26 (1), 2025, 356-366

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Bridging Knowledge and Fear: Citizen Science in Enhancing Herpetofauna Literacy, Identification Skills, and Reduced Fear

Dian Samitra*, & Mareta Widiya

Biology Education Department, Universitas PGRI Silampari, Indonesia

Abstract: Species literacy and species identification skills are important to protect diversity and are issues in Sustainable Development Education. Fear of animals, especially herpetofauna, makes students avoid them and makes it difficult to study them. Based to the literature study, citizen science has the potential to solve this problem. This study aims to determine the impact of citizen science on species literacy, species identification skill, and fear of herpetofauna. This study included 44 biology education students from PGRI Silampari University who were studying Vertebrate Zoology classes. The data on species literacy was obtained using essay questions. Reports provided information on species identification skills. A questionnaire was used to collect fear data on the herpetofauna. The instrument used was declared valid and reliable. Species identification ability data was analyzed based on species resulting from citizen science activities. Species literacy data were analyzed descriptively and using the Wilcoxon Signed Rank test. Literacy increase data is calculated using the N-Gain Score. The results obtained show that 1) Species literacy data after the Wilcoxon test obtained sig. <0.05. The N-gain analysis obtained was 0.72 in the high category. 2) The herpetofauna identification data was 71.23%, indicating that students skills are passable in identifying species. The results of citizen Science activities showed that a maximum of 17 species were caught and a minimum of 6 species; 3) The Wilcoxon test revealed a significant difference in fear of herpetofauna (sig. < 0.05). Therefore, it can be concluded that Citizen Science significantly increases students' species literacy, identification abilities and reducing students' fear of herpetofauna.

Keywords: citizen science, species literacy, species identification skill, herpetofauna.

▪ INTRODUCTION

Rapid environmental changes caused by human activity affect biodiversity around the world (Jurumai et al., 2023; Rêgo et al., 2018; Ukaogo et al., 2020). Herpetofauna is a type of biodiversity that can be an indicator of ecology and biodiversity (Amarasinghe et al., 2021; Saber et al., 2017; Samitra & Rozi, 2020). However, herpetofauna research is often hampered by the lack of data and understanding between the public and scientists (Teixido et al., 2021; Vergara-Rios et al., 2021). Conservation efforts of Herpetofauna can be improved through knowledge or literacy of the species.

Species literacy is an essential ability for individuals to recognize and understand species (Hooykaas et al., 2019). Efforts to increase species literacy are also a key issue in Sustainable Development Education (ESD) (Härtel et al., 2023; Lindemann-Matthies et al., 2024). Species knowledge can be improved by improving species identification skills (Aldhebiani, 2018; Zukmadini et al., 2024). Therefore, students should develop knowledge and identification skills. One is through the application of citizen science.

Citizen science is a new trend in which people can collaborate in scientific research, regardless of their scientific backgrounds (Astuti & Rahayuningsih, 2022; Callaghan et al., 2019; Hamdiah et al., 2024). Citizen science refers to the active participation of citizens in the scientific data collection process, enabling the collection of information to be broader and the distribution of data more efficiently (Bonney et al., 2016; Brown &

Dian Samitra*, & Mareta Widiya
*Email: dsamitra@unpari.ac.id

DOI: http://dx.doi.org/10.23960/jpmipa/v26i1.pp356-366
Received: 06 February 2025
Accepted: 24 February 2025
Published: 15 April 2025

Williams, 2019; Phillips et al., 2019). Citizen science is not only linked to data acquisition and reporting, but also to the collaboration of knowledge and skills related to scientific research (Boone et al., 2024; Pocock et al., 2017; Voigt-Heucke et al., 2024). Furthermore, citizens' science can increase species literacy and species identification abilities hrough activities that come into contact with objects (Backstrom et al., 2024; Eugenio-Gozalbo et al., 2022; Perry et al., 2021; Soria Aguirre & Tormáné Kovács, 2023; Willi et al., 2019).

One factor that may hinder species literacy is the fear of herpetophobia (da Silva et al., 2021; Reynolds et al., 2018). Fear is often based on myths or ignorance, reducing the ability of students to identify species (Mutya & Inocian, 2024; Pandey et al., 2016). As a result, many students feel hesitant or anxious when they deal with herpetofauna, although they play an important role in the ecosystem.

The importance of improve species literacy and reducing prospective biology teacher students' fear of herpetofauna is a strategic step toward developing a generation of educators who are environmentally aware and support conservation initiatives. As future educators, biology students have a key role in transferring scientific knowledge and forming students' positive attitudes towards herpetofauna. This was confirmed by a statement from Zukmadini et al. (2024) and Skarstein & Skarstein (2020) species literacy and species identification skills will have a significant impact on the success of teaching and conservation of the species.

We conducted a search via Publish or Perish using the Google Scholar database. The results of studies on the influence of citizen science on species knowledge have been conducted on insect observations (Aripin et al., 2022; Paradise & Bartkovich, 2021; Perry et al., 2021) and bird (Backstrom et al., 2024). Based on past research, we discovered a gap that citizen science is used for insect and bird taxonomy, while herpetofauna has not yet been implemented. Apart from that, the impact of citizen science on reducing fear has not been studied. In this study, citizen science is expected to increase species literacy and reduce students' fear of herpetofauna.

This paper discusses the impact of citizen science on student literacy and the identification skills of species of herpetofauna that have not been studied. This study aims to determine the influence of citizen science on student literacy, species identification, and fear of herpetofauna.

▪ METHOD

Participans

The population in this study consisted of 44 Biology students from Universitas PGRI Silampari who joined in the Vertebrate Zoology course during the academic year 2023/2024. The sampling technique used was purposive sampling, so that all populations became samples.

Research Design and Procedures

The research used is pre-experimental, with a one-group pretest-posttest design. The research stages in figure 1. This study does not require a control group, thus the experimental class got intervention using differentiated learning techniques (Ningsih et al., 2024).

Figure 1. One-group pretest-posttest research design

The research technique consists of three stages: preparing and implementation. The preparing step comprises developing learning tools and learning scenarios based on citizen science. Creating instruments for pretests and post-tests to assess species literacy and fear of herpetofauna. In the implementation step, a pretest is used to determine initial abilities. Before beginning citizen science, students are given instruction learn to identify and search for herpetofauna. Small teams create citizen science initiatives. After searching for herpetofauna, students write a report and then give a posttest.

Instruments

Species literacy data was obtained using essay with a framework adapted from Hooykaas et al. (2022) and Mammola et al. (2023). The 10 species listed in the question come from the research results of Samitra & Rozi (2020) and Rozi & Samitra (2020), to adapt to the local herpetofauna found. Species identification skill data based on species analysis resulting from citizen science activities. Data on fear of herpetofauna were obtained using a questionnaire with a framework adapted from (Tomažič et al., 2017). The instruments used have been tested for validity and reliability. The essay instrument was declared valid (sig. < 0.05) with a reliability of 0.71. The questionnaire instrument was declared valid (sig. < 0.05) with a reliability of 0.73.

Data Analysis

Species literacy data obtained will be analysed using SPSS 25.0. Prerequisite tests will be used to assess species literacy data. If the data is normal and homogeneous, the t-test will be used, and if it is not normal and homogeneous, the Wilcoxon signed rank test will be applied. Additionally, increased literacy calculated by the N-Gain Score. Species identification ability data were analyzed descriptively.

▪ RESULT AND DISSCUSSION

Citizen Science Towards Species Literacy

Table 1 shows that citizen science has an overall increase in literacy of 0.72 in the high category. High category increases occurred in aspects of binomial nomenclature, local names, useful and harmful for humans. Meanwhile, diet and conservation status are sufficient category and the habitat aspect is low category.

The results of the prerequisite test using pretest and posttest data were not normal and homogeneous (sig. <0.05), so the species literacy data was analyzed by the Wilcoxon test. The results of the Wilcoxon test analysis are in table 2. There are differences in students' species literacy between pretest and posttest. Therefore, it can be concluded that citizen science significantly increases students' herpetofauna species literacy. These results are in line with research by Aripin et al. (2022) and Christ et al. (2022) that citizen science increases species literacy.

The increase in the results of the analysis of the citizen science pre-posttest is due to the experience of students with direct learning with subjek material. This active involvement encourages students to understand scientific concepts better and develop literacy (Listiawan et al., 2023). This was reinforced by Aripin et al. (2022) and Brandt et al. (2022) Citizen science improves species literacy by actively involving people in hands-on projects that increase their understanding. Citizen science improves the literacy of species by actively involving people in project-based learning. In addition, students read several references when identifying herpetofauna. These references help students understand the natural phenomena around them and enhance their understanding of species (Samitra & Widiya, 2024).

Table 1. Student species literacy N-Gain data

Aspect	N-Gain	Category
Binomial nomenclature	0.79	High
Local names	0.95	High
Habitat	0.29	Low
Diet	0.61	Sufficient
Conservation status	0.51	Sufficient
Useful for humans	0.77	High
Harmful for humans	0.89	High
Mean	**0.72**	**High**

Table 2. Results of wilcoxon analysis of species literacy data

Z	-5.777
Asymp. Sig. (2-tailled)	0.000

According to Coracero et al. (2022) dan Katili et al. (2021), increasing student literacy has an important impact on their ability to recognize the diversity of species and to preserve them wherever they are. Furthermore, species literacy is something that must be acquired because it allows them to solve environmental problems, to have a firm perspective, and to be very sensitive to making scientific decisions (Fajri et al., 2023; Katili et al., 2021). Therefore, in order to create a literacy society, literacy culture in higher education must be improved.

Table 1 shows that the habitat aspect received a low category. This is because students have prior understanding of the habitat. They learned about herpetofauna in elementary school, where it was covered extensively. A variety of strategies have been used to teach herpetofauna species, including augmented reality media and outdoor (Photo, 2024; Winarni & Purwandari, 2019).

According to Figure 2, 52% of students successfully answered the conservation aspect. This indicates that students have a limited understanding of each animal's conservation status. These findings are especially concerning because comprehending conservation is critical in conservation efforts. Understanding conservation is crucial for prospective teachers, as it equips them to foster environmental literacy and promote sustainable practices among their future students (Aydın & Keleş, 2021; Fakhriyah et al., 2024; Kipasika, 2023).

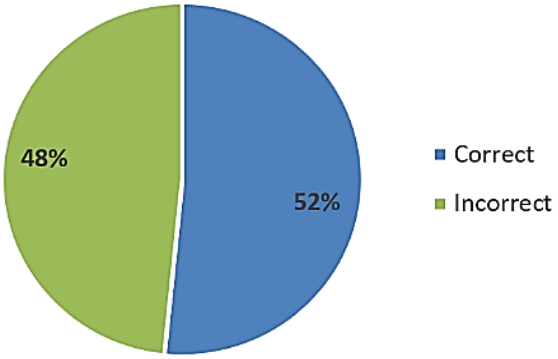

Figure 2. Percentage of student responses to conservation aspects

Citizen Science on Species Identification Skill

Table 3 shows an identification accuracy of 71.23%, this shows that students' skills are quite good at identifying herpetofauna species. The results of citizen science activities showed that a maximum of 17 species were caught and a minimum of 6 species. These results are in line with research by Aripin (2023) and Perry et al. (2021) that citizen science improved species identification skills.

In Citizen Science, students carry out activities to search for and identify species. This direct experience encourages students to increase their taxonomic knowledge and experience in identification (Aripin, 2023; Farr et al., 2023). Students' skills in identifying herpetofauna species are quite good because students already have the awareness to prevent the reduction or loss of biodiversity in an area.

The ability to identify species is vital for successful decision-making in biodiversity protection (Hooykaas et al., 2019). Apart from that, this capability can help in monitoring environmental health, mitigating biodiversity loss caused by human activity and climate change, and averting harmful circumstances (Tivarekar & Virani, 2017). Therefore, prospective biology teacher students need good identification skills so that these abilities can be conveyed to students.

Table 3. Species identification skill data

Species minimum	Species maximum	Average Species identified	% identification accuracy
5	14	8.15	71.23

Citizen Science on the Fear of Herpetofauna

Figure 3 shows the change in the number of students at each level of fear between pretest and posttest. The increase occurred in the not afraid and slightly afraid categories. Meanwhile, the decline occurred in the categories of fear and very fear. The results of the prerequisite test using pretest and posttest data were not normal and homogeneous (sig. <0.05), so the species literacy data was analyzed by the Wilcoxon test. The results of the Wilcoxon test analysis are in table 4. There are differences in students' fear of herpetofauna between the pretest and posttest. Therefore, it can be concluded that citizen science has significantly reduced students' fear of herpetofauna.

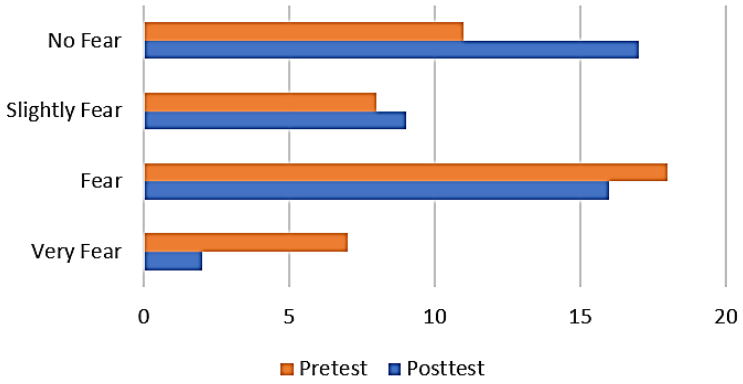

Figure 3. Data on student fear of herpetofauna

Table 4. Results of wilcoxon analysis of fear data in herpetofauna

Z	-3.217
Asymp. Sig. (2-tailled)	0.001

Students' fear of herpetofauna decreased because citizen science was able to understand animal behavior. Student involvement in contextual matters around them has an impact on behavior (Monica et al., 2024). This was confirmed by Teel et al. (2022), citizen science influences perceptions, behaviors towards wildlife and reduces fear. Student teachers need to have good knowledge and perspective on herpetofauna. This knowledge and perspective can be transmitted to students through learning. Students need to acquire basic knowledge about herpetofauna, so that later attitudes of fear and disgust disappear and change to friendly attitudes (Suryanda et al., 2024).

▪ CONCLUSION

Based on the research results, it can be concluded that citizen science has a positive impact on increasing species literacy, species identification skills and reducing students' fear of herpetofauna. The findings of this study contribute to the advancement of educational theory, including learning methodologies, species literacy, and student abilities. Besides from it, citizen science approaches can be used in middle school biology classes; this application serves as a platform for students to learn about the biodiversity in their surroundings. Future study may investigate such uses of experimental methods with control groups or the application of citizen science at different educational levels, such as in middle school.

▪ REFERENCES

Aldhebiani, A. Y. (2018). Species concept and speciation. Saudi Journal of Biological Sciences, 25(3), 437–440. https://doi.org/10.1016/j.sjbs.2017.04.013

Amarasinghe, A. A. T., Putra, C. A., Henkanaththegedara, S. M., Dwiyahreni, A. A., Winarni, N. L., Sunaryo, Margules, C., & Supriatna, J. (2021). Herpetofaunal diversity of West Bali National Park, Indonesia with identification of indicator species for long-term monitoring. Global Ecology and Conservation, 28, e01638. https://doi.org/10.1016/j.gecco.2021.e01638

Aripin, I. (2023). Online citizen science to develop local species identification skills and biodiversity awareness of prospective biology teacher students. Symposium on Biology Education, 347–355. https://doi.org/10.26555/symbion.11742

Aripin, I., Hidayat, T., Rustaman, N., & Riandi, R. (2022). Citizen science project's contributions to species literacy for pre-service biology teacher. Jurnal Bioedukatika, 10(1), 42. https://doi.org/10.26555/bioedukatika.v10i1.21646

Astuti, G. A., & Rahayuningsih, M. (2022). Pendekatan citizen science sebagai upaya konservasi burung dilindungi di desa ngesrepbalong. Life Science, 11(2). http://journal.unnes.ac.id/sju/index.php/LifeSci

Aydın, S., & Keleş, P. U. (2021). Teachers candidates' awareness of sustainable development. Shanlax International Journal of Education, 9(S1-May), 221–227. https://doi.org/10.34293/education.v9is1-may.4015

Backstrom, L. J., Leseberg, N. P., Callaghan, C. T., Sanderson, C., Fuller, R. A., & Watson, J. E. M. (2024). Using citizen science to identify Australia's least known birds and inform conservation action. Emu, 124(2), 199–205. https://doi.org/10.1080/01584197.2023.2283443

Bonney, R., Phillips, T. B., Ballard, H. L., & Enck, J. W. (2016). Can citizen science enhance public understanding of science? Public Understanding of Science, 25(1), 2–16. https://doi.org/10.1177/0963662515607406

Boone, A., Rothschild, A., Koo, X., Pfohl, G., Sheehan, A., Disalvo, B., Le Dantec, C. A., & Disalvo, C. (2024). Reimagining meaningful data work through citizen science. Proceedings of the ACM on Human-Computer Interaction, 8(CSCW2). https://doi.org/10.1145/3687049

Brandt, M., Groom, Q., Magro, A., Misevic, D., Narraway, C. L., Bruckermann, T., Beniermann, A., Borsen, T., Gonzalez, J., Meeus, S., Roy, H. E., Sa-Pinto, X., Torres, J. R., & Jenkins, T. (2022). Promoting scientific literacy in evolution through citizen science. Proceedings of the Royal Society B: Biological Sciences, 289(1980). https://doi.org/10.1098/rspb.2022.1077

Brown, E. D., & Williams, B. K. (2019). The potential for citizen science to produce reliable and useful information in ecology. Conservation Biology, 33(3), 561–569. https://doi.org/10.1111/cobi.13223

Callaghan, C. T., Rowley, J. J. L., Cornwell, W. K., Poore, A. G. B., & Major, R. E. (2019). Improving big citizen science data: Moving beyond haphazard sampling. PLoS Biology, 17(6), 1–11. https://doi.org/10.1371/journal.pbio.3000357

Christ, L., Hahn, M., Sieg, A. K., & Dreesmann, D. C. (2022). Be(e) Engaged! How students benefit from an educational citizen science project on biodiversity in their biology classes. Sustainability (Switzerland), 14(21). https://doi.org/10.3390/su142114524

Coracero, E. E., Facun, M. C. T., Gallego, R. J., Lingon, M. G., Lolong, K. M., Lugayan, M. M., Montesines, K. B. G., Sangalang, L. R., & Suniega, M. J. A. (2022). Knowledge and perspective of students towards biodiversity and its conservation and protection. Asian Journal of University Education, 18(1), 118–131. https://doi.org/10.24191/ajue.v18i1.17178

da Silva, M. X. G., Braga-Pereira, F., da Silva, M. C., de Oliveira, J. V., de Faria Lopes, S., & Alves, R. R. N. (2021). What are the factors influencing the aversion of

students towards reptiles? Journal of Ethnobiology and Ethnomedicine, 17(1), 1–10. https://doi.org/10.1186/s13002-021-00462-z

Eugenio-Gozalbo, M., Zuazagoitia, D., Ruiz-González, A., Corrochano, D., Hurtado-Soler, A., & Talavera, M. (2022). Implementing citizen science programmes in the context of university gardens to promote pre-service teachers' scientific literacy: a study case on soil. International Journal of Science Education, 44(10), 1619–1638. https://doi.org/10.1080/09500693.2022.2088877

Fajri, S. R., Sudiatmika, A. R., Suma, I. K., & Suardana, I. N. (2023). *Studi meta analisis : peningkatan kemampuan literasi biodiversitas berdasarkan model pembelajaran dan tingkat pendidikan.* Bioscientist : Jurnal Ilmiah Biologi, 11(2), 1764. https://doi.org/10.33394/bioscientist.v11i2.9686

Fakhriyah, F., Masfuah, S., & Margunayasa, I. G. (2024). A review of environmental literacy learning for prospective teachers. Jurnal Penelitian Pendidikan IPA, 10(8), 536–547. https://doi.org/10.29303/jppipa.v10i8.8327

Farr, C. M., Ngo, F., & Olsen, B. (2023). Evaluating data quality and changes in species identification in a citizen science bird monitoring project. Citizen Science: Theory and Practice, 8(1), 1–13. https://doi.org/10.5334/cstp.604

Hamdiah, N., Hidayat, T., Srihayati, S., & Gusti, U. A. (2024). How students communicate in citizen science project to build knowledge. Jurnal Pendidikan MIPA, 25(1), 1–13. https://doi.org/http://dx.doi.org/10.23960/jpmipa/v25i1.pp1-13

Härtel, T., Randler, C., & Baur, A. (2023). Using species knowledge to promote pro-environmental attitudes? the association among species knowledge, environmental system knowledge and attitude towards the environment in secondary school students. Animals, 13(6), 1–18. https://doi.org/10.3390/ani13060972

Hooykaas, M. J. D., Schilthuizen, M., Albers, C. J., & Smeets, I. (2022). Species identification skills predict in-depth knowledge about species. PloS One, 17(4), e0266972. https://doi.org/10.1371/journal.pone.0266972

Hooykaas, M. J. D., Schilthuizen, M., Aten, C., Hemelaar, E. M., Albers, C. J., & Smeets, I. (2019). Identification skills in biodiversity professionals and laypeople: A gap in species literacy. Biological Conservation, 238, 108202. https://doi.org/https://doi.org/10.1016/j.biocon.2019.108202

Jurumai, L. P., Abidin, A. A., Soetrisno, E. T., & Wibowo, D. (2023). Impact of population growth and housing development on the riverine environment: Identifying environmental threat and solution in the Wanggu River, Indonesia. Ecological Modelling, 486, 110540. https://doi.org/10.1016/j.ecolmodel.2023.110540

Katili, A. S., Utina, R., Yusuf, F. M., Pikoli, M., & Dama, L. (2021). Biodiversity literacy in science education. Journal of Physics: Conference Series, 1968(1). https://doi.org/10.1088/1742-6596/1968/1/012024

Kipasika, H. J. (2023). Environmental literacy in teachers' training: cognitive elements and environmental behaviour of prospective student-teachers. Journal of Adult Education in Tanzania, 25(1), 41–55. https://doi.org/10.61408/jaet2023v25i01.03

Lindemann-Matthies, P., Heber, E., & Remmele, M. (2024). Find the plant an educational game fosters plant species literacy. Sustainability (Switzerland) , 16(11). https://doi.org/10.3390/su16114702

Listiawan, Winarto, & Wiyatmo, Y. (2023). The impact of the group investigation (gi) learning model on enhancing middle school students' science literacy in thermal expansion topics. Jurnal Pendidikan MIPA, 25(3), 1549–1558. https://doi.org/http://dx.doi.org/10.23960/jpmipa/v25i3.pp1549-1558

Mammola, S., Adamo, M., Antić, D., Calevo, J., Cancellario, T., Cardoso, P., Chamberlain, D., Chialva, M., Durucan, F., Fontaneto, D., Gonçalves, D. V, Martínez, A., Santini, L., Rubio-López, I., Sousa, R., Villegas-Ríos, D., Verdes, A., & Correia, R. A. (2023). Drivers of species knowledge across the Tree of Life. eLife Sciences Publications, Ltd. https://doi.org/10.7554/elife.88251.2

Monica, E., Suprapto, N., Budiyanto, M., Satriawan, M., & Cheng, T.-H. (2024). Measuring learners' scientific literacy skills using contextual environmental issues. Jurnal Pendidikan MIPA, 24(4), 1648–1664. http://dx.doi.org/10.23960/jpmipa/v25i4.pp1648-1664

Mutya, R., & Inocian, E. (2024). Knowledge, attitude, and practices toward snakes and snakebites among non-medical college students in cebu, philippines: a mixed method approach. Biosaintifika: Journal of Biology & Biology Education, 16(2), 285–296. https://doi.org/10.15294/biosaintifika.v16i2.8383

Ningsih, A. G., Firmansyah, F., Hastuti, W. S., Kawuryan, S. P., Kuswidyanarko, A., & Rizki, I. A. (2024). Enhancing students' mathematical creative thinking through ethnomathematics - based differentiated learning. Jurnal Pendidikan MIPA, 25(3), 1618–1634. http://dx.doi.org/10.23960/jpmipa/v25i3.pp1618-1634

Pandey, D. P., Subedi Pandey, G., Devkota, K., & Goode, M. (2016). Public perceptions of snakes and snakebite management: implications for conservation and human health in southern Nepal. Journal of Ethnobiology and Ethnomedicine, 12(1), 22. https://doi.org/10.1186/s13002-016-0092-0

Paradise, C., & Bartkovich, L. (2021). Integrating citizen science with online biological collections to promote species and biodiversity literacy in an entomology course. Citizen Science: Theory and Practice, 6(1), 1–13. https://doi.org/10.5334/CSTP.405

Perry, J. R., Sumner, S., Thompson, C., & Hart, A. G. (2021). 'Citizen identification': online learning supports highly accurate species identification for insect-focussed citizen science. Insect Conservation and Diversity, 14(6), 862–867. https://doi.org/10.1111/icad.12528

Phillips, T. B., Ballard, H. L., Lewenstein, B. V., & Bonney, R. (2019). Engagement in science through citizen science: Moving beyond data collection. Science Education, 103(3), 665–690. https://doi.org/10.1002/sce.21501

Photo, P. (2024). Exploring the impact of zoological garden visits on science learning in primary school: acknowledging and transforming prior knowledge via outdoor learning. Journal of Outdoor and Environmental Education, 0123456789. https://doi.org/10.1007/s42322-024-00175-3

Pocock, M. J. O., Tweddle, J. C., Savage, J., Robinson, L. D., & Roy, H. E. (2017). The diversity and evolution of ecological and environmental citizen science. PLoS ONE, 12(4), 1–17. https://doi.org/10.1371/journal.pone.0172579

Rêgo, J. C. L., Soares-Gomes, A., & da Silva, F. S. (2018). Loss of vegetation cover in a tropical island of the Amazon coastal zone (Maranhão Island, Brazil). Land Use Policy, 71(June), 593–601. https://doi.org/10.1016/j.landusepol.2017.10.055

Reynolds, B. R., Salamander, T., & Wilson, T. P. (2018). A walk in the woods: changing student attitudes toward amphibians and reptiles. Creative Education, 09(02), 182–191. https://doi.org/10.4236/ce.2018.92014

Rozi, Z. F., & Samitra, D. (2020). Amphibians diversity in sulap hill and watervang dam, Lubuklinggau. Jurnal Biodjati, 5(1), 153–163. https://doi.org/10.15575/biodjati.v5i1.5340

Saber, S., Tito, W., & Said, R. (2017). Amphibians as bioindicators of the health of some Wetlands in Ethiopia. The Egyptian Journal of Hospital Medicine, 66, 66–73. https://doi.org/10.12816/0034635

Samitra, D., & Rozi, Z. F. (2020). Short communication: The herpetofauna around human settlements in Lubuklinggau city, south Sumatra, Indonesia: Composition and diversity. Biodiversitas, 21(4), 1432–1437. https://doi.org/10.13057/biodiv/d210422

Samitra, D., & Widiya, M. (2024). *Perspektif calon guru pendidikan dasar terhadap herpetofauna.* Seminar Nasional Sains, 5(1), 19–24.

Skarstein, T. H., & Skarstein, F. (2020). Curious children and knowledgeable adults – early childhood student-teachers' species identification skills and their views on the importance of species knowledge. International Journal of Science Education, 42(2), 310–328. https://doi.org/10.1080/09500693.2019.1710782

Soria Aguirre, J. M., & Tormáné Kovács, E. (2023). Contribution of nature conservation related citizen science projects to learning, attitude and behavioral change of participants. Review on Agriculture and Rural Development, 12(1–2), 27–36. https://doi.org/10.14232/rard.2023.1-2.27-36

Suryanda, A., Azrai, E. P., Rini, D. S., Nur, D. B., Amaliah, A., & Syaikhan, A. A. H. (2024). *Meningkatkan sikap ramah ular peserta didik sekolah menengah.* Jurnal PKM: Pengabdian Kepada Masyarakat, 07(05), 609–616. http://dx.doi.org/10.30998/jurnalpkm.v7i5.23296

Teel, T. L., Adams, M., Don Carlos, A. W., Bonnell, M. A., & Breck, S. W. (2022). A Mixed-methods social psychology application evaluating the role of citizen science in mitigating Human-Wildlife Conflict. Society & Animals, 31(5–6), 645–668. https://doi.org/https://doi.org/10.1163/15685306-bja10067

Teixido, A. L., Sehn, H., Quintanilla, L. G., Gonçalves, S. R. A., Férnandez-Arellano, G. J., Dáttilo, W., Izzo, T. J., Layme, V. M. G., & Moreira, L. F. B. (2021). A meta-analysis of the effects of fragmentation on the megadiverse herpetofauna of Brazil. Biotropica, 53(3), 726–737. https://doi.org/10.1111/btp.12955

Tivarekar, R. P., & Virani, H. G. (2017). Species recognition using audio processing algorithm. 2017 International Conference on Trends in Electronics and Informatics (ICEI), 527–532. https://doi.org/10.1109/ICOEI.2017.8300715

Tomažič, I., Pihler, N., & Strgar, J. (2017). Pre-service biology teachers' reported fear and disgust of animals and their willingness to incorporate live animals into their teaching through study years. Journal of Baltic Science Education, 16(3), 337–349. https://doi.org/10.33225/jbse/17.16.337

Ukaogo, P. O., Ewuzie, U., & Onwuka, C. V. (2020). Environmental pollution: Causes, effects, and the remedies. In Microorganisms for Sustainable Environment and Health. INC. https://doi.org/10.1016/B978-0-12-819001-2.00021-8

Vergara-Rios, D., Montes-Correa, A. C., Urbina-Cardona, J. N., De Luque-Villa, M., E. Cattan, P., & Granda, H. D. (2021). Local community knowledge and perceptions in the Colombian Caribbean towards Amphibians in urban and rural settings: tools for biological conservation. Ethnobiology and Conservation, 10(May). https://doi.org/10.15451/ec2021-05-10.24-1-22

Voigt-Heucke, S., Haklay, M., & Hecker, S. (2024). Citizen science. In Elgar Encyclopedia of Interdisciplinarity and Transdisciplinarity (pp. 46–49). Edward Elgar Publishing.

Willi, M., Pitman, R. T., Cardoso, A. W., Locke, C., Swanson, A., Boyer, A., Veldthuis, M., & Fortson, L. (2019). Identifying animal species in camera trap images using deep learning and citizen science. Methods in Ecology and Evolution, 10(1), 80–91. https://doi.org/10.1111/2041-210X.13099

Winarni, E. W., & Purwandari, E. P. (2019). The effectiveness of turtle mobile learning application for scientific literacy in elementary school. Journal of Education and E-Learning Research, 6(4), 156–161. https://doi.org/10.20448/journal.509.2019.64.156.161

Zukmadini, A. Y., Rohman, F., Dharmawan, A., Sari, M. S., Rochman, S., & Razak, S. A. (2024). Potential biodiversity from ethnozoology of enggano island: utilization, a quantitative analysis, list of animals conserved by local people, and application of research findings empowering species literacy in biology student teachers. Indonesian Journal of Science and Technology, 9(2), 463–496. https://doi.org/10.17509/ijost.v9i2.71581