

# The Jatinangoriense Herbarium as Learning Innovations within the Independent Learning Independent Campus (MBKM)

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## Notes

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## ABSTRACT

The Jatinangoriense Herbarium is a teaching herbarium managed by the Biosystematics and Molecular Laboratory, Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University. It stores approximately 8,000 specimens, including collections of angiosperms, ferns, algae, fungi, seed collections, simplicia, and carpology. The herbarium serves as a facility for learning, research, community service, and plant identification services. In line with the Merdeka Belajar Kampus Merdeka (MBKM) program, the presence of this teaching media plays an essential role in supporting the program as a means of developing digital teaching media and courses that focus on the competence of biocurators. This qualitative research employs the 4D model with four stages: define, design, develop, and disseminate. The result is an instructional video on the techniques and management of the herbarium, which serves as one of the teaching materials in the Collection and Management of Biological Specimens course. Additionally, the MBKM program facilitates off-campus students by using digital learning facilities, encouraging universities to develop virtual museums and herbaria that can be widely accessed as sources of knowledge. The Bachelor's Degree Program in Biology at the Faculty of Mathematics and Natural Sciences, Padjadjaran University, provides students with the opportunity to learn and practice the development of a virtual herbarium through the Digitalization of Biological Objects course, utilizing various specimens from the Jatinangoriense Herbarium.

**Keywords:** Museum; biocurator; herbarium jatinangoriense; knowledge management

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## 1. INTRODUCTION

The herbarium has become one of the main centers for learning about plant taxonomy, systematics, biodiversity, and collection management (Cota-Sánchez & Harms, 2009). The herbarium has stored various collections of important plant specimens/*voucher* specimens (Maden, 2004). Each specimen represents the product of exploration and captures classic field experiences. They are unique data representing biological records at a specific place and time (Flannery, 2013; Monfils et al., 2017). Therefore, herbarium specimens serve as historical collections, reference collections, research resources, and education media. Many specimen collections in academic institutions directly result from field-based learning and research processes. They can be physical evidence and historical records for biological phenomena (Flannery, 2013; Maden, 2004; Monfils et al., 2017). Thus, the herbarium becomes an institution that can be utilized to train students in maintaining and conserving plant diversity, allowing integration into education.

The Jatinangoriense Herbarium is a teaching herbarium managed by the Laboratory of Biosystematics and Molecular, Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University. The herbarium has been nationally indexed since 2006. It stores approximately 8,000 specimens, including collections of angiosperms, ferns, algae and fungi, seed collections, simplicia, and carpological specimens (Girmansyah et al., 2018). It serves as a facility for education, research, community engagement, and plant identification services.

In 2020, the Ministry of Education and Culture issued Regulation No. 3 of 2020 on the National Standards for Higher Education (SNPT), which governs the Independent Learning Independent Campus or *Merdeka Belajar Kampus Merdeka* (MBKM) program. The higher education institutions are required to design curricula and implement learning processes that enable students to achieve optimal learning outcomes in terms of attitudes, knowledge, and skills. Furthermore, the learning system has shifted from Teacher-Centered Learning (TCL) to Student-Centered Learning (SCL), which aims to produce outcomes known as Outcome-Based Education (OBE).

The MBKM program also allows students to take certain courses outside their study program and participate in various programs offered by universities, institutions, industries, and the Ministry of Education and Culture. This condition also gives opportunities for students to participate in these programs remotely. The global COVID-19 pandemic 2020 has also exerted pressure, necessitating rapid learning process changes and shifting toward online or distance learning. Consequently, educational transformation is forced to adapt to these circumstances (both curriculum changes and the pandemic situation) by utilizing various technologies.

Although face-to-face interaction and direct training are crucial for students to master identification skills in taxonomy (Cota-Sánchez, 2020), the MBKM curriculum in Indonesia and the COVID-19 pandemic challenge the education system and push educators to move away from traditional teaching methods. Moreover, many universities worldwide, including some in Indonesia, have adopted a hybrid learning model that combines in-person and online/virtual lectures. This situation presents challenges in teaching and requires a great deal of creativity. Therefore, options for delivering content effectively and training students in botany, plant taxonomy and systematics, and even herbarium management must incorporate both hands-on experience and digital or virtual elements.

Thus, in the course "Collection and Management of Biological Specimens and Digitalization of Biological Objects," which focuses on achieving learning outcomes in

biological curation (biocuration), it is necessary to update the learning process. Students can receive instruction through instructional videos provided in links and then practice independently in the field. They can even engage in projects that involve exploring, collecting, and digitizing specimens directly. Furthermore, the project can be extended to digitize the biological specimens stored in the Jatinangoriense Herbarium, transforming it into a virtual herbarium. According to Contiu (2021), creating a virtual herbarium offers a creative solution to the challenges faced by educators and students who cannot engage in face-to-face field activities. Additionally, the digitization process accommodates access to limited herbarium specimens. This is important due to the fragile nature of herbarium specimens, which hold significant value, or they may be stored in herbaria located in different countries (Flannery, 2013).

Modern and advanced computer technology enables effective digital documentation of herbaria. Specimen-based digitization has provided access to a wealth of biodiversity information and expanded the reach of natural history collections. Additionally, the combination of physical specimens and online access to specimen data creates new opportunities for creating a progressive learning environment, both formally and informally (Efthim, 2006; Monfils et al., 2017). Direct examination of archived collections enhances appreciation for nature and encourages ongoing exploration and appreciation of global diversity (Monfils et al., 2017). The digitization and accessibility of herbarium collection data have opened up new possibilities, serving as relevant resources for a broader scientific community. This shift transforms herbaria from mere storage facilities for specimens into valuable data sources with diverse applications.

One of the digitization efforts that has been undertaken is the Australasia Virtual Herbarium at the national level and the Global Biodiversity Information Facility at the international level (Catrill, 2018). Digitized herbarium collections (virtual collections and exhibitions) are easily accessible as references for students to directly compare old and newly collected specimens in the learning process (Cota-Sánchez, 2020). Cota-Sánchez (2020) argues that distance education has great potential for everyone, regardless of location or resources, as long as there is internet access, enthusiasm, and motivation to learn.

## **2. METHODS**

This qualitative research utilizes the 4D model, which consists of four stages: define, design, develop, and disseminate (Ayu et al., 2022; Tegeh et al., 2019). These stages are employed for the development of instructional materials such as instructional videos and virtual herbaria. The process begins with defining the objectives and parameters of the project, followed by the design phase, where the structure and content of the materials are planned. Next, the development stage involves creating and refining the instructional materials. Finally, the dissemination stage focuses on implementing and sharing the materials with the intended audience.

In general, the defining stage includes the following steps:

- ✓ Front-end analysis: Analyzing the development needs.
- ✓ Learner analysis: Considering the students' needs in the learning process.
- ✓ Task analysis: Determining the competencies related to the developed material.
- ✓ Concept analysis: Identifying the subject matter to be developed.
- ✓ Specific instructional objectives: Establishing learning achievement indicators.

During the design phase, instructional media determines the design, media, and script (Tegeh et al., 2019). Firstly, the design concept is determined, which includes instructional videos and a virtual herbarium. Secondly, the media chosen for storing the instructional videos is YouTube, while the virtual herbarium is developed with an independent website domain. Thirdly, the video script and various aspects are prepared and discussed with professional videographers and editors. As for the virtual herbarium concept is developed with students in the Digitalization of Biological Objects course, and further consultation is conducted with experienced website developers. The creation of the virtual herbarium begins by establishing the concept, layout, and information to be presented (Cantrill, 2018).

In the development stage, instructional videos and the virtual herbarium are produced, followed by the implementation stage (dissemination). Here are the development stages for each design concept:

#### *A. Learning Video*

The instructional video consists of two parts: "Herbarium" and "Techniques for Preserving Plant Materials" (Maden, 2004). Part one covers the definition of a herbarium, types of plant collections, and plant collection techniques. Part two includes techniques for preservation, pressing and drying, mounting techniques, and labeling of herbarium specimens. A professional videographer conducts the video shooting, utilizing the various specimen collections available in the Jatinangoriense Herbarium at the Laboratory of Biology, Padjadjaran University.

Once the video recording is completed, a professional editor then edits it. The responsible faculty member reviews the curated content to ensure alignment with the learning outcomes. After the curation process is finished and there are no copyright issues with the selected background music, the video is uploaded to the official YouTube page of the Department of Biology, Padjadjaran University.

#### *B. Virtual Herbarium*

The creation of the virtual herbarium begins with the documentation process of the herbarium specimens in the Jatinangoriense Herbarium, located in the Laboratory of Biosystematics and Molecular, Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University. This process is carried out by all students taking the Digitalization of Biological Objects course who have received training in photography. Each student practices capturing photographs that will be uploaded to the virtual herbarium website. The course instructor reviews the curated photos of the documented herbarium specimens based on specific criteria, such as ensuring that specimens used by different students are not the same, the photo subjects are clear and not blurry, and there is clear information about the specimens being used.

Next, the development continues by uploading all the documented results and accompanying information to the virtual herbarium website. The website is a platform to showcase and disseminate the herbarium collection for mass access. Professional website developers handle uploading, layout design, and overall website development.

### 3. RESULTS AND DISCUSSION

#### A. Learning Video

The creation of instructional videos is based on the analysis of the need to provide teaching materials for internal students of the Biology Program at Padjadjaran University and students from other institutions. These instructional videos are specifically tailored for the Collection and Management of Biological Specimens course. This course is an elective subject offered through the MBKM (Independent Campus, Free Learning) program, including student exchange programs such as Sasrabahu (PTN BH), Nuni-Mobi, and the MBKM Network of Biology Programs in Indonesia. Participating MBKM students come from various institutions, including Universitas Airlangga, Universitas Bengkulu, Universitas Islam Negeri Syarif Hidayatullah Jakarta, Universitas Negeri Jakarta, Universitas Atmajaya Yogyakarta, Universitas Islam Negeri Sunan Gunung Djati Bandung, and Universitas Nasional Jakarta.

The instructional video content covers the definition and concept of a herbarium and the techniques for collecting and creating herbarium materials (Maden, 2004). The video production is divided into two parts. The first part focuses on defining a herbarium, the types of plant collections, and plant collection techniques. The second part covers preservation techniques, pressing and drying methods, mounting techniques, and labeling of herbarium specimens. The video production process takes place in the Jatiningoriense Herbarium, Department of Biology, Faculty of Mathematics and Natural Sciences, Padjadjaran University, and is uploaded to the official YouTube channel of the Department of Biology, Padjadjaran University, as captured below.



Figure 1. Video display of the herbarium specimen-creating technique on the UNPAD Biology Youtube channel (<https://www.youtube.com/watch?v=54VBYV2L2vc&t=150s>)

The instructional video on the techniques of creating herbarium specimens, which has been uploaded, is not only used for the course on Collection and Management of Biological Specimens but also for other botany-related courses such as Plant Taxonomy, Plant Ecology, Ethnobiology, and Plant Bioprospecting. The availability of these instructional videos facilitates students from outside Padjadjaran University to access additional teaching materials, and the general public can also access them. The instructional video serves as one model for the development of hybrid teaching. The hybrid teaching model combines face-to-face classroom meetings and online sessions, as developed by Padjadjaran University.



Figure 2. A hybrid learning process that combines face-to-face methods (left image) with virtual face-to-face online (right image)

### *Virtual Herbarium*

Herbarium is a collection of dried/preserved plant specimens mounted on specific sheets of paper to study botany. Also, herbarium refers to the cabinets/rooms/buildings where plant collections are stored and managed for research purposes (Girmansyah et al., 2018). The herbarium collection consists of preserved plants from explorations in a particular region. The Jatinangoriense Herbarium collection includes approximately 8,000 specimens, comprising collections of angiosperms, ferns, algae, fungi, seed collections, plant extracts, and carpological specimens. These collections are obtained through explorations in various conservation and non-conservation areas in West Java. The collection also features unique specimens such as mangroves from different regions of Indonesia, Kantung Semar (a carnivorous plant) from Kalimantan, Rami plants from West Java, and several weed species found around the Padjadjaran University.

With the advancement of computer and photography technology, it has become possible to document herbarium collections digitally. The virtual herbarium method is a project conducted in the Digitalization of Biological Objects course, which is a mandatory course in the bioscience specialization of the Biology Program at Padjadjaran University. This course trains students in the digitalization of specimens in the Jatinangoriense Herbarium. The documented results are then uploaded to a website page in the form of a virtual exhibition called Evolution Biological Exhibition (<https://biologicalexhibition.code-breeder.com>).

The digitally documented herbarium collections (virtual collections and exhibitions) are easily accessible as references for students to directly compare old and newly collected specimens in the learning process. Some herbarium specimens are documented through photographs and uploaded (Figure 4 and 5). Furthermore, the developed virtual herbarium also incorporates the concept of Virtual Reality (VR). To fully experience it, virtual museum visitors are required to use VR headsets for optimal immersion.



Figure 3. Several types of herbarium collections found in the Jatiningoriense Herbarium (clockwise: hemp specimens, weed specimens, mangrove specimens, and pitcher plant specimens)

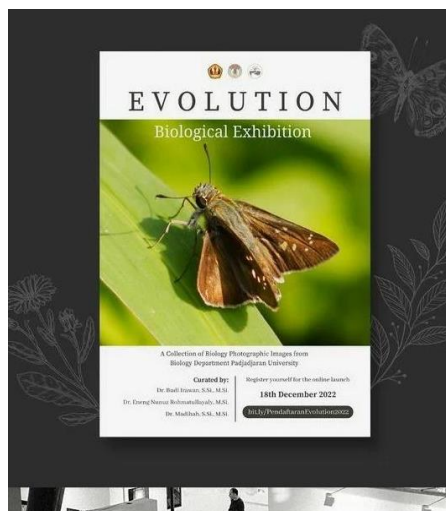


Figure 4. Evolution biological exhibition event conducted to launch the virtual herbarium exhibition

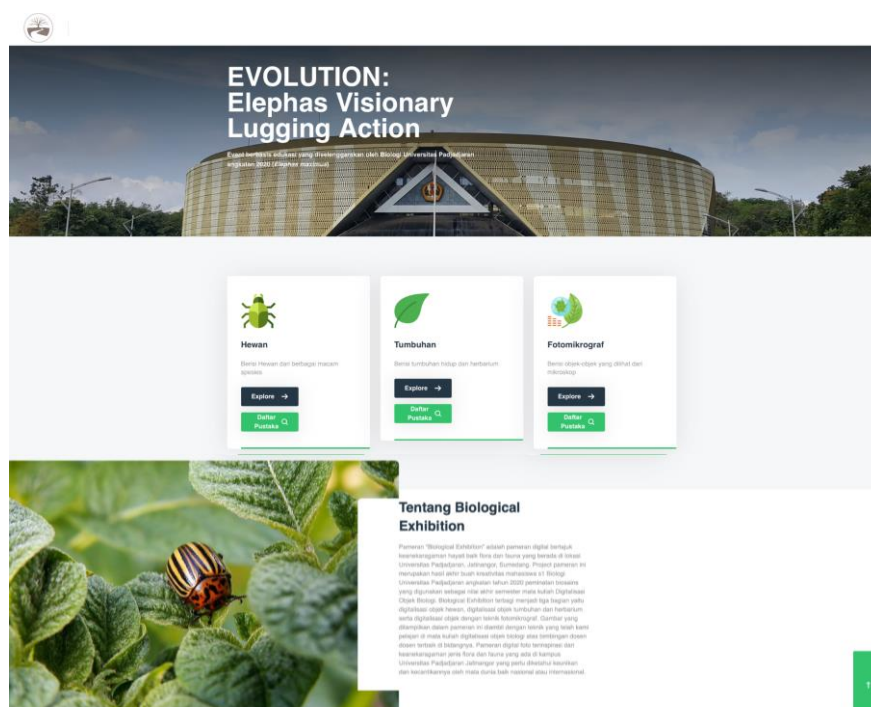


Figure 5. The website of Jatiningoriense Herbarium virtual and other specimens (<https://biologicalexhibition.code-breeder.com>)

The herbarium plays a crucial role in botanical research in Indonesia and can be developed as a database hub that serves as an information source for biodiversity in the country. Digital herbaria offer a potential solution to the limitations of traditional herbaria (Setiawan et al., 2020) in the era of the Merdeka Campus curriculum and hybrid learning systems combining face-to-face (offline) and online learning. Additionally, combining physical specimens and online access to specimen data provides new opportunities to create a progressive learning environment, both formally and informally (Efthim, 2006; Monfils et al., 2017). It also enhances conservation practices and provides better long-term protection for plant diversity in Indonesia (Setiawan et al., 2020). Digitalization can also accommodate the limitations of accessing fragile herbarium specimens or specimens stored in different countries (Flannery, 2013).

The herbarium plays a vital role in fulfilling the *Tridharma* (three pillars) of higher education, which includes education and teaching, research, and community service. Therefore, digital transformation is necessary to accommodate various needs. The digitalization of the herbarium can be achieved by creating teaching materials in the form of instructional videos and developing a virtual herbarium. We have created digital teaching materials covering herbarium specimens' collection and creation process (Figures 1 and 2). These openly accessible videos facilitate independent learning for students participating in the Merdeka Campus program. Instructional videos are considered more effective for learning as they enhance engagement, stimulate interest, and improve comprehension (Tegeh et al., 2019). Students have more time to enhance their understanding of a subject because they can replay the instructional videos. According to Tegeh et al. (2019), instructional videos can be utilized not only in the classroom but also anywhere and anytime, offering flexibility in learning.

In addition, our virtual herbarium has enhanced students' abilities to document, curate digital works, verify the information to be presented, and gain experience in building a publicly accessible virtual herbarium. According to Contiu (2021), student involvement in virtual herbarium projects stimulates their initiative, develops communication and collaboration skills,



boosts self-confidence, and encourages self-assessment and assessment of their group members' abilities. Furthermore, this project is an interactive method that enhances creativity and capacity-building through inter- and transdisciplinary approaches. These competencies support biology students in understanding the skills of a biocurator, such as collecting, preserving, documenting, and managing biodiversity, and contribute to the expected learning outcomes/competencies of the Merdeka Campus, including developing 21st-century soft skills. Currently, the collection of specimens in the Jatinangoriense Herbarium can be easily accessed, adding to Indonesia's wealth of biodiversity information, although it is still limited in quantity. According to Monfils et al. (2017), examining directly archived collections can enhance appreciation for nature, encourage ongoing exploration, and foster a global appreciation for biodiversity.

#### 4. CONCLUSION

The development of instructional videos and the transformation of Jatinangoriense Herbarium into a virtual herbarium provide new alternatives for the contribution of herbaria in education, particularly by offering flexibility for students to learn from anywhere within the *Merdeka Belajar Kampus Merdeka* (MBKM) curriculum. The Biology undergraduate program at Padjadjaran University, Faculty of Mathematics and Natural Sciences, facilitates students in the Digitalization of Biological Objects course to gain learning experiences and practice in developing a virtual herbarium using various specimens available in the Jatinangoriense Herbarium.

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