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Utilizing university food gardens as an instructional tool for teaching horticulture: Gaining insights from project experience

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ABSTRACT Advanced Horticultural Production Technology is a course that may be chosen as an option in the Agrotechnology Study Programme. Ineffective legal laws and slow technical progress hinder the growth of Indonesian horticulture products. Additionally, insufficient human resource capabilities, weak horticultural institutions, and suboptimal technological innovation further impede this development. Horticultural Postharvest Technology students find this material inspiring and beneficial. This course instructs students in applying agronomy, plant breeding, plant protection, soil science, and social sciences to enhance resource efficiency, quality, and sustainability in agricultural activities. Tropical horticultural items, such as vegetables and fruit, will experience an impact. This research is limited to examining commodities, morphology, plant environment, plant varieties, and growth methodology specifically related to tomato-produce plants. Students participate in offline and online FGBL activities—an initial questionnaire ascertained identity. Questionnaires, brainstorming, assignments, and monitoring of media reports are used to evaluate each stage of FGBL activities. To gain these abilities, employ the method of project-based learning (FGBL). FGBL includes the development of a project plan and timetable, assessing student attributes, formulating structured inquiries for experimental design, supervising progress through reports, exchanging ideas, and evaluating the project. This article provides a detailed discussion of various measures that assess student motivation for learning, such as participation during lectures and engagement in brainstorming activities.

1. INTRODUCTION

Even though there are many campus food gardens on campuses in Indonesia, this is rarely the case throughout the country. Gardens can take a variety of forms, including volunteer community gardens dedicated to the university or broader community (Jannah, 2015; Pierre, 2022; Wicaksono, 2015) or service learning gardens (Arsa et al., 2021; Pribadi, 2023), which serve as showcases of the University's sustainability efforts or as official teaching and research locations (Darlis & Amalia, 2018; Kurniasih & Adianto, 2018; Lestari et al., 2023). Many campuses in Indonesia have food gardens (Kaiser, 2015; Lal, 2020) or botanical gardens (Spilková, 2018; Torrijos, 2021; Ullevig, 2021). Higher education in Indonesia has not yet fully utilized food gardens as valuable assets for teaching and research. Although some campuses may have food or botanical gardens (Gramazio, 2018; Pohl, 2022; Sokoloff, 2021), food cultivation outside biology or physics is rarely integrated into the curriculum and expressly included in specific courses.

Advanced Horticultural Production Technology is an elective course in the Agrotechnology Study Program at the Faculty of Agriculture (Kuhar & Doughty, 2018; Manickam, 2021; Satishchandra, 2019). The contribution of the Agrotechnology study program to graduation competencies is determined by the acquisition of learning skills at graduation. Students can participate in cooperative projects and demonstrate their social awareness and dedication to social and environmental causes (Hlaing, 2018; Otten et al., 2022, 2018). Their knowledge includes theoretical ideas and expertise in cultivation technology (Kozai, 2016; Yang, 2019; Yuniwati, 2022), growing media and technology (Knežević, 2017; Shamshiri, 2022), environmental science and technology (Brown, 2016; Carolan, 2020), as well as sustainable production of wet tropical crops (Armanda, 2019; Nadal, 2017; Xia, 2016). Students can develop logical (Sudiantini et al., 2023), critical (Cakir & Lambiotte , 2014; Varghese, 2022) and systematic thinking skills (Linn, 2019; Otten et al., 2022), and innovative by emphasizing and using scientific, technical, and knowledge-based advances (Fernández-Batanero, 2022; Förtsch, 2018; Korber, 2018; Quispe, 2021).

Furthermore, they underscore the importance of human values in their field of expertise. Children can independently and effectively demonstrate their skills and achievements in a way that can be seen and evaluated. Students can participate in scientific investigations of agronomy, plant breeding (Liu, 2018), plant protection (Otten et al., 2022), soil (Berendsen, 2018), and social sciences (Hassan, 2021; He, 2021; Plat, 2022). They will gain the knowledge and skills to use resources efficiently and in an environmentally friendly way using optimal farming techniques. Lecturers can increase students' motivation to learn by using a "food garden" approach in their courses, making this effort more achievable.

Based on field observations, the courses above cover various tropical horticultural commodities, including vegetables, ornamental plants, medicinal and herbal plants, and fruit. It would be ideal if these plants were available to students and collected quickly, allowing them to practice independently in their homes. The main subtopics of discussion revolve around commodity prospects, morphology, growing conditions, plant varieties, and specific cultivation techniques such as seeding, soil preparation, planting, maintenance, fertilization, herbicide control, plant disease management, harvesting, and propagation systems.

In recent years, the learning approach in the Advanced Horticultural Production Technology (AHPT) course has prioritized the delivery of lecture content through contact hours, student presentations, lecture elaborations, and assessments. Prioritizing Mid-Semester Exams, Final Semester Exams, Individual Assignments, Independent Assignments, and Group Assignments is no longer considered suitable. Being directly involved in processing one or two commodities without involving groups, experimental design, and brainstorming will not effectively increase student talent.

Although there are efforts to integrate experiential learning into university curricula (Egerer, 2019; Green& Duhn, 2015), most teaching and research in higher education, particularly in the arts, law, and social sciences, continue to prioritize traditional book-based approaches (Baur, 2022). Except for biology and physics, most disciplines and degrees have no practical component, let alone an externally taught component (Majewska, 2020; Marsh, 2020). Many factors contribute to this phenomenon (Mcata, 2019), including research measurement (Fitriana, 2019), long-term policies and promotions, and ingrained ideas about intellectualism and knowledge (Classens, 2015; Joy, 2014; Samson, 2012).

Over the last five years, along with the increasing prevalence of online learning, students have been required to have digital literacy and complete their work remotely. Some complete it in their offline classes. As a result, group discussions and presentations were not optimal and stopped. These limitations are mainly caused by technical problems, such as loss of hotspots due to power outages, network problems, insufficient telephone credit, and annoying noise that disrupts online learning. A common problem experienced by most students is the need for more concentration when following the learning process via the Zoom platform. Even offline learning cannot bring online classes to their full potential. Apart from the habit of students who prefer online classes as an effect of learning classes when they were affected by the pandemic several years ago, it was discovered that they could not maximize literacy or even students' ability to practice knowledge when lectures were conducted offline.

During Zoom lectures during the pandemic, lecturers faced challenges in engaging students and fostering their enthusiasm for active participation in the learning and discussion process. Excessive and continuous daily use of Zoom has been identified as contributing to this. Students' lack of concentration causes the evaluations used so far inappropriate. Therefore, students are expected to show more interest and motivation in the project-based learning (PJBL) approach (Gary, 2020; Krajcik, 2014; Zhao, 2016). They will experience reduced stress levels associated with technical challenges and will be able to cultivate an entrepreneurial mindset (Etesami, 2018; Morales, 2018).

PJBL is an educational approach that places a project (activity) as the center of learning (Jumaat, 2021; Paluszek, 2020; Svihla, 2016). In PBL learning, students are assigned to create a project that centers on developing a performance product (Duke, 2021; Kusumaningsih et al., 2024; Lin, 2016). It involves conducting studies or research, addressing a problem, and synthesizing the knowledge gathered. The results of the learning process are the culmination of the collective efforts of student groups.

The food garden strategy synergizes with the Project Learning (food garden learning/FGBL) model or environment-based learning by using the garden as an educational instrument, where children actively carry out activities such as planting, fertilizing, watering, and caring for plants. This approach offers hands-on experience and motivation for children to develop ecological literacy and foster an understanding of environmental conservation (Beamount, 2014; Lin, 2016; Sefira et al., 2024)(Beaumont, 2014; Lin, 2018; Sefira et al., 2024). The aim of fostering environmental awareness among students is to ensure the preservation of nature and encourage sustainable development, which is essential for society and education. Edible Landscapes Stimulate children's propensity for knowledge by offering them opportunities for exploration and discovery, with adult support and direction, in various environments such as gardens and parks (Somerset & Markwell, 2009), Moreover, Gwinner et al. (1988) believe that the food garden-based learning model is more comprehensive and can be applied to today's needs. The focus is on environmental literacy, sustainable livelihoods, healthy eating habits, nutrition education, and life skills. This model prioritizes educational experiences, combines multiple disciplines, and broadly impacts schools, families, and communities. Food garden-based learning includes more than just using the garden as a teaching tool (Biebach et al., 1994; Kos & Jerman, 2012). This involves providing students with immersive experiences encouraging ecological literacy and sustainable development.

Apart from that, Advanced Horticultural Production Technology is an elective course in the Agrotechnology Study Program, which can be done by developing a product. However, the development of Indonesian horticultural products is hampered by statutory regulations. Apart from that, the technical development used in developing products is inefficient. Other things are limited human resource capabilities, weak horticultural institutions, and less-than-optimal technological innovation. So, this research aims to motivate and improve agricultural faculty students in Postharvest Horticulture activities.

The same research has been carried out many times by including food gardens in the classroom. However, the difference between this research and previous research is that this course teaches students how to use several material components such as agronomy, plant breeding, plant protection, and some soil science and social sciences knowledge. The components in these materials are needed to increase the efficiency, quality, and sustainability of resources through agricultural practices.

The agricultural practices carried out will produce tropical horticultural products, namely vegetables. The focus of this research on commodities, morphology, plant environment, plant varieties, and growth methodology in tomato vegetable plants limits this. Students from the fifth semester of the Agrotechnology Study Program, Wisnuwardhana Faculty, Malang, Indonesia, took part in the offline-online FGBL in the Horticulture class. Furthermore, the FGBL activities are synergized with the food garden strategy. So, this research is essential to carry out and will be an update on research that has been carried out previously.

2. METHOD

This research uses action research to examine how an integrated learning model based on food garden strategies develops naturalist intelligence in fifth-semester Agrotechnology Study Program students at the Faculty of Wisnuwardhana Malang, Indonesia, in 2022/2023. Action research using Kemmis and McTaggart was used. The researcher worked with the class lecturer on this collaborative action research technique throughout the lesson. Together, researchers and class lecturers create and implement learning activities. They also reflect together after each step.

This research uses an action research approach developed by Kemmis and McTaggart, adopted from The George Lucas Educational Foundation (2005) (Brassart, 2015). Designing includes asking basic questions, creating a project plan, establishing a timeline, monitoring student and project progress, evaluating results, and assessing the overall experience. This classroom action research uses the first, second, and third activity cycles. The researcher obtained approval from the Head of Study Program and observed the academic progress of Study Program students before starting the cycle activities. Two jobs with four stages are then carried out in each iteration. This classroom action research involved researchers, lecturers, and students involving 32 participants—14 men and 18 women. Road Research Locations. Lake Sentani Raya Number ninety nine, Madyopuro Village, and Kedungkandang District, Malang City, East Java.

Students use online and offline project-based food garden learning. The first questionnaire confirmed the identification. Each FGBL level is assessed using questionnaires, brainstorming, assignments, and media reports. FGBL learning involves creating project plans and schedules, analyzing student qualities, creating guided questions for experimental design, and monitoring progress through reporting, brainstorming, and evaluating projects. Many factors can determine student learning motivation, including lecture and brainstorming engagement. Researchers collected data by recording, observing behavior, and interviewing participants in this research (Cheang, 2017).

This research uses data analysis to determine garden-based learning methods based on constructive learning theory. This method involves students learning from their experiences. Garden-based learning encourages students to learn independently. Collaborative learning, especially in small groups, employs projections. According to Vygotsky's social constructivism, stronger interpersonal relationships enhance cognitive development. Sharing perspectives, listening to others, and reflecting on conversations empower people. Project-based learning provides an authentic environment where lectures help students develop professional and collaborative problem-solving skills.

Saldana added that research data is coded. Coding and categorization, themes, and concepts become research conclusions. Lecturers must set competency standards for course discussion. Required skills cover the basics of the program. Lecturers must ask questions, organize, and conduct project/work production activities with students. Lecturers and students exchange notes to help resolve the problem.

3. RESULT & DISCUSSION

3.1 Before Implementation: Student Profile of Wisnuwardhana Faculty of Agriculture, Malang, Garden-Based Learning Strategy

The Wisnuwardhana Malang Education and Social Foundation (YPS) founded Unidha, a private university (PTS) in Malang, East Java, on May 20, 1981. Unidha utilized campus and off-campus food gardens—underutilizing food production due to insecurity. Unidha Malang's sustainability program prioritizes environmental education across scientific disciplines. Sustainability is a "top priority" for operations, infrastructure, education, and research. The Sustainability Institute teaches sustainability and initiated the University's 8-year Sustainability Plan. The Institute's organic food garden teaches students and the community about sustainable food farming, healthy eating patterns, and service learning. They optimize land use by farming organic vegetables.

Unidha Malang uses yards to overcome agricultural problems and empower communities to help with government food security and self-reliance initiatives. Food security has been a global issue for 20 years, including Indonesia. Food security means every household has safe, affordable, and fair food. Nutrition for every family is essential for national food security. Each home must maximize its resources, including its yard, to feed its family. Despite university efforts to add practical learning, most teaching and research degrees, except biology and physics, lack valuable components or are taught externally. Structure and culture include research, hiring, promotion, and intellectual or learning assumptions.

Learning where lecturers can divert academically capable students from vocational courses to institutions focused on theory will produce people who are "technologically illiterate and technologically incompetent". Unskilled people may recognize the benefits of technology but not its drawbacks. Orr asserts that institutions have produced tens of thousands of "highly qualified" graduates without realizing their environmental impact. Students in Indonesia rarely farm or live off the land. Food cultivation has taught people to understand natural scarcity, influencing ecological literacy (Cattiveli, 2022; Patel, 2022). Our survival depends on plants. Urbanization reduces this relationship for city residents. Only by studying natural systems "roughly like the ones we experience" can universities produce ecologically literate students. Students must understand nature through experience. After conducting interviews and observations of lecturers, classroom action research was carried out to find out whether students could carry out agronomy (Hellinger et al., 2022), plant breeding (Kiup, 2017), plant (Glowa et al., 2019), soil (Cherukuri & Parthasarathy, 2023) and social science practices to achieve effectiveness, efficiency, protection, quality and sustainability of resources by good agricultural practices. (KK1). Involvement in lectures and brainstorming shows students' passion for learning.

3.2 Planning Advanced Horticultural Production Technology Learning: Lecture Programs and Projects

The FGBL-based AHPT course is ideal for students who want to learn practical skills in the agricultural sector that emphasize effectiveness, efficiency, protection, and quality. This training emphasizes resource sustainability, aligned with superior agricultural practices (KK1). Students must produce five major tropical commodities. Tomato vegetables are an example. Vegetable commodities are produced from artificial plant propagation, cultivation of multipurpose and existing plants, fruit plants, and medicinal plants. Students will learn a lot about the topic, develop it well, and solve cultivation problems during production. The FGBL Advanced Horticulture team meets to design the technical implementation of the course to meet the stated objectives. Learning planning includes identifying projected goals, analyzing student characteristics, determining learning techniques, managing worksheets, designing learning resource needs, and creating assessment instruments (Sherry, 2022). The team discussed the FGBL model project with students to explain it, ask for their opinions once it was released, and consider the timing.

3.3 Implementation of Advanced Horticultural Production Technology Learning: Lecture programs and projects

In implementing FGBL learning, lecturers must evaluate how domicile location, land, altitude, and seed supply enable the development of the FGBL Advanced Horticulture project. Some lowland plants thrive, but none are perfect—the growth of perennials in student dormitories. The team will recommend additional tomato plants that can be adapted to each student's area for students to plant. It should be noted that this lecture activity is carried out online, so FGBL activities may impact the selection of tomato varieties. So, the FGBL team had to submit an inquiry into the information. Therefore, the evaluation activity is to provide a questionnaire to all students in the FGBL class. The results show the questionnaire that the students have filled out. Google Earth estimates altitude. Teams of teachers and students analyze questionnaires to determine whether the commodities grown meet students' concerns. The results of the analysis show that all students are in lowland areas. Thus, the lecturers and students decided to plant tomatoes with the Mirah, Opal, and Zamrut tomato cultivars. These three varieties are very suitable for planting in the lowlands and have a high tolerance to bacterial wilt disease. This high-quality cultivar has a potential yield ranging from 30 to 35 tons per hectare. In addition, this tomato has a fruit storage capacity of 8 to 9 days, and the tomatoes themselves are characterized by their large size, weighing 35 and 60 grams, respectively.

After determining the type of tomato plant, the lecturer divides the group into one type of tomato variety. This is done so that each group can focus on only 1 type. After that, field tests can be carried out. During the field test, the lecturer provided guiding questions. Horticulture courses provide students with guidance that can be measured through experimental design. Thomas' main questions must be answered by each group. Guide Questions Questions are projection-based learning (Bouvier, 2012). Students' anticipated work comes from questions or problems that help them understand the basics of a subject. Students' work motivates them to work on their own. The first question is about experimental design. "What treatment should be given, and what is the level of treatment?" How many times was each experiment repeated? This will improve students' abilities in fertilizer and manure, experimental design, crop production, plant physiology and agroclimatology, and soil science. A classic ideation approach will be used to assess the results of group conversations to build an experimental design.

3.4 Evaluation and Brainstorming of Student Learning Motivation in Learning Advanced Horticultural Production Technology: Lecture programs and projects

According to Sudirman, Guarana recognizes Project Learning as a student-centered strategy that can involve students by emphasizing nature and initiative. Students in each group in each activity are asked to collect the results of the development of tomato plants for the lecturer. The notebooks collected show the teaching team tracking student progress throughout the project. Monitoring is accessible in every phase. FGBL facilitators can confirm iLearn and Google Classroom documentation data and facts through real-time ideas about sowing and cultivating land. Monitoring will inform the meeting team about plant conditions and project progress. Students can use creativity to solve problems and understand the science of plant cultivation. Instructor learning consists of visual activities and predicted progress reports. Students identify seeds, vegetative growth, and sound sources through brainstorming. A cultivator, fertilizer kiosk, or internet provider can provide it. The organizing team must verify the expiry date of the seed packaging or contact the original farmer or trader.

Lecturers teach by evaluating the results of their project reports. Suppose seeds cannot germinate without imbibition or sunlight. Tomatoes need light to grow. To grow well, tomatoes require seed extraction. Some groups have difficulty extracting seeds, so providing tomato seeds becomes a problem. Wet extraction purifies tomato seeds by separating them from the flesh and pulp (Manickam, 2021; Satishchandra, 2019). Poorly extracted sources slow germination, increase microbial contamination, and slow plant growth (Arnal, 2018; Hlaing, 2018; Maeda-Gutiérrez, 2020). The mucus and pulp on tomato seeds and a dull yellow color indicate improper extraction of tomatoes (Abbas, 2021; Beamount, 2014; Rosa-Martínez, 2021). Unclean pulp sources are susceptible to microbial contamination (Araújo, 2018), causing rapid root damage and slow germination. Tomato flesh contains abscisic acid, which inhibits seed germination and reproduction.

All tomato growers experience drying problems. Seed quality is also affected by drying. Natural drying in the sun, oven drying at a specific temperature, and drying with a fan are standard methods (Sanwal, 2022). After extraction, the seeds are dried to reduce moisture before germination or storage (Chen, 2021). Natural drying increases the viability of tomato seeds more than oven drying (Gadekallu, 2021). Drying in the sun from 27○C to 32○C is a simple way to dry seeds. This procedure usually takes 3-4 days . Modern seed drying can be done in one day at 420C in an oven.

Tomato growers in group B experience germination problems, which is indicated by the hardening of the outer skin of group B tomato seeds. The seed's outer shell begins compaction, while the interior of the source retains moisture, inhibiting germination and indicating that the source has become watertight. Hasanah states that the drying process in an oven is the most practical method because the temperature is always high, thus ensuring even seed drying. However, this procedure can result in seed impermeability, characterized by the outer layer of the source becoming complicated while the inner part remains moist. Group B farmers experienced stunted plant roots, so the seed coat was not water-resistant and inhibited seed germination (Yuniwati et al., 2024).

Many people need tomato seeds of the Mirah variety. So, the previous owner of the source was contacted to help find it. Due to selection errors made by certain groups, the propagation material used to plant ruby tomatoes in polybags as a planting medium had to be changed (Yuniwati et al., 2023). Some students who read the material found it challenging to plant tomatoes by drying them using an oven, especially during extraction activities. The team recommends using a compound containing chloride to speed up germination using NaOcl.

Some groups cover the germination for a long time, silencing it or providing protection during cutting to avoid sunlight. Therefore, etiolation makes seeds susceptible to transplantation-induced death. In some cases, prolonged exposure to water can damage tomato seeds and germination. Each student must cultivate a plant. Grafting or occultation may reveal them. Grafting and occultation need to consider the lower tree and its competence.

Students reflect on individual or group learning during idea generation. Students should express their thinking, evaluate what works and change, and debate new Questions. Students need brainstorming to improve their social skills. Students listen, ask questions, and learn about plant cultivation, which includes sewing and planting in lectures.

Project-based learning requires a student's desire to persist. The students' basis for questionnaire question one (P1) was shown by 70.62% of students agreeing. Answering the third question (P3) requires active brainstorming. 69.50% of students agree. After hearing lecturer P7's response, 78.70% and 22.30% of students decided. Question 10 (P10) says, "I try to attend brainstorming sessions on time." This idea was supported by 81.25% of students agreeing and 18.75% working on the idea diagram assignment. We conclude that FGBL creativity enhances learning.

Systematic, controlled, and scientifically empirically evaluating field experiments produce objective and reliable results. This data is used to discover, predict, test, and manage social phenomena to understand, anticipate, and overcome problems in the field . Outdoor experiments allow students to grow the best plants on aspects of new field experiments that help students understand them. Statistics show that 64.50% of students agree, and 32.40% strongly agree. To answer Q15, I used FGBL rather than conventional techniques. This assertion was supported by 61.70% of students stating, "I have a comprehensive understanding of sawing and planting in the field." Our data shows that 49.60% of students strongly agree, and 34.30% agree. Field experiments benefited 68% of students, and 36% strongly agreed. Learning projections teach students about tomato farming. Students get the most significant benefits from project-based learning, including (Bortolini, 2017; Muljono, 2021; Young, 2016): (1) increasing attendance, independence, and positive learning attitudes; (2) providing equivalent academic benefits or better outcomes through alternative models in which students participating in the project take more responsibility for their education; (3) develop complex skills such as critical thinking, problem-solving, collaboration, and communication; and (4) expanding student opportunities.

4. CONCLUSION

The FGBL technique in the Advanced Horticultural Production Technology course begins with project planning and time schedules, analyzing student characteristics, formulating experimental design guiding questions, monitoring progress reports, exchanging ideas, and evaluating results. Determining student learning motivation comes from several factors, including student attention to the instructor, concentration ability, and active involvement in brainstorming activities. Research findings indicate that brainstorming in an FGBL (Project-based food garden learning) environment fosters a favorable disposition toward the knowledge acquisition process. Field experiments have the potential to improve student's knowledge and skills. Students gain a deeper understanding of plant ideas and the development of horticultural species diversity.

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