Journal of Engineering Science and Technology
Special Issue on ISCoE2022 Vol. 18, No. 4 (2023) 10 - 19

INTEGRATING CITIZEN SCIENCE IN ANIMAL SYSTEMATICS COURSE USING INATURALIST PLATFORM

ULFI FAIZAH[1, 2], NURYANI Y. RUSTAMAN[1,*], YAYAN SANJAYA[1], ANA R. WULAN[1], RENI AMBARWATI[2], DWI A. RAHAYU[2]

[1]Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi No. 229, Bandung, 40154, Indonesia
[2]Universitas Negeri Surabaya, Jl. Ketintang Surabaya, 60231, Indonesia
*Corresponding Author: nuryanirustaman@upi.edu

Abstract

This study aimed to describe the use of the iNaturalist platform for integrating Citizen Science into the Animal Systematics Course. It used a qualitative descriptive research approach and involved 87 biology students at a state university in Surabaya, Indonesia, from February to June 2022. Integrating citizen science into the course was accomplished by involving students in citizen science activities in a research project built on the iNaturalist platform and the implementation was evaluated descriptively and quantitatively using statistical data from four iNaturalist components: Observers, Observations, Species, and Identifiers. The result shows that 61 students became observers, resulting in 249 observations, 121 species, and 95 IDs. As a result of the student's active participation in their research project activities, a large number of observations were made. Students with their research skills discovered and identified a wide range of animal species. This study concludes that the iNaturalist platform can be used effectively to integrate citizen science into the Animal Systematics Course. Through this activity, students can participate in local activities that have global implications.

Keywords**:** Biodiversity, ICT, Invertebrate and vertebrate animals, Research project.

1. Introduction

Currently, many activities are being developed in courses in colleges that use Information and Communication Technology (ICT) platforms [1-6], such as the iNaturalist platform, which are integrated with citizen science activities [7-9]. The ICT platform contains components responsible for moving data from ICT tools to data stores as well as software for data extraction and visualization [10]. It collects, analyses, and presents valuable data. ICT frameworks are useful in activities that require creativity and collaboration [11]. A discovery network is a valuable tool for member collaboration [12, 13].

iNaturalist is a citizen science platform with ICT that uses artificial intelligence technologies to assist a global community by observing and identifying biodiversity [14-16]. On the iNaturalist website (https://www.inaturalist.org/pages/help) it is explained that the iNaturalist platform use of several technologies and data sources, such as PostgreSQL, elastic search, Ruby on Rails, Express, and React Native. Google Maps provides maps and geocoding services, and the iNaturalist team uses Flickr and Wikimedia Commons, as well as the Catalogue of Life, uBio, and a range of other data sources to import taxonomic information. To give automatic taxon identification suggestions, iNaturalist uses computer vision algorithms that have been trained on user photographs and identifications.

ICT tools, such as iNaturalist, the citizen science platform, are a pathway to promote science learning and education for sustainable development in schools [17-20]. Adapting traditional natural history field activities to an emerging paradigm in Biodiversity Informatics. It is the technology that can improve student engagement and learning perception, and its wider incorporation into coursework might benefit regional and global efforts to document and protect biodiversity [21, 22]. Biodiversity education is widely regarded as an essential component of global biodiversity protection since it assists in changing damaging attitudes and behaviors among students and society [23]. It should help students understand and analyse the various meanings and dimensions of biodiversity, allowing them to acquire critical thinking skills [24]. Citizen science is a method of involving students or the general public in biodiversity and environmental concerns that can be used in a formal learning setting [25]. Citizen science is an excellent instructional procedure for non-conservation groups, providing them with a sense of accomplishment and the opportunity to share data and discuss research. Scientists also get benefits from collecting the necessary data [26]. The results of research on the implementation of research project assignments in the Animal Systematics course showed citizen science has the potential to be a follow-up to project assignments in studying biodiversity, providing a global perspective and meaningful communication with the community [27].

We reviewed seven Indonesian universities' descriptions of biodiversity courses (such as Animal Systematics, Biosystematics, Invertebrate and Vertebrate Taxonomy, and Invertebrate and Vertebrate Zoology courses). As a biodiversity education course, this one looks at the morphological traits, categorization, identification, description, nomenclature, and variety of invertebrate and vertebrate creatures. This course also covers the advantages of animals to human life, tax kinship, and other research approaches. Sometimes the content is given in a student-centred manner through practical activities such as research projects, and the results are published as scientific publications. Based on the literature, there are no reports

on learning activities that integrate citizen science using the iNaturalist platform in the Animal Systematics Course, which is one of the courses that study the biodiversity of Animalia (invertebrate and vertebrate). So, this research needs to be done.

This study aimed to describe the use of the iNaturalist platform for integrating Citizen Science into the Animal Systematics Course. The research method used a qualitative descriptive research approach. The novelties of this study are: 1) Provide information about the implementation description of integrating citizen science into the Animal Systematics Course by utilizing the iNaturalist platform; 2) Provide a best practice in learning that gives project assignments related to biodiversity; and 3) Provide an alternative activity that involves students being active in citizen science activities.

2. Method

This study used a qualitative descriptive research approach. It involved 87 biology students from three classes joining the Animal Systematics course in the 4th semester at a state university in Surabaya, Indonesia, from February to June 2022. They formed groups of 2-3 people to carry out a research project on animal biodiversity, either invertebrates or vertebrates, in their area. Courses were held in full online due to the COVID pandemic.

Integrating citizen science into the course is accomplished by involving students in citizen science activities in a research project built on the iNaturalist platform (https://www.inaturalist.org/projects/project-peneltian-mandiri-sh-2022).
iNaturalist is an online community that allows students as members to contribute observations to discuss, recognize, and produce research-quality citizen science data for science and conservation. Students' observations are recorded as biodiversity data and include a photo, location, and time stamp. Other members of the iNaturalist community assist participants in identifying and validating their findings. The implementation of this activity was evaluated descriptively and quantitatively using statistical data from four iNaturalist components: Observers, Observations, Species, and Identifiers. 13 students became respondents by answering questions about the use of iNaturalist in this activity.

3. Results and Discussion

There were 87 students using iNaturalist to integrate citizen science into animal systematics courses have formed 43 groups (@ 2-3 students) to carry out a biodiversity study project. All students have registered as members of iNaturalist (https://www.inaturalist.org/signup) and can participate in projects created on the platform (https://www.inaturalist.org/projects/project-peneltian-mandiri-sh-2022). Students observe and identify organisms discovered during research projects, and then share their discoveries by uploading photos to iNaturalist. Student involvement in this project is documented in the statistics of the iNaturalist project, as seen in Fig. 1. It showed about 61 students as observers who carried out a research project on animal diversity in their area and shared information with the public through the iNaturalist platform in 249 observations of 121 animal species. It also showed the scientific interaction between students and 95 other members of the scientific community who serve as identifiers for 400 identifications. The student activities were a contribution to citizen science. A more complete

explanation of observer, observation, species, and identifier data related to the iNaturalist platform and its relation to citizen science is explained as follows:

Fig. 1. Stats in iNaturalist's projects.
(https://www.inaturalist.org/projects/proyek-peneltian-mandiri-sh-2022?tab=stats)

3.1. Observers

According to Fig. 1. 87 students from three classes have registered to become members of the iNaturalist community, with 61 students (70.16%) active as observers. Almost 30% of students are not actively involved in the iNaturalist project. Several respondents said the main reasons for this are that they did not know about iNaturalist before, were confused about the iNaturalist features available, were unable to communicate with other iNaturalist members, and were confused about following up on animal data discovered while conducting research projects in the Animal Systematics course. The right solution is needed to ensure that all students can participate in iNaturalist activities.

The difficulty arose because students were not familiar with the iNaturalist platform. The solution can be introduced to students at the beginning of their studies after they are familiar, they will get used to the course. The University of Massachusetts Boston uses the iNaturalist platform for its freshmen orientation activities with bio-blitz activities. This activity's pedagogical purpose was to allow students to view nature and engage in a citizen science initiative [28]. Students and teachers should be proactive in asking questions and discussing. In carrying out the iNaturalist project, students generally receive assistance from the teacher [29]. Students should also be proactive in finding information about iNaturalist by exploring the iNaturalist web (https://www.inaturalist.org/) because there is already information about it completely and in detail. Students can also look for tutorials about iNaturalist on YouTube. At present, it is recognized that YouTube is a technology and a medium that can assist in the field of education by utilizing appropriate content or tutorials [30, 31].

3.2. Observations

Observations, the basic units of iNaturalist activities, record an encounter with an individual organism at a particular time and location. This includes encounters with signs of organisms like tracks, nests, or things that just died. The observation results are divided into three categories: 1) Casual: the results are not clear or invalid; 2)

Need ID: The results are clear enough and valid with suitable information. It requires identification assistance to reach species level; 3) Research Grade: The results are clear and valid, accompanied by metadata and the species name. Based on Fig. 1. The iNaturalist project received 249 observations from the 43 completed research projects, resulting in the following results: casual (0.8%), needs identification (59.84%), and research grade (39.56%). These results show that the results of observations in the Research Grade category have met the information criteria for citizen science contributions [26]. Photos of observations must be taken in the field, not from photos available on the internet. The iNaturalist observation material contained photos of wild animals and metadata, dates, and georeferenced. Students were trained to be honest as part of meaningful learning [27]. iNaturalist, as a platform with big data technology, this application will recognize and not accept inappropriate photos.

Identifying species on iNaturalist is typically accomplished by uploading photos and then selecting the appropriate species from the iNaturalist database. This is not appropriate with the aim of the Animal Systematics course, which is to train students to be skilled at directly identifying species by attention to various characteristics. Most of the respondents stated that they only identified using the facilities at iNaturalist. As a result, students in animal systematics courses are still needed to do direct identification by examining native specimens. Identification using iNaturalist can be used to confirm the accuracy of the information gathered. When connecting to nature through technology, people must use environmental ICT wisely, such as the iNaturalist platform, as a more intimate approach to knowing, feeling, or engaging with nature directly [32]. The biodiversity of Animalia is one of the Biological foci and must be investigated in nature. Students would have a range of experiences through learning in nature. It is that best encourages interest in and awareness of environmental concerns, biodiversity, and sustainable living [33, 34].

3.3. Species

In the Systematics research project, students learn to do research at the family level and then identify and classify the animals found according to their taxon. From 43 research projects, it was found that most were on arthropods (58%) and molluscs (33%). It is appropriate with the data from the 121 species recorded in the iNaturalist project (Fig. 1). The most common species found are insects (46%) and molluscs (24%). The information about the biodiversity of animals found in this project is a very useful contribution to citizen science. As knowledge about species increases, the notion of species literacy might be a suitable starting point for engaging people in biodiversity. It is becoming increasingly necessary to raise biodiversity awareness and get widespread support for protection [34].

Information about research locations from 43 studies conducted by students shows that there were 14 locations, and most were conducted in Surabaya (30%) and Gresik (19%). The data map of information on the iNaturalist platform shows the distribution of research locations. It can see the distribution of research locations, and each coordinate point can reveal information about the animals studied there (Fig. 2). Data visualization is vital in adequately sharing and comprehending biodiversity data. As a citizen science platform, iNaturalist has made it simpler to collect biodiversity data that may be utilized to maintain and

preserve biodiversity places. The Google Earth application provided on iNaturalist provides a representation that may be utilized for biodiversity site monitoring [35].

Fig. 2. Map of observations in iNaturalist's project.
Credits: https://www.inaturalist.org/projects/proyek-peneltian-mandiri-sh-2022

3.4. Identifiers

Identifiers are iNaturalis community members who help other users identify them based on their observations. The majority of them actively welcome collaboration for discussion or aid with biodiversity studies. This is a good sign to continue the collaboration as the embodiment of citizen science. IDs in iNaturalist are classified into four types: 1) Leading: Taxon descended from the communal taxon and might lead to the correct answer; 2) Improving: This taxon's first idea, which the community later agreed on; 3) Supporting: Taxon and community taxon are the same things; 4) Maverick: Taxon is not a descendent or ancestor of the community taxon. According to Fig. 1, the statistics from 400 identifications show that leading (37.5%), improving (32.5%), supporting (27.25%), and maverick (2.75%). This iNaturalist projects initiative had 95 identifiers (Fig. 1). The iNaturalist species identification community was able to generate high-quality biodiversity observations. Identifiers can make significant contributions to collectively strengthening students' awareness of biodiversity through their expertise [28]. The availability of citizen science data has led to an increase in biodiversity research applications. iNaturalist, a popular site, offers millions of digitally verified observations contributed by a global user base and a venue for community development and networking with other naturalists [36].

As a result of the student's active participation in their research project activities, a large number of observations were made. Students with their research skills discovered and identified a wide range of animal species. The students as respondents also stated benefits from this activity, they were assisting in identifying the animal, obtaining the information needed, adding to the experience of communicating with the community, and becoming active in citizen science. In general, implementing the integrating Citizen Science in Animal Systematics Course can be done well using the iNaturalist platform. Students can contribute to citizen science. Student participation as part of the citizen science community in the future can be continued and increased to be more active. Through this activity, students can participate in local activities that have global implications. This study gives additional data for the use of technology and teaching strategy for teaching difficult biology subject, as discussed in other reports [37-44].

4. Conclusion

This study concludes that the iNaturalist platform can be used effectively to integrate citizen science into the Animal Systematics Course. 61 students became observers, resulting in 249 observations, 121 species, and 95 IDs. Through a platform with appropriate technology, students can contribute to citizen science activities. They can accomplish this by observing, providing, and sharing biodiversity information from their research project, as well as engaging with the global community. Through this activity, students can participate in local activities that have global implications.

Acknowledgment

Thank you to Kemdikbud Ristek-Dikti, LPDP, Universitas Pendidikan Indonesia, and Universitas Negeri Surabaya for sponsoring this research, and to the Biology Education Students of 2020 and the iNaturalist community for participating.

References

1. Shah, S.S. (2022). Teaching and learning with technology: Effectiveness of ICT integration in schools. *Indonesian Journal of Educational Research and Technology*, 2(2), 133-140.
2. Akinoso, S.O. (2023). Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model. *Indonesian Journal of Educational Research and Technology*, 3(1), 79-90.
3. Bolaji, H.O.; and Jimoh, H.A. (2023). Usability and utilization of ICT among educational administrators in secondary students in public school. *Indonesian Journal of Educational Research and Technology*, 3(2), 97-104.
4. Bolaji, H.O.; and Onikoyi, O.A. (2024). Usability of ICT for class size remediation and learning among secondary schools. *Indonesian Journal of Educational Research and Technology*, 4(1), 23-28.
5. Bolaji, H.O.; and Adeoye, M.A. (2022). Accessibility, usability, and readiness towards ICT tools for monitoring educational practice in secondary schools. *Indonesian Journal of Multidiciplinary Research*, 2(2), 257-264.
6. Daramola, F.O. (2023). Utilization of ICT resources for teaching among some selected lecturers in colleges of education in Kwara State. *ASEAN Journal of Educational Research and Technology*, 2(1), 1-10.
7. Smith, H.; Allf, B.; Larson, L.; Futch, S.; Lundgren, L.; Pacifici, L.; and Cooper, C. (2021). Leveraging citizen science in a college classroom to build interest and efficacy for science and the environment. *Citizen Science: Theory and Practice*, 6(1), 1-13.
8. Paradise, C.; and 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.
9. Hernawati, D.; Chaidir, D.M.; and Meylani, V. (2020). The use of iNaturalist on learning courses of zoology vertebrates for prospective biology teachers. *Journal of Physics: Conference Series*, 1440(1), 012064.

10. Rachmawati, R. (2019). Utilization and quality of information system for administration services based on ICT in Patehan, Kraton, Yogyakarta. *Indonesian Journal of Science and Technology*, 4(1), 55-63.
11. Ariyanti, S.N.D.; and Maryanti, R. (2021). Developing the creativity of elementary school students in Cimahi, Indonesia through online learning media during the covid-19 pandemic. *Indonesian Journal of Teaching in Science*, 2(1), 7-16.
12. Krommyda, M.; Drakoulis, R.; Misichroni, F.; Tousert, N.; Antonakopoulou, A.; Portouli, E.; Rakotondravelona, M.R.; El-Bekri, M.; Kountche, D.A.; and Amditis, A. (2020). An ICT platform for the understanding of the user behaviours towards EL-Vs. *ICEIS*, 1, 233-240.
13. Omelyanenko, V.; Braslavska, O.; Biloshkurska, N.; Biloshkurskyi, M.; Kliasen, N.; and Omelyanenko, O. (2021). C-Engineering based industry 4.0 innovation networks sustainable development. *International Journal of Computer Science and Network Security*, 21(9), 267-274.
14. Unger, S.; Rollins, M.; Tietz, A.; and Dumais, H. (2021). iNaturalist as an engaging tool for identifying organisms in outdoor activities. *Journal of Biologycal Education*, 55(5), 537-547.
15. Niemiller, K.D.K.; Davis, M.A.; and Niemiller, M.L. (2021). Addressing 'biodiversity naivety 'through project-based learning using iNaturalist. *Journal for Nature Conservation*, 64, 126070.
16. Boone, M.E.; and Basille, M. (2019). Using iNaturalist to contribute your nature observations to science. *Edis*, 2019(4), 5-5.
17. Rodríguez-Loinaz, G.; Ametzaga-Arregi, I.; and Palacios-Agundez, I. (2022). ICT tools and citizen science: A pathway to promote science learning and education for sustainable development in schools. *Journal of Biologycal Education*, 17, 1-17.
18. Sanni, A.M. (2023). ICT tools for teaching the Arabic language. *ASEAN Journal of Religion, Education, and Society*, 2(2), 67-74.
19. Makinde, S.O.; Olorunnisola, S.K.; and Adeyemi, S.A. (2023). Influence of ICT availability, accessibility, and utilization on agriculture students' academic performance in universities. *ASEAN Journal of Agricultural and Food Engineering*, 2(2), 61-70.
20. Odefunsho, O.A.; Oladimeji, R.M.; Bolaji, H.O.; and Akinnubi, O.P. (2023). Lecturers' efficacy and readiness towards utilization of ICT for academic research in college of education. *Indonesian Journal of Teaching in Science*, 3(1), 9-16.
21. Hardy, C.R.; and Hardy, N.W. (2018). Adapting traditional field activities in natural history education to an emerging paradigm in biodiversity informatics. *The American Biology Teacher*, 80(7), 501-519.
22. Osawa, T. (2019). Perspectives on biodiversity informatics for ecology. *Ecological Research*, 34(4), 446-456.
23. Gass, S.; Mui, A.; Manning, P.; Cray, H.; and Gibson, L. (2021). Exploring the value of a BioBlitz as a biodiversity education tool in a post-secondary environment. *Environmental Education Research*, 27(10), 1538-1556.

24. Navarro-Perez, M.; and Tidball, K. (2012). Challenges of biodiversity education: A review of education strategies for biodiversity education. *International Electronic Journal of Environmental Education*, 2(1), 13-30.
25. Schneiderhan-Opel, J.; and Bogner, F.X. (2020). How fascination for biology is associated with students' learning in a biodiversity citizen science project. *Studies in Educational Evaluation*, 66, 100892.
26. de Vries, M.; Land-Zandstra, A.; and Smeets, I. (2019). Citizen scientists' preferences for communication of scientific output: A literature review. *Citizen Science: Theory and Practice*, 4(1), 2.
27. Faizah, U.; Rustaman, N.Y.; and Supriatno, B. (2021). The potential of citizen science as a follow up program of student project assignment for biodiversity studies to be meaningful. *Journal of Physics: Conference Series*, 1806(1), 012172.
28. Stevenson, R.; Merrill, C.; and Burn, P. (2020). Assessment of biodiversity data collected using iNaturalist compiled over three years of college freshman orientations. *Biodiversity Information Science and Standards*, 4, e59128.
29. Hitchcock, C.; Sullivan, J.; and O'Donnell, K. (2021). Cultivating bioliteracy, biodiscovery, data literacy, and ecological monitoring in undergraduate courses with iNaturalist. *Citizen Science: Theory and Practice*, 6(1), 1-13.
30. Garcia-Vedrenne, A. E.; Orland, C.; Ballare, K.M.; Shapiro, B.; and Wayne, R.K. (2020). Ten strategies for a successful transition to remote learning: Lessons learned with a flipped course. *Ecology and evolution*, 10(22), 12620-12634.
31. Maziriri, E.T.; Gapa, P.; and Chuchu, T. (2020). Student perceptions towards the use of YouTube as an educational tool for learning and tutorials. *International Journal of Instruction*, 13(2), 119-138.
32. Altrudi, S. (2021). Connecting to nature through tech? The case of the iNaturalist app. *Convergence*, 27(1), 124-141.
33. Palmberg, I.; Berg, I.; Jeronen, E.; Kärkkäinen, S.; Norrgård-Sillanpää, P.; Persson, C.; Vilkonis, R.; and Yli-Panula, E. (2015). Nordic-Baltic student teachers' identification of and interest in plant and animal species: The importance of species identification and biodiversity for sustainable development. *Journal of Science Teacher Education*, 26(6), 549-571.
34. Hooykaas, M.J.; Schilthuizen, M.; Aten, C.; Hemelaar, E.M.; Albers, C.J.; and Smeets, I. (2019). Identification skills in biodiversity professionals and laypeople: A gap in species literacy. *Biological Conservation*, 238, 1-10.
35. Cham, H.; Malek, S.; Milow, P.; and Song, C. (2022) Developing an ecological visualization system for biodiversity data. *All Life*, 15(1), 500-511.
36. Di Cecco, G.J.; Barve, V.; Belitz, M.W.; Stucky, B.J.; Guralnick, R.P., and Hurlbert, A.H. (2021). Observing the observers: How participants contribute data to iNaturalist and implications for biodiversity science. *BioScience*, 71(11), 1179-1188.
37. Glorifica, I. (2021). Media analysis of biology teaching book grade xii: A study based on science literation category. *Indonesian Journal of Educational Research and Technology*, 1(2), 17-22.
38. Olumorin, C.O.; Babalola, E.O.; Aladesusi, G.A.; Issa, A.I.; and Omolafe, E.V. (2021). Experts' validation of the developed 3-dimensional automated model of the human heart to teach a biology concept in Ilorin, Nigeria. *Indonesian Journal of Multidiciplinary Research*, 1(2), 299-308.

39. Babalola, E.O. (2022). Design and development of 3-dimensional model of human circulatory system to teach a concept of biology in senior secondary schools. *Indonesian Journal of Teaching in Science*, 2(1), 35-46.
40. Olumorin, C.O.; Babalola, E.O.; and Ayoola, D.A. (2022). Design and development of human excretory system model to teach a biology concept in Ilorin, Nigeria. *Indonesian Journal of Teaching in Science*, 2(2), 107-116.
41. Tipmontiane, K.; and Williams, P.J. (2022). The integration of the engineering design process in biology-related STEM activity: A review of Thai secondary education. *ASEAN Journal of Science and Engineering Education*, 2(1), 1-10.
42. Abdussemiu, A. (2022). Problems of teaching practical biology in senior secondary schools. *ASEAN Journal of Science and Engineering Education*, 2(3), 199-206.
43. Babalola, E.O.; Ayoola, D.A.; and Omolafe, E.V. (2023). Analysis of experts' opinion on the human excretory system model for teaching biology in Nigeria. *ASEAN Journal of Science and Engineering Education*, 3(1), 19-26.
44. Ala, N.A.; Onojah, A.O.; Ishyaku, A.M.; and Adamu, S.B. (2022). Development of an animation package in biology for teaching vertebrate, anatomy, and physiology. *ASEAN Journal of Science Education*, 1(2), 117-130.