



Bridging Biodiversity and Community Engagement through iNaturalist: Campus-Based Citizen Science Projects

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ARTICLE INFO

Article history:

Received 1 December 2025

Received in revised form 1 January 2026

Accepted 2 February 2026

Available online 3 March 2026

Keywords:

Citizen science; iNaturalist; biodiversity; academic libraries; SDG

ABSTRACT

This study explores the outcomes of two campus-based citizen science initiatives, Khazanah Alam Campus Challenge (2023) and Biodiversity Conservation & Climate Change Project (2024), organised by Al-Bukhari Library, Universiti Teknologi MARA (UiTM) Jengka Campus, Pahang. Designed to promote biodiversity awareness and civic engagement, these initiatives utilised iNaturalist, a mobile-based citizen science platform, to involve students, faculty, and local communities in real-world biodiversity monitoring. The programs were conducted in collaboration with non-governmental organisations (NGOs) and partner universities, with significant participation from ORBID (Organisation Biodiversity Club), whose members contributed as active citizen scientists. Participants engaged in observing and recording flora and fauna around the campus environment, fostering experiential learning and strengthening environmental stewardship. Drawing solely from iNaturalist data, the two initiatives recorded a total of 1,299 observations, identifying 638 unique species, contributed by 68 observers and verified by 268 global identifiers. The findings reveal high species richness, especially among plants and insects and underscore the effectiveness of digital citizen science platforms for localised ecological engagement. This paper highlights the evolving role of academic libraries in bridging science, technology, and community participation. By integrating open science tools with place-based learning, the initiatives demonstrate meaningful alignment with the Sustainable Development Goals (SDG 13: Climate Action, SDG 15: Life on Land, and SDG 17: Partnerships for the Goals). The experience affirms the potential of collaborative, tech-enabled approaches to cultivate biodiversity literacy and participatory conservation in higher education settings.

1. Introduction

Citizen science (CS) has emerged as a powerful approach for engaging communities in biodiversity monitoring, particularly within higher education contexts where sustainability and experiential

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<https://doi.org/10.37934/araset.57.5.3239>

learning intersect. Digital platforms such as iNaturalist facilitate individuals' contributions to global biodiversity datasets, promoting environmental literacy and civic participation [1]. This paper presents findings from two campus-based CS initiatives spearheaded by Al-Bukhari Library, Universiti Teknologi MARA (UiTM) Jengka Campus, Pahang: The Khazanah Alam Campus Challenge (2023) and the Biodiversity Conservation & Climate Change Project (2024). These projects effectively mobilised students, faculty, and local communities to collaboratively document biodiversity via iNaturalist, establishing the library as an integral driver of CS and environmental stewardship, aligned explicitly with Sustainable Development Goals (SDGs) 13 (Climate Action), 15 (Life on Land), and 17 (Partnerships for the Goals).

Supported by institutional collaborators and student-led associations, particularly the Organisation Biodiversity Club (ORBID), which comprises active student citizen scientists from UiTM Pahang, Jengka Campus, the initiatives fostered hands-on biodiversity learning and community engagement. This study aims to (i) evaluate the biodiversity observations collected via iNaturalist across both initiatives, and (ii) reflect on the role of academic libraries in facilitating citizen science-based environmental learning. By comparing two consecutive projects, this paper offers insights into scalable practices for integrating CS into higher education and highlights how campus-based programs can contribute meaningfully to global biodiversity monitoring efforts.

2. Literature Review

Citizen science (CS), defined as public participation in scientific research [2], has emerged as a critical approach for ecological monitoring and public engagement. Digital platforms such as iNaturalist enable users to document biodiversity at scale by uploading and verifying species observations globally, thus contributing to scientific datasets [3]. These tools facilitate participatory learning, enhance scientific literacy, and support open science practices aligned with the SDGs. The integration of iNaturalist into academic settings is increasingly well-documented. Tiago *et al.*, [1] show that campus-based Bioblitz events using iNaturalist significantly improve ecological literacy by linking classroom instruction with real-world observation and data collection. In Malaysia, Lee *et al.*, [4] demonstrate how iNaturalist contributes to the monitoring of native flora and fosters environmental awareness aligned with SDG 13 (Climate Action) and SDG 15 (Life on Land). Complementing these findings, Jaafar *et al.*, [5] report on the Universiti Sains Malaysia Campus Nature Challenge, where students engaged in biodiversity documentation via iNaturalist, fostering cross-campus collaboration and supporting national sustainability agendas.

Recent Malaysian CS initiatives further highlight the growing momentum for digital ecological participation. Idris *et al.*, [6] demonstrated the effectiveness of a nationwide, app-based tree planting campaign involving school children, contributing to SDGs 11 (Sustainable Cities and Communities) and 13 through inclusive digital engagement. These projects showcase the evolving landscape of youth-driven and tech-enabled environmental action. Libraries, long-standing champions of information access and community education, are increasingly recognised as strategic enablers of CS. Malaysian librarians are perceived as facilitators of CS through data stewardship, training Nurfarawahidah *et al.*, [7] highlight how initiatives, and outreach activities. Despite promising initiatives such as the "Bridging Worlds" program [8] and "Citizen Science Boot Camp" and empirical evidence of academic libraries leading biodiversity-focused CS projects using platforms like iNaturalist remains limited [9].

3. Methodology

This study employed a descriptive observational method grounded in CS practices to explore biodiversity patterns and participant engagement across two campus-based initiatives. Both projects were implemented by Al-Bukhari Library, Universiti Teknologi MARA (UiTM) Jengka Campus, to enhance biodiversity awareness through community-participatory observation using the iNaturalist platform. The initiatives followed a structured process involving pre-project planning, field implementation, and post-observation analysis. The first initiative, the Khazanah Alam Campus Challenge 2023, took place from 26 October to 10 November 2023. The second, titled Biodiversity and Climate Change Project 2024, was conducted from 20 to 27 February 2024. Each project spanned a duration of 10 and 7 days respectively, targeting active participation from students, staff, and external community members. Strategic partnerships were established with the student association; ORBID to support on-the-ground guidance and engagement, with ORBID members serving as citizen scientist mentors throughout both programs.

The iNaturalist platform was selected for its accessibility, mobile compatibility, and scientific credibility [1]. Participants were required to create user accounts and were briefed on observation protocols through online and on-site tutorials. They were encouraged to record flora and fauna around the campus and upload media-supported observations to the designated project page. The library served as the coordinating body, providing digital support, field guides, and coordination with iNaturalist curators. iNaturalist automatically categorised observation data into three quality levels: **Research Grade**, **Needs ID**, and **Casual**. Research-grade observations are those that meet the minimum criteria (media, location, date, and community-confirmed identification to the species level). Observations marked as Needs ID were pending further review by global identifiers, while Casual observations typically lacked necessary metadata or were flagged as cultivated/captive. This classification was used to evaluate the data quality submitted across both projects. Following project completion, observation data were downloaded in CSV format from the iNaturalist project dashboard and analyzed using Microsoft Excel. Key metrics analyzed included total observations, unique species count, number of observers, top contributors, and taxonomic group distribution. All charts and tables presented in this paper were generated from original datasets extracted from each project's digital archive.

4. Results

4.1 Citizen Science Projects

The Khazanah Alam Campus Challenge (2023) marked the first campus-based CS initiative organized by Al-Bukhari Library, UiTM Jengka Campus. This initiative aimed to cultivate environmental awareness, biodiversity literacy, and community involvement through field-based observations supported by the iNaturalist platform. The Biodiversity and Climate Change Project (2024) continuing the momentum of the earlier Khazanah Alam initiative. Organized again by Al-Bukhari Library in collaboration with ORBID and campus stakeholders, this second phase sought to reinforce biodiversity observation skills while embedding broader environmental themes such as climate change awareness and local ecological resilience.

A total of **1,044 observations** were recorded during the Khazanah Alam Campus Challenge (2023), contributed by **52 active observers**, and verified by **193 global identifiers**. The project documented a total of **494 species**, with the most frequently observed groups being **plants** and **insects**, followed by fungi, birds and arachnids. These observations were geotagged within the campus area and uploaded with supporting images or audio, enabling global experts to verify their accuracy.

On the other hand, the Biodiversity and Climate Change Project (2024) successfully recorded a total of **256 observations**, contributed by **17 observers** and verified by **75 identifiers** from the global iNaturalist community. The initiative recorded **144 distinct species**, showing consistent documentation quality despite a shorter duration and smaller participant group.

According to iNaturalist, data quality is classified into three levels: *Research Grade*, which indicates full metadata (date, location, media) and community-confirmed species-level ID; *Needs ID*, which indicates pending confirmation by additional identifiers; and *Casual*, which is frequently due to incomplete metadata or captive/cultivated specimens. The data quality classification was shown in **Table 1**, and the percentage proportion of observations by quality grade were visualized in Fig. 1.

Table 1
 Data quality classification according to the iNaturalist's

Status	Projects	
	Khazanah Alam Campus Challenge 2023	Biodiversity and Climate Change Project 2024
Research Grade	261	57
Needs ID	549	142
Casual	234	57
Total observation	1044	256

These proportions, illustrated in **Fig. 1**, show a quality profile closely aligned with the 2023 program, with a slightly higher rate of Needs ID observations in the Biodiversity and Climate Change Project 2024, reflecting the newer participant cohort and shorter identification window.

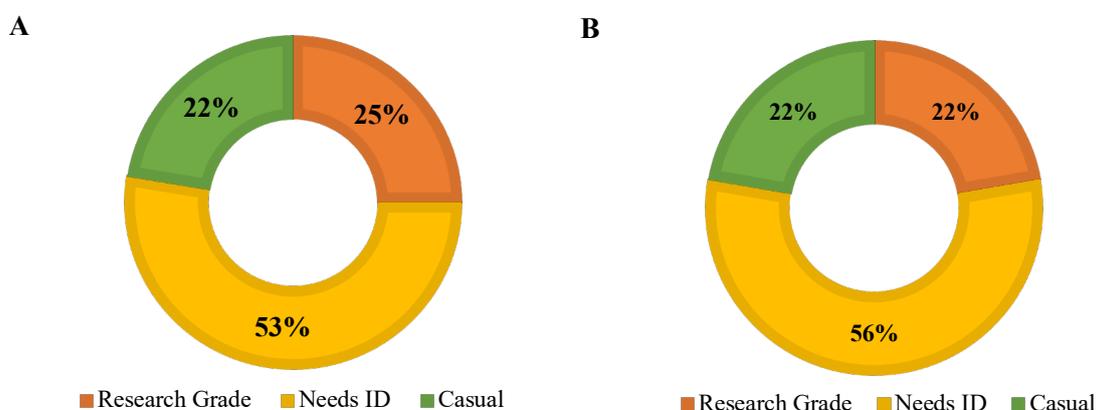


Fig. 1. A) Number of observations (N=1044) in the iNaturalist project Khazanah Alam Campus Challenge 2023 recorded by 52 observers from 26 October to 10 November 2023. **B)** Number of observations (N=256) in the iNaturalist project Biodiversity and Climate Change Project 2024 recorded by 17 observers from 20 to 27 February 2024.

4.1.1 Taxonomic diversity

The species observed were distributed across multiple taxonomic groups for both projects. For Khazanah Alam Campus Challenge (2023), plants account for most species recorded, with 283 species, representing 57.6% of the total, followed by insects with 123 species (25.1%) and fungi with 46 species (9.4%). Faunal groups showed lower representation, with birds and arachnids showing an equal number of species (12 species each, 2.4%), and reptiles, amphibians, mammals, fishes, and

molluscs, each representing less than 2% of the total species. Three species (0.6%) remain unidentified or unclassified, indicating the presence of species requiring further taxonomic work.

The observed species in the Biodiversity and Climate Change Project (2024) were primarily distributed across **plants, insects, and arachnids**, with minor representations from fungi and birds. The lower species count compared to the 2023 project is attributed to the shorter time frame and smaller observation team. Plants and insects dominate the list, with 88 and 31 species, comprising 17.9% and 6.3% of all species, suggesting a diverse population of these two groups in UiTM Pahang, Jengka Campus. Arachnids show a moderate diversity with 10 species (2.0%), followed by fungi with 4 species (0.8%) and birds and reptiles, both with 3 (0.6%) and 2 (0.4%) species. Molluscs and fish are both represented with only one species (0.2%), and 4 species remain unknown, requiring further taxonomic work. However, none of the mammals and amphibians were found and observed during the 7-day observation period, indicating an insufficient observation period and participants. The proportions of taxonomic groups by species count are depicted in **Fig. 2**.

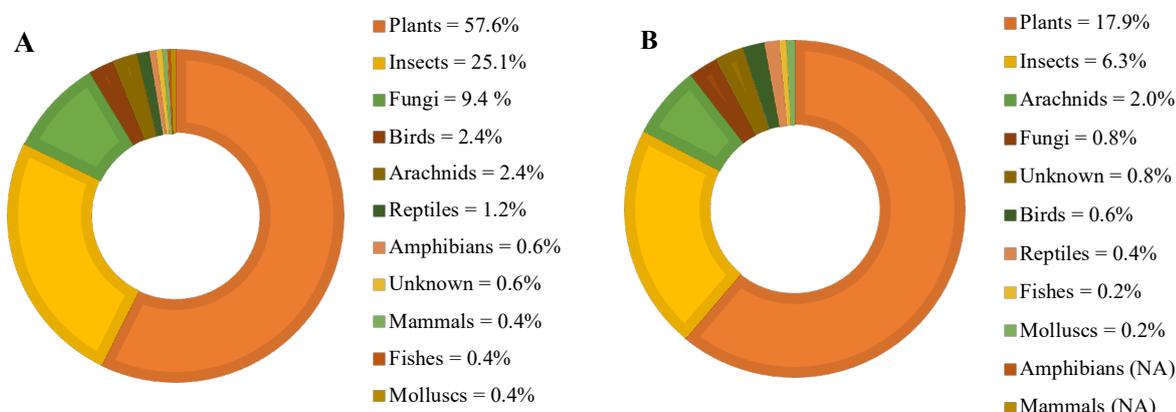


Fig. 2: A) Proportion of taxonomic groups based on the number of species (N=494) in the iNaturalist project Khazanah Alam Campus Challenge 2023 recorded by 52 observers **B)** Proportion of taxonomic groups based on the number of species (N=144) in the iNaturalist project Biodiversity and Climate Change Project 2024 recorded by 17 observers.

4.1.2 Most frequently recorded species

The top ten species observed during the Khazanah Alam Campus Challenge (2023) include a mix of flowering plants and commonly found insects in tropical forested habitats. The highest observed species was *Clidemia hirta* (Senduduk bulu) with a total of 15 observations, followed by *Tridax procumbens* (Kancing baju), with 13 observations. A total of 8 observations was recorded for each of *Lycopodium cernuum* (Paku serani), *Melastoma malabathricum* (Senduduk), *Tabernaemontana divaricata* (Susun kelapa), and *Valanga nigricornis* (Belalang kunyit). 6 observations were recorded for 4 species, which are *Mimosa pudica* (Semalu), *Ocophylla smaragdina* (Kerengga), *Bougainvillea glabra* (Bunga kertas), and *Hibiscus archeri* (Bunga raya).

The most frequently recorded species for the subsequent project in 2024 were again dominated by flowering plants and insects, with many overlapping species from the 2023 initiative. *Clidemia hirta* (Senduduk bulu) remained the most often encountered species, with 4 observations, followed by *Citrus sp.*, *Pilea microphylla* (Artillery plants), and *Tridax procumbens* (Kancing baju), each with 3 observations. Five species were recorded with 2 observations, which are *Mimosa pudica* (Semalu),

Catharanthus roseus (Kemuning cina), *Trithemis aurora* (Pepating merah jambu), *Ruellia simplex* (Bunga loceng gurun), *Amata huebneri* (Hübner's wasp moth), and *Pandanus amaryllifolius* (Pandan).

These results indicate a high ecological abundance of these species within the UiTM Pahang, Jengka campus. These findings affirm the program’s success in engaging the campus community and producing verifiable biodiversity data aligned with open science practices, as well as the persistence and adaptability of iNaturalist-based CS in sustaining biodiversity documentation efforts across multiple campus cycles. **Fig. 3 and Fig. 4 show** the top ten most frequently observed species based on observation counts **for the** Khazanah Alam Campus Challenge 2023 and the Biodiversity and Climate Change Project 2024.

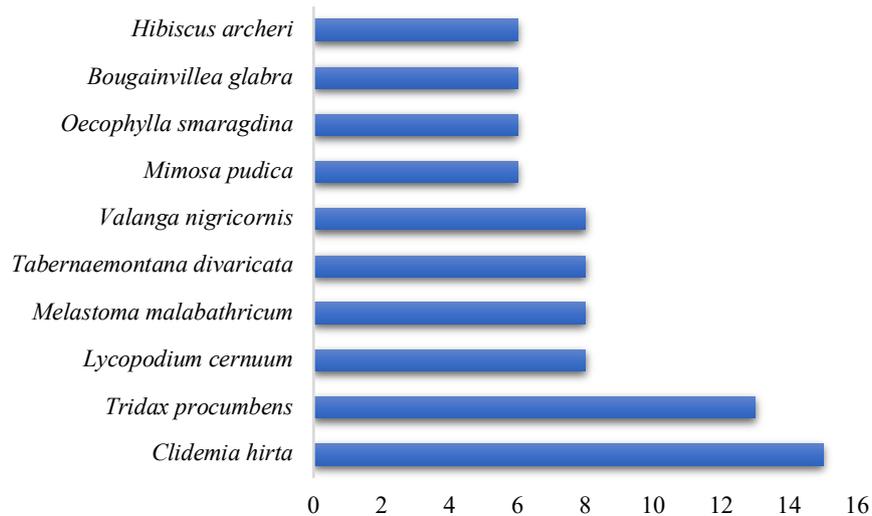


Fig. 3. The top ten most frequently observed species in the iNaturalist project Khazanah Alam Campus Challenge 2023 recorded from 26 October to 10 November 2023

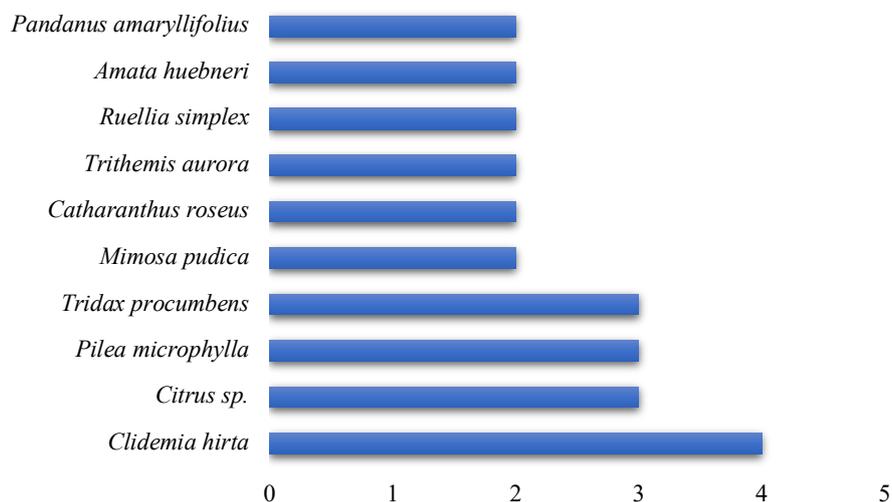


Fig. 4. The top ten most frequently observed species in the iNaturalist project Biodiversity and Climate Change Project 2024 recorded from 20 to 27 February 2024

A comparative reflection between the two projects reveals several notable insights. Despite variations in duration, participant numbers, and total observations, both programs demonstrated remarkably consistent proportions of observation quality, specifically in the categories of Research Grade, Needs ID, and Casual observations. This consistency highlights the effectiveness of training

methods and participant preparedness, likely supported by mentorship provided by ORBID student members. Species diversity recorded in the Khazanah Alam Campus Challenge (2023) was higher, attributed to the longer duration and larger number of participants involved. Conversely, the Biodiversity and Climate Change Project (2024) documented unique fungi and amphibian species that were absent in the earlier initiative, suggesting ecological differences influenced by seasonality. These complementary outcomes emphasize the value of recurring CS initiatives for capturing broader ecological trends over time. From a participation perspective, the 2023 project benefited from a broader and more diverse participant base, while the 2024 project showcased strong individual leadership, with fewer observers contributing a substantial portion of the records. These patterns indicate that targeted mentorship or incentive-based formats could positively influence participant engagement in future initiatives. Collectively, these findings illustrate the replicability and effectiveness of campus-based biodiversity monitoring initiatives and highlight the significant role of academic libraries in facilitating participatory biodiversity conservation aligned with sustainability and CS objectives.

5. Discussion

The results of both campus-based CS initiatives illustrate the evolving capacity of academic libraries to act as central platforms for participatory science and sustainability education. Al-Bukhari Library's leadership role in initiating, organizing, and managing the Khazanah Alam Campus Challenge (2023) and the Biodiversity and Climate Change (2024) highlights a significant shift in traditional library functions toward active engagement in knowledge creation. These expanded roles include facilitating digital literacy, scientific communication, participant training, and community outreach, aligning with open science practices and effectively bridging academic research with public participation [5,10,11].

Community engagement and experiential learning were critical achievements across both initiatives, with participants actively documenting local biodiversity using digital platforms such as iNaturalist. Supported by smartphones, geotagging, and immediate species identification capabilities, participants experienced real-world scientific processes that enhanced their ecological awareness and scientific literacy [1]. The sustained involvement of student-led associations, particularly the ORBID, played an essential role in participant mentorship, facilitating peer-guided learning and ongoing digital engagement. These repeated, structured CS projects demonstrated the potential to cultivate ecological knowledge, strengthen collaborative skills, and nurture future environmental leadership among student participants [4,5,12].

Both CS projects effectively advanced the SDGs, particularly SDG 13 (Climate Action), SDG 15 (Life on Land), and SDG 17 (Partnerships for the Goals). By encouraging active biodiversity monitoring and generating scientifically credible datasets, the initiatives contributed significantly to local and global biodiversity knowledge bases. The intentional collaboration with university departments, student organizations, and global CS networks exemplified strategic partnerships necessary for achieving sustainability objectives [3]. Overall, these initiatives underscore the critical role of academic libraries in driving participatory biodiversity conservation efforts and demonstrate the value of integrating CS into higher education as a mechanism for achieving broader sustainability outcomes.

6. Conclusion and Recommendations

This study highlights the educational value and community impact of campus-based CS initiatives supported by digital tools such as iNaturalist. These programs successfully engaged participants in

biodiversity documentation, promoting environmental awareness, enhancing digital participation, and fostering experiential learning through ecological observation. The consistent quality of data collected across both initiatives, despite differences in duration and scale, reinforces the reliability of this model. The findings demonstrate how academic libraries can play an active role in leading citizen science-based environmental learning by integrating digital tools, offering structured tutorials, and fostering interdisciplinary engagement. To strengthen future implementation, libraries should embed CS into formal and co-curricular education, establish partnerships with biodiversity experts and local agencies, and leverage collected data for research, institutional reporting, and sustainability policy. These strategies position academic libraries as key actors in promoting civic participation, digital inclusion, and ecological literacy. Ultimately, the initiatives offer replicable and scalable models for integrating CS into the academic environment, reaffirming the evolving role of libraries as catalysts for participatory learning and sustainability education.

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