worldwide that has been in existence throughout the Plio-Pleistocene period (Touka, et al. 2018). Relatively unstudied, with its long-term stability it has the potential to provide a sedimentary archive on long-term environmental and climatic history (Frogley et al. 2001). The lake, with the karst cave of Perama, aged 1.5 million years, at its north-eastern part the most popular tourist attraction of the region with the castle of Ioannina that is built on a top a rock promontory jutting into the lake, is considered a typical Mediterranean ecosystem with great biodiversity and aesthetic value (Papagiannis et al. 2004).

The present study is inspired by a review that criticized the dominance of papers that promote the subjective and self-confirmatory character as to the societal importance of geoparks rather than critically investigating the engagement of the actual stakeholder (the community) with the societal practices (Stoffelen, 2020). It is probably the first research endeavor that aims to investigate the potential of a citizen and student engagement in recording species through a Bioblitz that was carried out alongside the lake banks surrounding the rock of the castle and inside the castle, to contribute to the efforts of monitoring the biodiversity and ultimately include the public to the conservation of the area. Through its affordances a well-established social utility platform and a mobile application such as iNaturalist (www.inaturalist.org) provided the perfect crowdsourcing tool for species identification and Connectedness to Nature Scale (Frantz & Mayer, 2004) a mature means for detecting possible changes in the emotional connection with nature after the intervention.

Applied in officially registered geoparks, such an approach can promote the societal engagement and contribute to sustainable practices and the conservation of such areas from the grassroots while enhancing connectedness with nature and emotional engagement.

1.2. *Previews research in the area*

Numerous studies have been conducted throughout the years that include biological or chemical investigations of the communities of plants and fish species that occur in this aquatic ecosystem, the water quality, and the process of identifying

anthropogenic pressures onto the lake. Intensive agricultural activities, alteration of hydrological regime, contamination from point sources and changes in the land-use and fish stocking are considered the main drivers that add pressure affecting surface water bodies of the lake (Alexakis et al. 2013). Metal (Cu, Zn, Pb) concentrations are also reported (Ioannides et al. (2008; Papagiannis et al. 2004). Hela et al. (2005) detected high seasonal ecological risks with the use of pesticides, while Daskalou et al. (2009), report a distinct spatial distribution of polycyclic aromatic hydrocarbons and anthropogenic petroleum contamination. In the same vein, human disturbances lead to the change of composition of benthic communities to more tolerant taxa, reflecting the hypertrophic character of the lake according to Kagalou et al. (2006), while Pepa et al. (2020) used the indicator of chlorophyll-a to investigate the eutrophication of the lake. Another study confirms that the lake suffers from cyanobacterial blooms (Vareli et al. 2009) and that a cyanobacterial and cyanotoxin monitoring program is needed. Accordingly, Papadimitriou et al. (2012), proposed continuous monitoring, concluding that the toxic nature of cyanobacterial blooms, clearly indicates a human and fish hazard, and Kagalou et al. (2008), report the presence of microcystins in the brain of omnivorous fish species *Carassius gibelio*, which shows that they can penetrate the blood-brain barrier. In 2001, the latter stated in a study about the water chemistry and biology of the lake, that a successful management plan that involves long-term monitoring data, hydrodynamic and ecological modelling may even lead to the restoration of the lake (Kagalou et al. 2001, p.92). Most recently, Sarika et al. (2020), identified, described and classified the dominant plant communities into habitat types, carrying out a conservation status assessment. Earlier on, Leonardos et al. (2008), studied the historical changes of the lake Pamvotis' fish, using data from historical fish catches records, from the Fisheries Management Agency, and from field surveys. The authors reported a shift from four native species to a domination of nonnative species that have been introduced without any concerns on the general public, government agencies, planners and fishermen, through a period of over 80 years. This dramatic change and introduction of alien species contributed to the serious decline in the diversity of macro-invertebrae community, with effects on the food chains and trophic structure of the aquatic systems. Through their study, they stressed out the importance of an "effective habitat conservation and the rehabilitation, along with the prevention of the further spread of invasive alien fishes and the education of fishermen and any other related people" (p.171).

Finally, it was only last year that the case of the rapid expansion of canker stain of plain tree (*Ceratocystis platani*) since the first report of Tsopelas and Angelopoulos (2004), due to the anthropogenic pressures that leads to the extinction of *Platanus orientalis* in northwestern Greece, became visible at the lake banks of Pamvotis.

1.3. The need of the study

The previous brief review represents half of the most relevant studies that were retrieved through a quick search in Google Scholar by typing "Pamvotis" which is the name of the lake of Ioannina. The main concern, however, is not the volume of the studies that have been conducted by researchers and scientists, but the lack of participation of citizens or students. Although most of the studies were practically carried out by doctoral students with and/or on behalf of the university professors, there is no reference whatsoever to the participation of the community.

Using the same search engine, Citizen Science (CS) Greece was typed, to discover an emerging list of studies, starting from a review that updated freshwater crayfish distribution maps through a combination of literature and citizen-science data (Perdikaris et al. 2017), an approach of collecting information on bear presence through a citizen science program (Bonnet-Lebrun et al. 2020) and a report on the implementation of a series of practical 'citizen science' projects that contributed to the transformative socioecological research in the island of Samothraki (Petrides et al. 2017). The most cited article refers to the role that CS play in monitoring marine alien species in Greece (Poursanides & Zenetos, 2013), reporting that 14 out of almost 240 alien species found in Greek waters, were reported for the first time by citizen scientists (p.1). Giovos et al. (2018), reporting on the monitoring of the species *Pterois miles* (Bennet 1828) by citizen scientists, describe a basic CS set up by the NGO iSEA (www.isea.com.gr/?lang=en) that included a Google Form and a Group on Facebook. Finally, Galanos & Vogiatzakis (2022), investigating the group of actors regarding aspects of environmental CS, found that Citizen Science is well-established (see also Eitzel et al. 2017), although they report that there is a need for raising public awareness of CS itself (p.47).

And although the list goes on with several case studies, none of them took place in the city of Ioannina. In a nutshell, there have been numerous studies concerning the

lake Pamvotis, the fish fauna, water quality, eutrophication and contamination but the community was absent.

Among the duties of the Management Body of Pamvotis Lake (www.lakepamvotis.eu/en/home-en/) that was constituted in January, 2003 for the preservation of the ecosystem, the restoration and maintenance of the ecological balance of the lake and the promotion of human and economic activities under the pillars of sustainability, is public education and awareness. In their homepage, immediately after the purpose, they state that "the contribution of the local community is essential and crucial to the success of this goal". Although there is no reference to how such a contribution can take place, other than volunteering. In other words, no systematic approach has been considered so far.

Citizen science has emerged as cost-efficient method to collect data for wildlife monitoring and can effectively inform research and conservation. In a very recent article that presents the history and the contributions of iNaturalist in Australia, although the authors acknowledge that the quality of CS has historically been questioned, they state that iNaturalist is one of the most globally successful based on participation and quality of data collected (Mesaglio & Callaghan, 2021). They also recognize the potential for understanding the spatial and temporal distribution of threatened species and conservation-based monitoring through the application, presenting a figure that describes the positive contribution of iNaturalist (Figure 1).

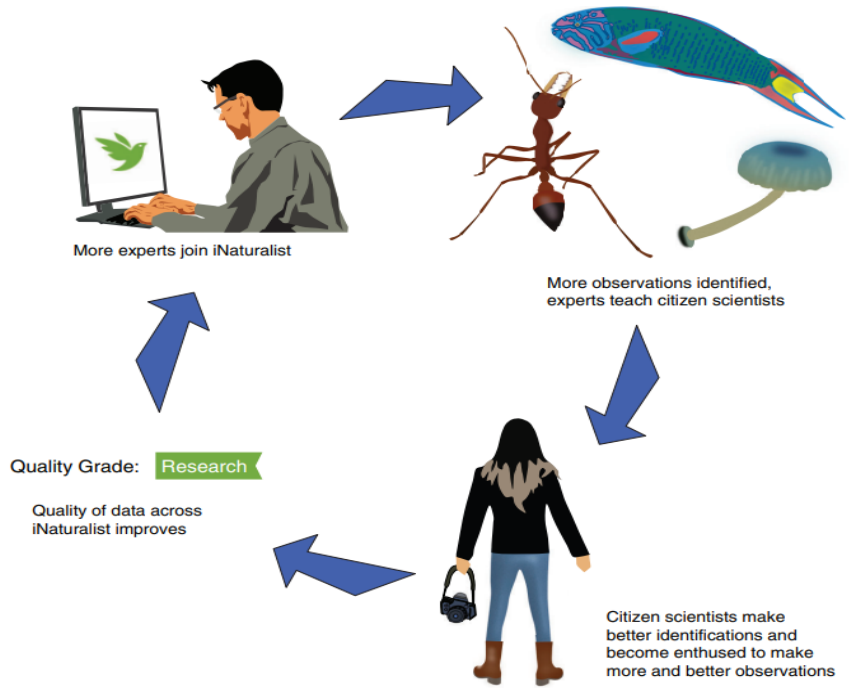


Figure 1. Conceptual figure showing the positive feedback loop as iNaturalist continues to grow in Australia. As more taxonomic experts join iNaturalist, more observations will increase the bioliteracy of the data, providing more data for ecological and conservation research questions in Australia (Mesaglio & Callaghan, 2021).

Therefore, exercises that investigate Citizen Practice and its adoption by the community in its early stages, to serve the needs of a great biodiversity hotspot such as the area of the lake Pamvotis is deemed crucial towards its protection and conservation. A well-organized CS program can effectively support the Management Body of the Lake, through a constant monitoring of the biodiversity in the general area by citizens and experts and surely can aid in resolving tensions between professional expertise, scientific research and democratic governance regarding environmental protection. In this study, the assessment takes place in an urban setting of great historical and cultural interest that rests by the lakeshore, and the very aim is to investigate the role of such an endeavor in fostering connectedness to nature as a very basic principle of CS.

1.4. *Aim, Rationale and Objectives*

Consequently, the aim of the study is to raise public awareness about the biodiversity of such a sensitive area of outstanding natural and cultural beauty, whilst engaging university students and the citizen in biodiversity recording. This research is deemed as an appropriate step towards the democratization of science (Irwin, 1995) in its initial stages, along with the assessment of the connection with nature of the participants and the investigation of a possible positive shift after the intervention.

Therefore, an objective of such an endeavor, could be accommodated by CS Level 1, based on a typology that focuses on the level of participation (Haklay, 2013). According to that typology, Level 1 corresponds to crowdsourcing of volunteered computing by citizen-sensors (p.116). Therefore, the first objective would be to evaluate the results of the biodiversity recording of the participants. The second objective could be attained through the administration of pre- and post-questionnaires related with the construct of Connectedness with Nature. Ultimately, we would like to see how a mini-Environmental CS project affects the emotional connection that the participants have with nature and thus, measuring the levels of connectedness to nature before and after the project could aid in this direction.

2. **THEORETICAL BACKGROUND**

2.1 *iNaturalist*

"iNaturalist.org", the project by Nathan Agrin, Jessica Kline and Ken-ichi Ueda at UC Berkeley's School of Information (2008), has dramatically grown and become a joint initiative between the California Academy of Sciences and the National Geographic Society. One of the largest unstructured biodiversity survey projects spanning the world" (Di Cecco et al. 2021, p.1), iNaturalist (https://www.inaturalist.org) is a web-based and mobile supported CS social network platform, where individuals can upload photo observations and identify organisms (Aristeidou et al. 2021). Echeverria et al. (2021) used the CS iNaturalist application and platform in secondary education, while Unger et al. (2021) engaged first-year undergraduate biology majors via outdoor labs of aquatic and terrestrial ecosystems using iNaturalist as a tool. Although the list of the articles that either refer to CS alone or on the contribution of data collected by citizens or students via iNaturalist, has grown recently, and a systematic review of such an area would be challenging, a recent article by Aristeidou et al. (2021), that adequately covers the theoretical background, stresses the need for contributions like the present study. The authors argue that the challenge to tackle biodiversity loss involves dissolving the citizens' ignorance of such an issue, stressing out the importance of personal responsibility, building scientific knowledge and encouraging public action (Sharman, Mlambo, 2012; McKinley et al. 2017). Notwithstanding the arguments about the accuracy and quality of the contributions by beginners and young people in CS (Parrish et al. 2019), Aristeidou et al. (2021)

explored the observations of young volunteers, in three National History Museums (two in California and one in the UK), to conclude that young people contribute observations that receive Research Grade, acknowledging the asymmetrical contribution through iNaturalist (few participants contributed the majority of Research Grade observations) and that volunteers with lasting participation are more likely to deliver valid data. In their final notes, they state that scaffolding through in-person engagement, training on the app, and tools for taking better quality photos are likely to enhance the overall quality of the data (p.14).

2.2. *Connectedness with Nature Scales and Benefits of Connection with Nature*

Inspired by the reflections of the influential ecologist Leopold (1949), and the Biophilia hypothesis (Wilson, 1984; Kellert & Wilson, 1993), many researchers focused on the connection between humans and nature and developed a wide range of tools for measuring the construct of connection with nature; as per the study of Tam (2013), there have been 17 scales. To name a few, the new Environmental paradigm (NEP) scale (Dunlap et al. 2000), the Inclusion of Nature in Self (INS) scale (Schultz, 2001), the Environmental Identity (EID) scale (Clayton, 2003), the Connectedness to Nature (CNS) scale (Mayer & Frantz, 2004) and the Nature Relatedness (NR) scale by Nisbet et al. (2009). Based on Tam's review, although there is some divergence among some scales, they seem to measure the same underlying construct (p.182). Consequently, CNS, which measures an individual's emotional and experiential response to nature, was chosen.

Whether emotional or cognitive, connection with nature benefits have been adequately discussed in the literature, such as in health (Martyn et al. 2020; Shanahan et al. 2016; Maller et al, 2016), happiness (Richardson et al. 2016), well-being, mindfulness and innovative thinking (Schutte et al. 2018; Howell et al. 2011; Leong, Carmen, and McClure 2014). Furthermore, associations with lower levels of anxiety (Martyn & Brymer, 2016) and increases in self-confidence (Swami et al. 2016), have also been reported. With respect to the environment, connection with nature is associated with pro-environmental beliefs, behavior and lifestyle (Davis, Green, and Reed 2009; Mayer and Frantz 2004; Nisbet et al. 2009). While Richardson et al. (2017), in their review, go beyond psychology and well-being, to more specific effects in cases of rehabilitation, improvements in the heart function, blood pressure and tension in the

muscles. Finally, responsible social behavior and strengthening of social ties have also been reported (Pirchio et al. 2021; Triantafyllidis & Darvin 2021), while the meta-analysis of Capaldi et al. (2014) also found an association with greater life satisfaction and vitality.

2.3 Research questions

In effect, the design and the findings of a side project of an overall program, namely "Title" is presented, which is hosted by iNaturalist and included an open training course, and the utilization of the Connectedness to Nature Scale (CNS – Frantz & Mayer, 2004) before and after the activity to detect a possible statistical change after a CS activity. To achieve this aim, two key questions were addressed:

- What are the results of the biodiversity recording conducted by the citizens and the university students via the project?
- How did the use of iNaturalist affected post CNS scores?

3. **MATERIALS AND METHODS**

3.1 *Study Area*

The Ioannina basin is a polje, probably formed during the Late Pliocene to Early Pleistocene (Clews, 1989), ca 30 km long and up to 15 km wide, and it is located at 470 meters above sea level in Epirus, northwest Greece. Its transitional climate between Mediterranean and continental allows for cold and wet, yet mild winters, and hot dry summers (Wilson et al. 2008). Data from the period 1956-2010 shows a relatively high precipitation and an annual mean of 1090 mm, according to the Hellenic National Meteorological Service (www.emy.gr). Finally, its bedrock comprises Mesozoic and early Cenozoic limestones and flysch overlain by thick Pliocene and Quaternary Lake sediments (IGME, 1963). Lake Pamvotis (39°40′N, 20°53′E) is a base level of a karst aquifer underlying the mountain Mitsikeli (1810 meters a.s.l).

Almost a decade ago, a group of researchers conducted a study that "explored the likelihood that Ioannina can contribute to the conservation of the regional pool of plant species" (Kantsa et al. 2013). Specifically, their lenses studied, i) alien plants and floristic variations during the past century, ii) plants of conservational value, and iii) the conservation potential and perspective of some typical urban habitats encountered in Mediterranean cities. Among the four areas that they focused on, lies the area of the

Castle of Ioannina on a small peninsula that extends in the lake (Fig.1). This first endeavor aims to contribute to the recording of biodiversity in the area and comprises the first CS project, conducted in the city of Ioannina, in the literature.

Figure 2. (A) Citadel: The medieval Citadel of Ioannina, it is still inhabited and entirely surrounded by the Fortress (Kantsa et al. 2013).

The whole city of Ioannina is included in a Special Protection Area (SPA) for the avian fauna (GR2130012) encompassing the urban pine forest which is a Landscape of Particular Natural Beauty (AT3011034) and the lake Pamvotis, a Site of Community Importance of the Natura 2000 (GR2130005). The lake stands between the city and the mountain Mt. Mitsikeli (1810m) that is both SCI (GR2130008) and part of the National Park of Northern Pindus (Kantsa, et al 2013).

3.2. *Description*

In the end of September 2022 “Title of program”, aka MSM, was uploaded to the European Sustainable Development Week (ESDW) platform and the Facebook page “Title of program Official”, inviting citizens to participate in an educational program that involved the recording of biodiversity in the area around the lake shore surrounding the Citadel and inside the Castle via the “Title” project that had already been set up through the iNaturalist platform (Anonymous 2022). A 3-hour training session hosted by the Department of Early Childhood Education of the University of Ioannina, through Microsoft Teams, took place in the beginning of October, presenting the application to the participants along with a brief introduction to the basics of biodiversity taxonomy.

3.3. *Sample*

Out of a total 116 of the participants, 86 were undergraduate students of the Early Childhood Education (46 freshmen, 40 senior) and 30 citizens. A week prior to the activity, an open session was delivered by the authors via Microsoft Teams, as part of the course "Introduction to Natural Sciences", providing the volunteers with a basic training in the use of iNaturalist and the basics of taxonomy.

3.4. *Tools*

The introduction of iNaturalist as a learning tool is not something new. In their recent study, Niemiller et al. (2021), tried to address 'biodiversity naivety' using the application, and although they outlined the challenges of using iNaturalist for learning, they stressed the importance of familiarizing students with the platform's goals and affordances (p.3). Through the training course, participants were provided with guidelines and examples of suitable observations (Unger et al. 2021, Boone & Basille, 2019), while they were introduced to the founders of Zoology and Botany, in the western world, (Aristotle and Theophrastus respectively) (Thanos, 1994), and to the modern taxonomy through the works of Charles Linnaeus (1799). Through the iNaturalist platform a BioBlitz project was created with the designation of an area that spreads along the lake banks and parts of the old town that surround the castle (Fig. 3)

Figure 3. Distribution of the observations from the "Title" project.

The CNS tool measures 'the extent to which an individual feels a sense of community, equality, kinship, embeddedness, and belongingness to nature' (Salazar et al. 2020, p.23). The tool consists of 14 items, to which people respond on a 5-point scale, where 1=strongly disagree and 5=strongly disagree, scoring a high internal consistency (Cronbach's alpha=0.84) and high test-retest reliability (Frantz & Mayer, 2004). Initially, Connectedness to Nature Scale (CNS) was translated through Back Translation as per Navarro et al. (2017). A native Greek translator with excellent

English literacy translated the scale from English to Greek, and the new scale was then translated back to English by a native English translator with excellent Greek literacy. Prior to the course, the questionnaire was administered to the participants through Google Forms. Finally, by the end of the project, post-CNS questionnaires were collected, along with the consent by the individuals that the data would be used only for the purposes of the study.

4. **RESULTS**

4.1. *"Title" project in numbers*

The project reached 997 observations of 207 species, along with the participance of 191 members of iNaturalist community who contributed to the identification process (Fig.4).

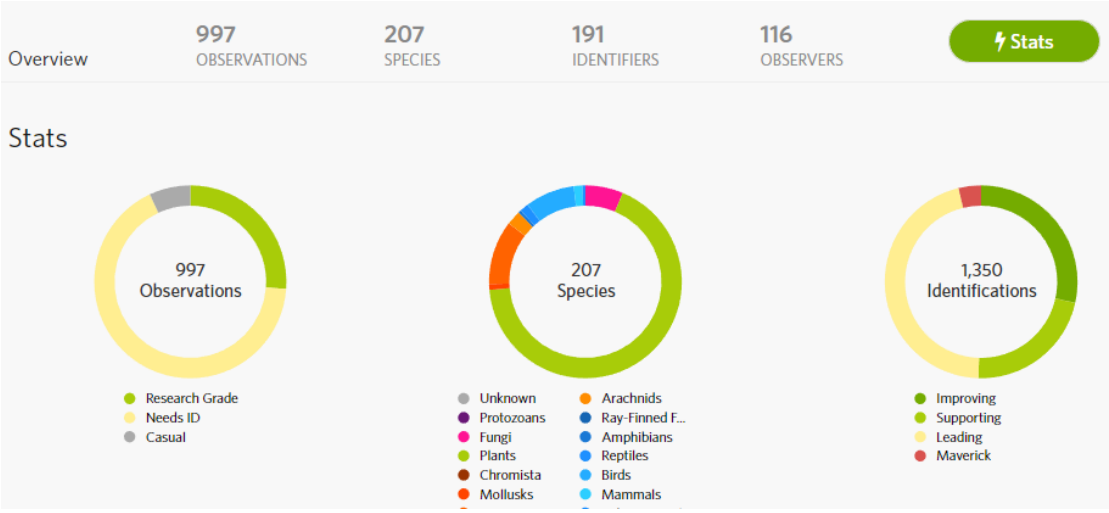


Figure 4. Basic statistics of "Title" project.

A total of 296 supportive, 385 improving identifications contributed to a total of 261 observations that received a research grade, representing 26,18 % of the total observations (iNaturalist contributors, iNaturalist, 2022). Specifically, 138 plant species were observed (*Acer platanoides, Iris albicans, Platanus orientalis, Cercis sliquastrum, Ficus carica, Campanula versicolor, Lythrum salicaria, Malva sylvestris, Taraxacum officinale, Impatiens walleriana, Mirablis jalapa, Sternbergia lutea, Aegopodium podagraria, Portulaca oleracea, Hibiscus syriacus, Arundo donax, Robinia pseudoacacia, Heliotropium europaeum, Juglans regia, Mirabilis jalapa, Solanum dulcamara, Phragmites australis, Verbena officinalis, Cichorium intybus, Alliaria petiolata, Acer monspessulanum, Tradescantia pallida, Viburnum tinus,*

Ligustrum lucidum, Sambucus ebulus, Ecballium elaterium,Phytolacca americana, solanum lycopersicum, Populus alba), 22 insects (*Sarcophaga* true fly, *Apis mellifera, Pyrrhocoris apterus,* genus *Polistes,* genus *Formica,* genus *Tapinoma,* family *Muscidae,* sub-family *Vespinae,* subfamily *Gomphocerinae,* tribe *xantholinini, Chrysolina haemoptera,* genus *Zabrus, Ocypus opthalmicus, Aphaenogaster testaceopilosa,* genus *Messor, Liometopum microcephalum, Macroglossum stellatarum*), 17 birds (*Chroicocephalus ridibundus, Podiceps cristatus, Corvus cornix, Columba livia,* C *Falco naumanni, Pica pica, Tachybaptus ruficollis, Corvus monedula, Motacilla cinerea, Fulica atra, Streptopelia deaocto, Anas platyrhynchos, Garrulus glandarius, Turdus merula, Motacilla alba, Spinus spinus),* 13 fungi (*Marasmius oreades, Leucoagaricus leucothites, Volvopluteus gloiocephalus, Rusavskia elegans,* family *Lecanoraceae, Xanthoria parietina, Genus Mycena, Family Candelariaceae,* family *Chrysothricaceae,* genus *Panaeolus, Lacrymaria lacrymabunda, Agaricus campestris, Agaricus bernandii*), 5 arachnids (family *Araneidae,* genus *Brachythele,* superfamily *Phalangioidea,* genus *Heliphanus,* genus *Allothrombium,* 3 reptiles (*Podarcis muralis, Natrix tesselata, Hemidactylus turcicus*), 2 mammals (*Erinaceus roumanicus, Equus caballus*), 2 mollusks *(Eobania vermuculata,* sub-family *Hellicellinae)* and 1 amphibian (*Pelophylax kurtmuelleri*).

4.2. *CNS*

A. Exploratory Factor Analysis and Reliability

For the statistical analysis of the pre-CNS collected by the participants, IBM SPSS Statistics 23 was used. The participants' average age in years was (M=22,05, SD=6,21). The mean age of the freshmen and senior students was 19 and 22.17 years respectively, while for citizens the mean age was 26.6 years, (SD=8,62). An Exploratory Factor Analysis (EFA) was carried out, following the same procedure as per Mayer and Frantz (2004) and other studies that analyzed its psychometric properties and considering the recommended sample size for conducting EFA (Nunally, 1975). Since the size of the study was N=116 and CNS consists of 14 items, sampling (sample/subject=8,28) was more than Gorsuch's (1983) suggestion of at least five subjects per variable and less than Everitt's (1975) minimum ten. Pre-CNS showed a good level of reliability (Cronbach's alpha = .86,6). After reversing the three negative worded items (item 4, 12 and 14), a factor analysis on the items of CNS produced a one

factor solution, suggesting a one-dimensional scale and that all the 14 items tap a single theoretical construct. Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy reached a .87 and the Bartlett's Test of Sphericity (χ^2 = 530, 591, df = 91), confirming significance. In particular, based on eigenvalues and the scree plot, a parallel analysis showed that only one component exceeded the mean eigenvalue, and therefore the other two components that exceeded an eigenvalue of 1 were excluded.

The eigenvalue of that factor was 5.26 and accounted for 37,62% of the variance, very close to that of the first study of Mayer and Frantz in 2004 (5.29 and 38 % respectively). All items loaded on it positively, from .38 to .75, with an average factor loading of 0.60 (Table 1). Finally, the mean score of the scale was 52.67 (S.D. =6,23).

The same process was repeated for post-CNS (Cronbach's alpha = .85,5) and the corresponding results are as summarized as follows (Figure 5).

(a)

Item	Pre-CNS	Post-CNS
1	,673	,553
2	,714	,634
3	,676	,691
4	,619	,431
5	,527	,623
6	,515	,586
7	,613	,607
8	,502	,670
9	,740	,752
10	,601	,712
11	,756	,726
12	,498	,568
13	,384	,328
14	,646	,442

(b)

Pre-CNS

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,844
Bartlett's Test of Sphericity	Approx. Chi-Square	531,614
	df	91
	Sig.	,000

Post-CNS

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,870
Bartlett's Test of Sphericity	Approx. Chi-Square	530,591
	df	91
	Sig.	,000

(c)

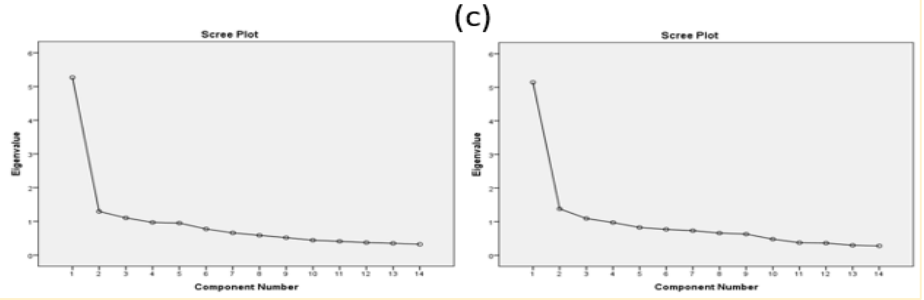
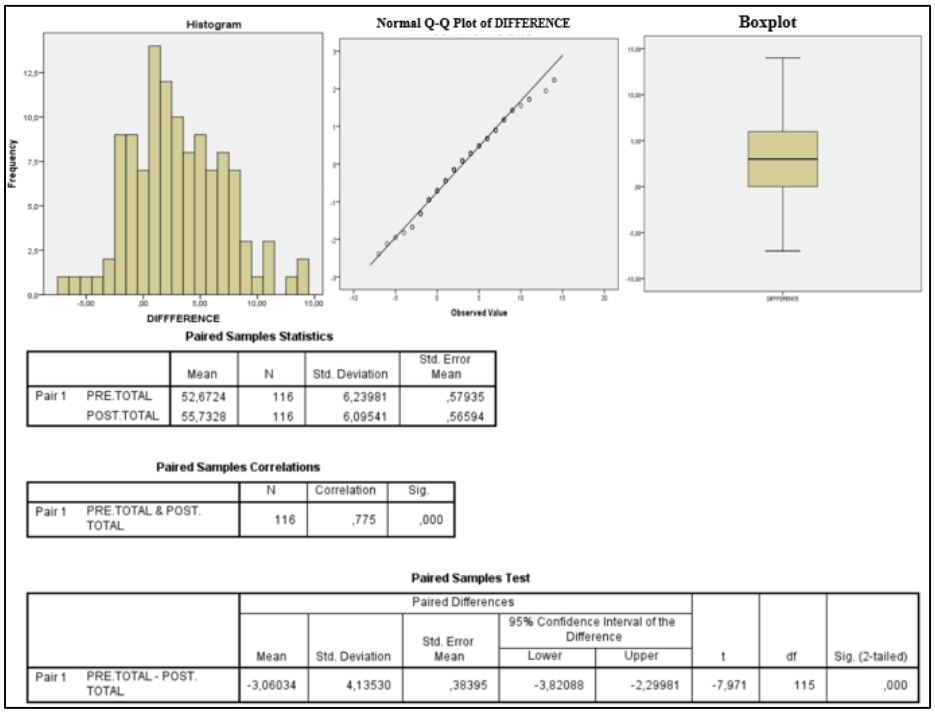


Figure 5. (a) Factor loading for individual items, (b) KMO and Bartlett's Test, (c) Scree Plots

B. Paired samples T-Test

Subsequently, the goal was to determine the effectiveness of that Level 1 CS and see whether there was statistically significant difference between the pre-CNS scores and the post-CNS after the training course and the iNaturalist Bioblitz "Title". Testing the assumptions, the normal distribution of the difference between the pre-CNS

and post-CNS (Statistic = .93, Kolmogorov-Smirnov = .016, Statistic = .984, Shapiro-Wilk = .179, df=116), and the graphics, allowed for a Paired Samples t-test (Figure 6).



Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE.TOTAL	52,6724	116	6,23981	,57935
	POST.TOTAL	55,7328	116	6,09541	,56594

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PRE.TOTAL & POST. TOTAL	116	,775	,000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	PRE.TOTAL - POST. TOTAL	-3,06034	4,13530	,38395	-3,82088	-2,29981	-7,971	115	,000

Figure 6. Graphics of DIFFERENCE variable (on the top) and Paired Samples T-Test statistics (down)

Results of the paired samples t-test showed a statistically significant difference between the mean pre-CNS (M = 52,67, SD = 6,24) before the open course and the "Title" iNaturalist project and the post-CNS (M = 55,73, SD =6,09), t (115) = -7,971, n=116, $p<0.05$, 95 % CI for mean difference: -3.820 to -2.299, r = 0.775. On average, there was a positive change in the CNS scores increased by 3,06 after the intervention. Finally, statistics of the three different groups (Freshmen, Seniors and Citizens) are also provided showing the greater change in the citizens group (Table 1).

Table 1. Pre and Post CNS scores within each group.

Groups	Pre-CNS Mean & SD	Post-CNS Mean	Difference
Freshmen (n=46)	Mean=50,78, SD=5,53	Mean=53,80 SD=5,56	Mean=3,02 SD=4,73
Seniors (n=40)	Mean=54,02 SD=6,39	Mean=56,37 SD=5,99	Mean=2,35 SD=4,21
Citizens	Mean=53,76	Mean=57,83	Mean=4,06

	SD=6,51	SD=6,33	SD=2,70

5. **DISCUSSION**

The results of the biodiversity recording are considered poor as 66 % observations still need identification and almost 7% are casual (meaning that the organism is not wild, or the observation lacks basic information). There are still photos that do not allow for accurate identification due to poor quality. Although the training course was oriented towards the presentation of the required steps for recording the observation via the app, there was no reference to the prerequisites of a proper photo, such as clarity. However, the recording of more than 200 hundred species gives an indication of the rich biodiversity in the area. It is noteworthy that almost a year after the implementation of the Bioblitz project, more than 25% of the participants carried on with observations and the use of the application.

The findings of the study, also indicate that utilization of iNaturalist in the recording of the biodiversity, aided in increasing the CNS score of the participants even through a program of short duration, providing positive feedback with regards to the second research question. Furthermore, not only were the students engaged in a CS activity for the first time in the city of Ioannina but also their awareness about natural heritage around an area of outstanding cultural beauty was enhanced. Those results are also consistent with that of Sellmann and Bogner (2013), where the authors explored the effect of a 1-day environmental education program on environmental attitudes and connectedness with nature. In their study, they reported a significant increase in INS scores after the participation levelling back again to the initial scores after a period of 4 to 6 weeks (p.1082). In their concluding remarks they argue that short term programs do not have a persistent impact on connectedness with nature although effects on environmental attitudes may be achieved. Liefländer et al (2013) also, have remarked that the construct can be influenced by the duration, frequency and setting of the natural encounters and can have an impact even on the ages before 11. Therefore, a future study that also involves these parameters could further investigate in depth the role of iNaturalist in changing CNS levels and shed light on the adulthood age.

Proceeding from Level 1 CS to Level 2 labeled "Distributed Intelligence" by Haklay where people as basic interpreters with volunteered thinking contribute to a natural assessment of a cultural park, would be a challenge. For instance, a CS program that involves the recording of *Ceratocystis platani* would surely engage people to the struggle towards the preservation of *Platanis orientalis.* In essence, peoples' connectedness to nature could be enhanced and be more durable, when the people feel that they participate in meaningful actions that help preserve the natural environment.

However, and even though the construct has been adequately explored in the literature, the role of ICTs such as iNaturalist should be interrogated, that "get users to 'connect' with an authoritative defined 'nature' when it seems that they instead promote a colonizing way of knowing that reinforces the distance between human as subject and nature as object, rather than a more intimate way of knowing, sensing and interacting that acknowledges the nonhuman others as the subjects with whom we share and constitute our habited spaces" (Altrudi, 2021, p.139). Nevertheless, as the creators of iNaturalist have stated, iNaturalist is a community, of not only scientists and experts, but all kind of nature lovers, that encourages the exploration of all living things from one's neighborhood to far away deserts, mountains, jungles and such. A utility that is different from the traditional citizen science ones, in the sense that it is user-focused and can cultivate a lifestyle of data collection, through the self-interest of a hobbyist and not only an altruist desire to aid researchers as per its developers.

6. CONCLUSION AND FUTURE DIRECTIONS

The study aimed at presenting the results of a study where a CS project was designed and implemented and included the assessment of the biodiversity in an area of outstanding natural and cultural beauty through the aid of a well-established crowdsourcing mobile application. The results, although partially adequate, indicate that through the utilization of a promising crowdsourcing utility and application such as iNaturalist and the proper preparatory course, the recording of biodiversity in places of outstanding natural and cultural beauty such as part of the lakeshores of Pamvotis and the Castle of Ioannina, researchers can include students and citizens in the assessment of the area and contribute to a favorable change in the participants' Connectedness to Nature. Thus, enhancing democratization of science's efforts to

record and monitor the biodiversity of an area and include the community at the very first stages of conducting such research, strengthening the bonds between people and nature.

Most recently, the Ministry of Culture and Sports, the Ministry of Environment and Energy, the Natural Environment & Climate Change Agency and the National and Kapodistrian University of Athens, scheduled a program for the recording of flora and fauna of 20 archaeological sites in Greece (source: The National Herald, retrieved on August 3, 2022). The present study is in line with that announcement and perhaps such an activity has the potential to provide a more democratic approach through which citizens and higher education students can contribute to the scientists' efforts towards recording and monitoring biodiversity in sites of outstanding natural and cultural beauty. Not to mention that the study was carried out a few months before the local authorities proceed with actions for the restoration of sites of interest inside the Castle, such as the Ottoman Baths and the Ottoman Library and the Aslan Pasha Mosque with a view to establishing a cultural park inside the castle. Part of the volunteers' observations took place around these places, as they were stations of the overall program.

Anticipating further developments, a new program has been designed, that will be implemented through a Geotour along the first part of Louros River. It includes biodiversity recording in special sites of geological importance such as Kokkinopilos (Harris & Vita-Finzi, 1968), architecture, such as the Roman Aqueduct (Poulter, 2000) and Mousterian Middle Paleolithic Tool Industry, Asprochaliko (Higgs, 1966) among others.

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ETHICAL STATEMENT

An informed consent was received by the participants and all animal and plant rights were safeguarded. No human observation was involved throughout the project and there was no animal or plant misuse or mistreatment. Finally, the results of the observations made by the participants were treated as a total and there was no particular mention of a specific species or participant disclosing any sensitive information"