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Utilizing the iNaturalist Application for Biology Research and Learning

Ipin Aripin[1*], Aden Arif Gaffar[2], Rika Firda Rizkia[3], Diana Yulianti[4]

[1,2,3] Pendidikan Biologi Universitas Majalangka, Jl. K.H. Abdul Halim No. 103 Majalengka, Indonesia
[4] MA Ar Rahmat, Jl. Weragati Selatan, Majalengka, Indonesia
* Corresponding author: ipin_aripin@unma.ac.id

ABSTRACT

This literature study aims to describe the utilization of the iNaturalist application (https://www.inaturalist.org/) in biology research and learning activities. iNaturalist is an Online Citizen Science (OCS) application available on the web and Android (Apps) platforms. This application has various features for collecting, identifying, and mapping varied biodiversity worldwide. It is suitable for biodiversity research and can also be used in learning biology on relevant concepts such as biodiversity, ecology, environment, plantae, animalia, and others. This article will discuss the advantages of the iNaturalist application, how to use it, and the utilization of the application in learning biology. The working principle of the iNaturalist application is to utilize artificial intelligence technology in the form of image processing so that it can identify various uploaded biodiversity data. This application offers community learning, the process of identifying research data involving the iNaturalist community worldwide. The way the iNaturalist application works is that users record data, share data with fellow naturalists and discuss research results. iNaturalist in research can be used for collecting, identifying, and publishing ecological, environmental, and biodiversity research data. The use of iNaturalist application in learning can be used in biology learning to train science process skills, especially observation skills, biodiversity learning, taxonomy learning, and research skills. In addition, this application supports Citizen Science activities that are suitable for use in education biology because it can create contextual and collaborative learning.

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INTRODUCTION

Biology has often been perceived as a difficult and memorizing subject (Çimer, 2012; Raida, 2018). Difficulties in learning biology are caused by several factors: material characteristics, teacher teaching style, learning habits in students, perceptions of biology subjects, and limited learning facilities (Çimer, 2012). Research conducted by Milarika et al., (2019) revealed that there is an influence between the perception of learning biology and biology learning outcomes; students who have a positive perception of biology students have good learning outcomes and vice versa. Perceptions of biology subjects are influenced

by enthusiasm, the way teachers teach, and students' expectations of biology subjects (Kahar, 2018).

To build students' positive perceptions of biology lessons, teachers can use creative and innovative teaching techniques (Kahar, 2018). Teachers must be able to manage the learning process by utilizing various learning resources available. One form of biology learning that many students are interested in today is digital learning (Jayawardana, 2017). Digital learning, such as mobile learning, can increase students' motivation and interest in biology subjects (Aripin, 2018).

One of the platforms that can be used in research and learning biology in the digital era is the iNaturalist application (https://www.inaturalist.org/). iNaturalist is an application used in Citizen Science activities to document biodiversity observations around the world. Participants involved in Citizen Science projects can submit media (images, videos, or audio files) of biodiversity to the iNaturalist data portal, which is then identified online by the community (Chandler et al., 2016). The application is available on both web and App platforms (Agrin et al., 2008).

The iNaturalist application can be used in collecting research data and as an educational tool. As an educational tool, the iNaturalist application has been widely used for learning activities such as in zoology courses (Hernawati et al., 2020; Rosa et al., 2022), conservation biology (Aripin, 2022), plant biodiversity (Echeverria et al., 2021), organism diversity (Unger et al., 2021), environment (Smith et al., 2021), herpetofauna (Maharani et al., 2022).

Since its launch in 2008, iNaturalist has had 54 million observations of 306,000 identified species, involving 1.4 million observers from 252 countries and regions worldwide (Mesaglio & Callaghan, 2021). In Indonesia itself, the iNaturalist application still needs to become more familiar. The iNaturalist application in Indonesia is still limited to certain circles, such as students and students or communities interested in nature and biodiversity.

The iNaturalist application are very relevant to introduce and utilize in Indonesia. Indonesia is the second largest mega biodiversity country in the world which also has many limitations in the number of scientists (LIPI, 2015). This condition is very relevant for the government or related stakeholders to develop Citizen Science programs and optimize the use of iNaturalist for data collection based on Indonesia's biodiversity wealth (Aripin et al., 2021). The active role of citizens is needed to collect, identify, utilize and protect Indonesia's biodiversity through various activities such as Citizen Science, research, and conservation activities. This review article aims to provide information regarding the utilization of the iNaturalist application and research and learning.

METHOD

This research used the literature study method, collecting data by reading, recording, analyzing, and processing research materials from library sources or documents (Melfianora, 2016). In this study, researchers collected various research results from national and international journals and other relevant sources. The data obtained is then analyzed in depth and restated based on the results of the researcher's synthesis and interpretation of the findings of the previously conducted studies.

RESULTS AND DISCUSSION

1. Utilization of iNaturalist Application in Research

iNaturalist is an application called a "community of practice"; participants involved in the iNaturalist project can share and communicate their findings to contribute to the collection of scientific information openly (Agrin et al., 2008). The iNaturalist application can be used to collect research data related to biodiversity (Aripin et al., 2021). This application is also popular in Online Citizen Science activities and is very familiar among scientists as a means of collaborating on research activities (Altrudi, 2021).

Currently, many research activities utilize ICT to assist scientists in collecting, analyzing, and publishing their research results (Beza et al., 2018). The use of the iNaturalist application in research is considered a bridge "man with nature" the use of this application in research helps researchers in producing research data of scientific value; the image processing capability of the iNaturalist application is one of the advantages of research data documentation over the use of ordinary cameras (Altrudi, 2021). Another advantage of the iNaturalist application in research is its ability to detect objects and classify them based on available data (Horn et al., 2018; Unger et al., 2021). Research that has been done on utilizing naturalists in research includes:

Table 1. iNaturalist Implementation in Research

Authors	Utilization of iNaturalist
Ball-Damerow et al., (2019)	iNaturalist application as a data base for biodiversity research
Setiawan et al., (2020)	iNaturalist application as a data base for biodiversity research
Cima et al., (2020)	Butterfly biodiversity data collection using iNaturalist
Ellwood et al., (2015)	Use of iNaturalist application for biodiversity specimen data collection
Mo & Mo, (2022)	The iNaturalist application to identify Iguana species
Maharani et al., (2022)	Utilization of iNaturalist for herpetofauna research through the Citizen Science program
Hitchcock et al., (2021)	Ecological monitoring through the use of the iNaturalist application
Horn et al., (2018); Unger et al., (2021)	iNaturalist application in species identification efforts
Rosa et al., (2022)	iNaturalist application in species identification efforts

In utilizing the iNaturalist application as a community-based research tool, observers (users) can do so through three stages, namely: (1) the observer can upload the finding data and then start a dialog by identifying the species observed, (2) other participants (observers)

help to identify and complete the observation ID, and (3) the community approves the observation ID to provide more accurate taxonomic identification accuracy (Agrin et al., 2008).



Figure 1. How the iNaturalist App Works
(Source: https://www.inaturalist.org/)

Fig. 1 shows the workflow of the iNaturalist application starting from observation, then various observations with fellow naturalists (participants), and then discussing the findings online to be identified with the community. The following flow shows the expert assessment of observation results to obtain reliable research data.

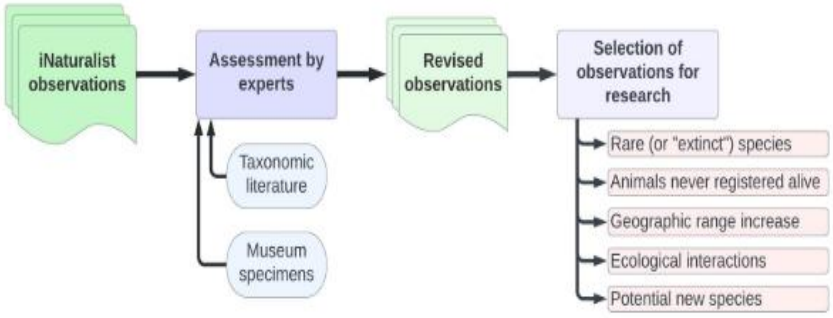


Figure 2. Flowchart of How the iNaturalist Application Works for Research
(Source: Rosa et al., 2022)

Fig. 2 shows the workflow of the iNaturalist application, starting with participant observation, validation by the community and experts, revisions to the initial identification results, and determining the results of observations for research data. The following is a picture of the process of improving the quality of research data using the iNaturalist application.

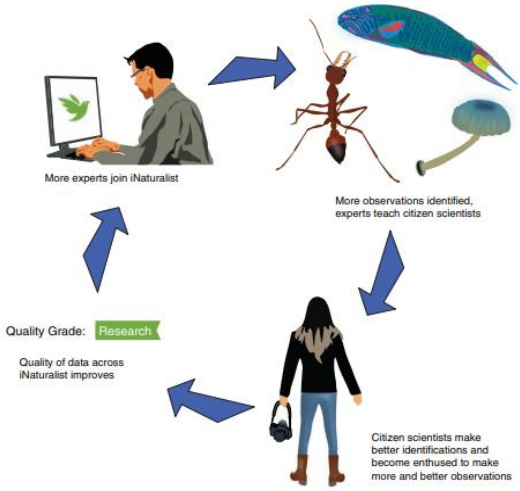


Figure 3. Improving the quality of observational data through expert involvement (Source: Mesaglio & Callaghan, 2021)

Fig. 3 shows the process of improving the quality of observation data through the involvement of scientists (experts) who are members of the iNaturalist community. More scientists involved in iNaturalist will positively impact the validation of participant observation data, and scientists can assist in providing professional taxonomic identification to improve the quality of research data collected in the iNaturalist database (Mesaglio & Callaghan, 2021). Data in the iNaturalist application is generally divided into three, namely Casual, Need ID, and Research Grade. Validated research data with the Research Grade category can be further identified as research data (Agrin et al., 2008; Mesaglio & Callaghan, 2021).

2. Utilization of iNaturalist Application in Learning

The iNaturalist application can be utilized by teachers/lecturers as learning media for project-based activities or ecological learning, taxonomy learning, environment, and biodiversity. iNaturalist can be used as an observation tool in Citizen Science activities or biodiversity learning (Stevenson et al., 2021). The iNaturalist application is widely used in various schools in Europe, America, and Australia as a tool in Citizen Science activities aiming to develop an interest in biodiversity and environmental awareness in students (Smith et al., 2021; Mesaglio & Callaghan, 2021). The iNaturalist application can also be utilized to improve students' research skills (Aristeidou et al., 2021).

Tabel 2. iNaturalist Implementation in Learning

Authors	Utilization of iNaturalist
Joyner & O'Donnell, (2021)	Application of iNaturalist to develop students' literacy through an outdor class Citizen Science project
Echeverria et al., (2021)	The use of iNaturalist in data collection in out-of-class learning projects
Hernawati et al., (2020)	Utilization of iNaturalist application in invertebrate zoology course
Paradise & Bartkovich, (2021)	Use of iNaturalist in entomology lectures to develop species literacy
McNair et al., (2023)	Use of iNaturalist app for taxonomy research and learning

In its implementation, the use of the iNaturalist application in learning can be done through the following stages: (1) students create an account to register for the project, (2) students conduct data collection, (3) add identification and comments on classmates' observations, (4) add data sources (www.inaturalist.org).

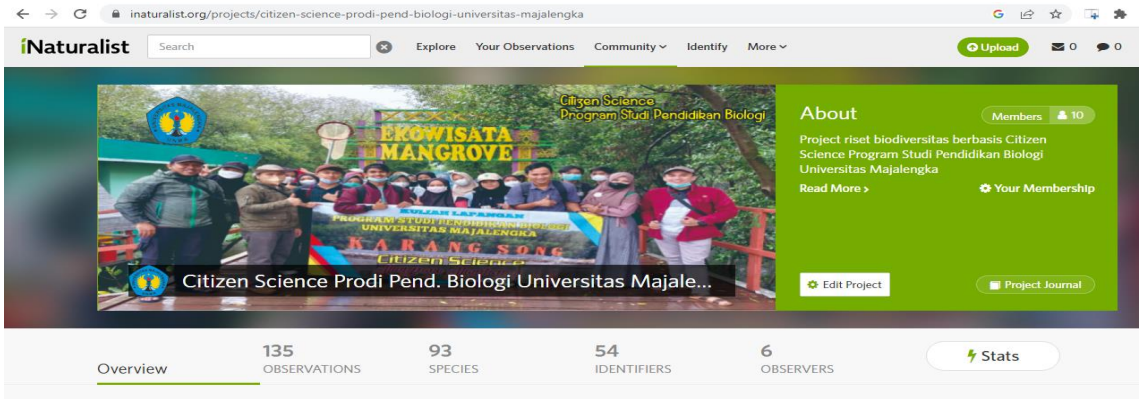


Figure 4. Example of iNaturalist Application Utilization in Learning
(Source: https://www.inaturalist.org/projects/citizen-science-prodi-pend-biologi-universitas-majalengka)

In utilizing the iNaturalist application in learning, teachers can create observation projects on the iNaturalist application. As participants in project activities, students are asked to upload the observations obtained and identify their own and other students' observations. Students can also comment on and write journals on the iNaturalist application (Agrin et al., 2008). The following illustrates the utilization of the iNaturalist application in learning.



Figure 5. Stages of iNaturalist Utilization in Learning
(Source: Echeverria et al., 2021)

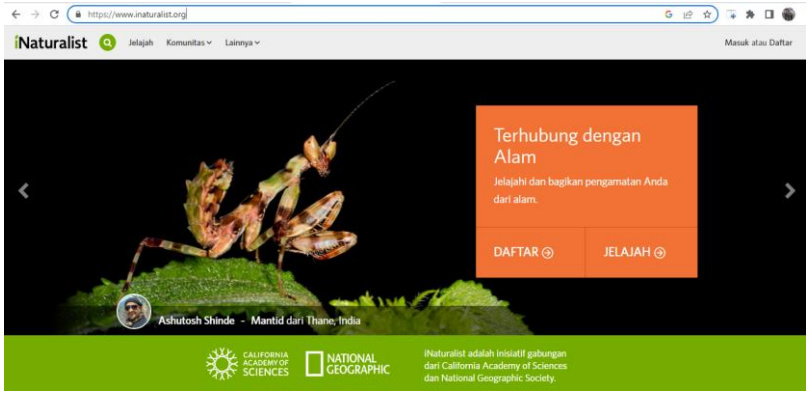
Fig. 5 shows the stages in utilizing the iNaturalist application in learning which also contributes to global biodiversity data collection / Global Biodiversity Information Facility (GBIF). Using the iNaturalist application in learning can train science process skills in students, especially observation skills. Observation skills are one of the science process skills that students must first have. Observation skills are skills to use all the senses to obtain

facts from the object/phenomenon being explored (Rustaman, 2007). Student observation data can also be developed into a digital herbarium that can be utilized in biology learning (Aripin et al., 2022).

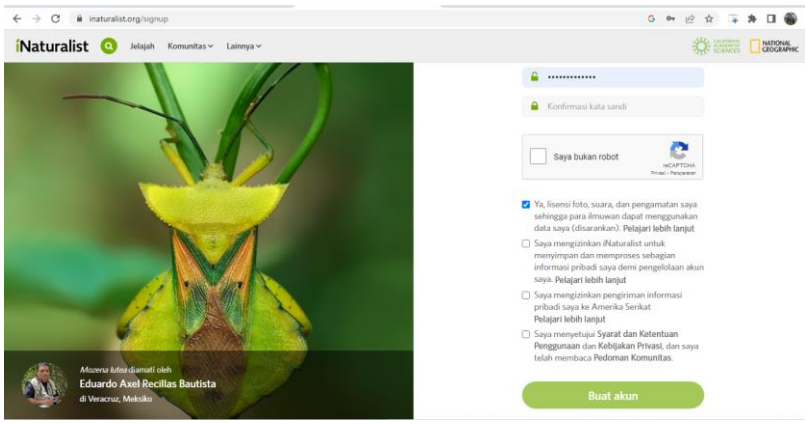
3. How to Register iNaturalist Application

This section will briefly explain how to register for the iNaturalist application on the web. The following describes a brief guide to registering the web version of the iNaturalist application.

1) Registering the iNaturalist application is to log in to the web or download the application on PlayStore.

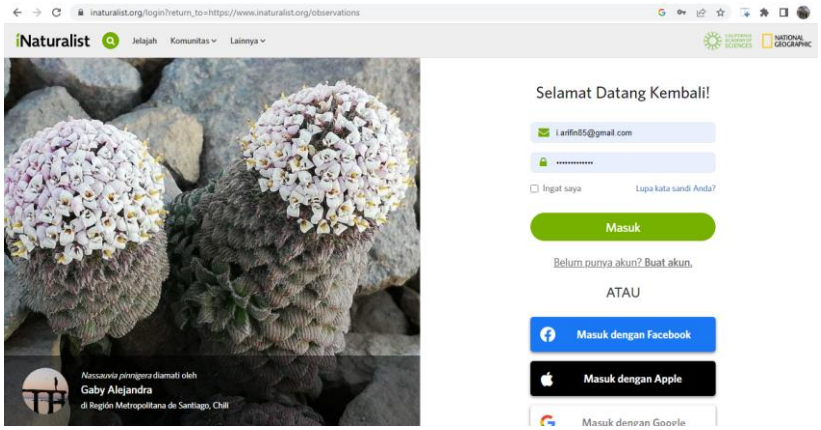


2) Fill in the registration fields

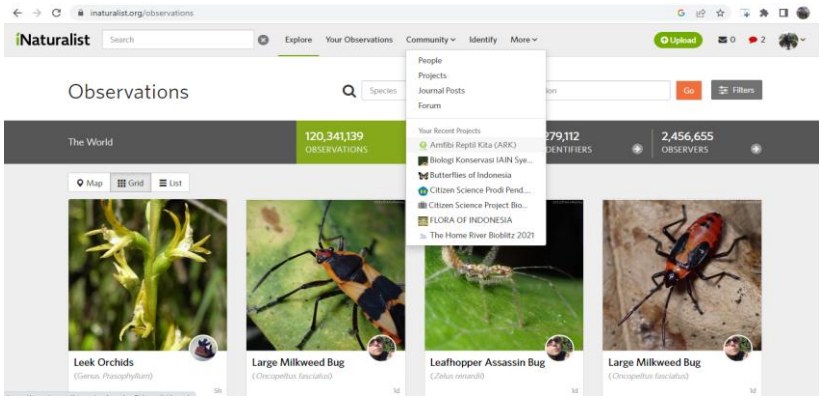


3) Register and verify registration

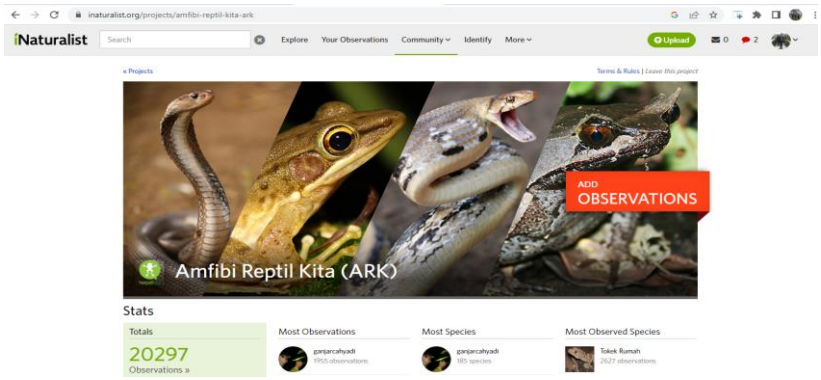
4) Login to the inaturalist app



5) Join the research community



6) Start the project by uploading each observation



CONCLUSION

iNaturalist is an Online Citizen Science (OCS) application that can be used for biodiversity data collection, identification, and publication. This application can facilitate research and learning, especially biology learning. Data generated from OCS activities using the iNaturalist application can be utilized by scientists for research activities. The iNaturalist application can be utilized in learning by creating Citizen Science projects in learning. The iNaturalist application can also be used to improve abilities in taxonomy and research skills, which are essential skills that must be possessed by students and students studying biology.

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