

**AN EVALUATION OF THE CONCEPTUAL UNDERSTANDING AND  
TEACHING METHODS OF PLANT TAXONOMY AMONG  
UNDERGRADUATE STUDENTS AT THE UNIVERSITY OF BENIN**

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**UNIVERSITY OF BENIN**

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**A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF CURRICULUM  
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**APRIL 2026**

## CERTIFICATION

We, the undersigned, hereby certify that this research work was carried out by Noah Osemudiamen OSHOSE in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City.

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## **DEDICATION**

*To my family, the OSHOSEs.*

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## ABSTRACT

This study evaluated the conceptual understanding of plant taxonomy and investigated the teaching methods employed among undergraduate students at the University of Benin, Benin City. It was guided by four research questions. The population of the study comprised 178 fourth-year undergraduate students from the Department of Plant Biology and Biotechnology (PBB) and the Department of Curriculum and Instructional Technology (CIT) - Biology Education and the sample size of 118 students. A descriptive survey research design using a quantitative approach was adopted. Data were collected using a Plant Taxonomy Conceptual Understanding Diagnostic Test (PTCUDT) and a structured questionnaire and were analyzed using descriptive and inferential statistics. The results indicated that only 18.56% of the students had a strong conceptual understanding and 81.44% of the students scored below the 70% threshold. The only statistically significant correlation found with conceptual understanding was prior knowledge ( $r = 0.251$ ,  $p = 0.013$ ). Teaching approaches ( $r = 0.079$ ,  $p = 0.444$ ) and student interest ( $r = 0.124$ ,  $p = 0.225$ ) were not statistically significant. The most highly rated teaching method was experiential learning through field trips and the least highly rated was lecture based delivery. Students showed low interest in plant taxonomy with examination-driven motivation and rote memorization as the dominant learning orientations. The study recommends incorporating conceptual change strategies such as the 5E instructional model, systematizing field-based and herbarium activities as core curricular components, integrating AI-assisted plant identification tools and reforming assessment practices to measure conceptual reasoning over rote recall. Professional development for instructors in active learning pedagogies is also recommended.

# **CHAPTER ONE**

## **INTRODUCTION**

### **BACKGROUND OF THE STUDY**

Biology is a natural science that studies living organisms, ecosystems and life's fundamental processes (Malokhat, 2026). It is concerned with the study of humans and their environments as it equips students with the knowledge to understand the structure and functions of the various parts of the body, the environment in which they live and how best to interact within it (Enebechi, 2021). Biology is introduced at the senior secondary school level as a foundation for human development where it serves as a platform where career abilities are nurtured and individual potentials and talents are discovered and shaped. As a prerequisite for many fields of study, it contributes significantly to the technological advancement of the nation, cutting across diverse disciplines such as medicine, pharmacy, nursing, agriculture, forestry, biotechnology, nanotechnology and many others (Gambari et al., 2014).

Taxonomy is a discipline in biological science related to the identification, description, classification and naming of the organisms at the level of species or other taxa (Kusumawardani et al., 2019). Maskour et al. (2019) emphasized that effective conservation of plant and animal species depends on adequate knowledge of their biology, as well as the ability to correctly identify and classify them. Plant taxonomy is a major contributor in other disciplines. Jacquemart et al. (2016) stated that if species of pharmaceutical importance are not well known,

it may lead to their future extinction. Lawrence (1955) explained that taxonomy demonstrates the great diversity of plants in nature and clarifies their relationships, thereby supporting academic studies on the genesis, evolution and heredity of plants. Taxonomy makes communicating biological information on plants much easier because it facilitates categorizing them. The activities of classification, nomenclature and identification are the main functions of taxonomy (Haider, 2018). Plant taxonomy is a necessity for naming plants and establishing uniform principles for their identification. Such knowledge is crucial for determining phylogenetic relationships, locating species within ecosystems and supporting preservation and conservation efforts. The knowledge of species, species identification and plant taxonomy is essential. Without an understanding of species, it becomes difficult to explain the structure and function of ecosystems that serve as life-support systems on Earth. This knowledge also underpins comprehension of biodiversity and its importance for sustainability (Maskour et al., 2022).

Understanding concepts is a component of the cognitive domain. It is a process whereby meaning is derived and articulated via communication (Berhita et al., 2020). According to Hutahaeen et al. (2017), understanding of a concept involves learners' ability to construct meaningful representations of learning messages, whether orally, in writing or through visual and graphical media during the learning process. By actively organizing and communicating what they have learned, these representations help students grasp concepts more deeply. Conceptual understanding enables learners to construct new knowledge by relating learned

content to other materials, however conceptual understanding is not based on memorizing-based learning and rigid learning implementation. Conceptual understanding does not have to always be about rote memorization, it can be developed through reading and writing activities during learning. Some problems of conceptual understanding built on one's perception on content that is learned, such as basic concept of a complicated content and it can be seen from the weak information used to explain a phenomenon, thus one finds difficult to understand completely. To understand a concept, problems relating to the learned material are applied to real situations (Lestari et al., 2019).

Teaching for understanding is an enormous challenge for science teachers. Among the challenges teachers in science face in teaching for understanding is the need to address students' misconceptions as well as to motivate students' interest in learning science. Studies have argued that students tend to consider this course boring because of the dominance of theory and the lack of practical experiences that supports learning (Juwita et al., 2024). One possible reason for lack of conceptual understanding among students is that science teachers rely on teaching methods or strategies that are ineffective for promoting science understanding (Mansor et al., 2010). Teaching methods refer to the approaches teachers use to facilitate the learning of concepts in the classroom. They include the strategies, techniques, styles and guiding principles used in carrying out teaching and learning process to enhance learners' understanding and promote easier assimilation of knowledge. The type of teaching method adopted determines to a greater extent what the students assimilates. When appropriate

teaching methods are selected for particular concepts, learning can be accelerated and the knowledge gained can be effectively applied to solving real-life problems (Udoh et al., 2025). The challenges faced in teaching plant taxonomy include its abstract nature, students' plant blindness and the barrier posed by Latin nomenclature (Wandersee & Schussler, 2001; Bhattacharyya, 2012; Juwita et al., 2024).

The multidimensional nature of biology requires an integrative approach grounded in real experiences. Effective instruction should promote understanding of the structure, functions and interactions of organisms within ecosystems, as well as applying biological knowledge to environmental and sustainability issues. Therefore, learning in biology education should extend beyond the classroom to include field activities that enable students to observe organisms in their natural environment. This method is expected to enhance understanding and support the contextual application of biological concepts. Several methods for teaching Taxonomy should include, Field trip, Project Based Learning, audiovisual and other innovative methods that enables learners to observe, interact and analyze objects of study within their natural environments, thereby enriching their understanding of concepts taught. It provide opportunities for students to identify plant species directly in their habitats, promoting deeper comprehension and stimulating interest through active participation and experiential learning within the context of plant taxonomy (Juwita et al., 2024).

A reduction in students' knowledge about plants and their identification has been discovered to be as a result of a decline in their interest (Maskour et al., 2022). When learning materials, teaching methods, classroom conditions and available resources fail to connect with what students find meaningful or engaging, they are unlikely to perform to their full potential simply because nothing about the learning experience captures their attention or motivates their effort. This places considerable responsibility on instructors to thoughtfully design and manage learning experiences in ways that resonate with students' interests, so that engagement is not left to chance but is deliberately cultivated and sustained over time (Wahdi et al., 2024). As interest wanes, the quality of learning deteriorates with it students shift from genuinely trying to understand to simply going through the motions of studying. Mansor et al. (2010) observed that the ability to explain scientific ideas and evaluate arguments based on evidence receives considerably less emphasis at all educational levels, suggesting that students are frequently learning science as a body of facts to be memorized rather than a framework of concepts to be understood.

According to Bides et al. (2017), teachers may find it challenging to provide deep learning because students frequently have trouble demonstrating a solid understanding of the fundamental concepts of a subject. Students' prior knowledge influences learning and may contribute to their poor conceptual understanding when it conflicts with scientific concepts. Prior knowledge guides and constrains the interpretation of new information and its encoding in memory. Such prior knowledge often originates from observations and attempts to explain

everyday phenomena outside formal instruction and may therefore be incompatible with the scientific concepts to be learned (Flaig et al., 2018; Azizah et al., 2021). Consequently, misconceptions may be acquired from students' personal experiences before entering school, through media exposure, textbooks or poor quality teaching which further reinforces these incompatible ideas (Maskour et al., 2019).

Despite these challenges associated with plant taxonomy instruction, studies focusing on students' conceptual understanding of plant taxonomy are few. This gap necessitates the present study which utilizes the University of Benin as a case study to evaluate undergraduate students' conceptual understanding of Plant Taxonomy, investigate the teaching methods used by lecturers in teaching plant taxonomy concepts and to identify conceptions and areas of difficulty that may inform improvements in its teaching and learning practices.

## **STATEMENT OF THE PROBLEM**

Biology Education students of the Curriculum and Instructional Technology (CIT) Department and Plant Biology and Biotechnology (PBB) students at the University of Benin take a foundational course, Plant Taxonomy, which is taught at the third year of their programme. Although a herbarium practical is included in the course, it has been observed that students often carry out the practical mainly to earn continuous assessment scores for a boost in their final grade rather than to deepen their understanding. A majority of students believe the course is challenging and abstract despite being exposed to plant classification concepts at

this level (Juwita et al., 2024). Why do students still find them difficult to understand after being exposed?

Teaching biology for conceptual understanding is particularly difficult because students are expected to understand abstract and technical concepts, such as plant taxonomy (Juwita et al., 2024). However, rather than developing meaningful understanding, many students rely on rote memorization. How well can students understand concepts related to plant taxonomy in a way that goes beyond memorization? As a result of rote memorization, they might individually learn scientific concepts without fully understanding them limiting their capacity to accurately apply the knowledge or explain its concepts.

To what degree do these students' prior knowledge affect their comprehension of plant taxonomy concepts? While prior knowledge can aid in the interpretation and integration of new information, it can also hinder learning when it conflicts with scientific explanations. These conflicting ideas can arise from everyday experiences, media exposure, textbooks or ineffective teaching practices and they often result in persistent misconceptions (Maskour et al., 2019). Reduced knowledge of plants and challenges in identifying and classifying them among these students has been linked to their declining interest in botanical studies (Maskour et al., 2022). Can it therefore be proposed that these students' interest contribute heavily to their conceptual understanding of the course?

Despite the integral role plant taxonomy plays in biology-related programs and other disciplines, there are still issues with how the subject is taught and learned at the undergraduate level. There are scarce opportunities for active, student-centered learning and inquiry which are crucial for gaining a deeper understanding because instruction often relies heavily on lecture-based methods (Jacquemart et al., 2016; Udoh et al., 2025). Instead of promoting meaningful conceptual understanding, could these approaches to instruction be encouraging an excessive dependence on rote memorization?

These issues raise important questions about how well students are actually grasping plant taxonomy and what factors might be shaping their understanding within the University of Benin. If students continue to struggle with deeply rooted misconceptions, it becomes necessary to ask what approaches might help them move past these difficulties and develop a more meaningful understanding of the subject. The outcome of such evaluation can be used to improve learning outcomes and guide instructional strategies.

## **RESEARCH QUESTIONS**

The following research questions were raised to guide the study:

1. What proportion of undergraduate students at the University of Benin possess strong conceptual understanding of plant taxonomy?
2. What factors influenced the current conceptual understanding level among the undergraduate students offering plant taxonomy?

3. What prevalent teaching methods were used to teach the concepts of plant taxonomy and to what extent were they perceived as effective to undergraduate students at the University of Benin?
4. What is the level of undergraduate students' interest in plant taxonomy?

### **PURPOSE OF THE STUDY**

The main purpose of the study was to evaluate the University of Benin undergraduate students' conceptual understanding of plant taxonomy. Specifically the study aimed to achieve the following objectives:

1. determine the proportion of undergraduate students at the University of Benin who possess strong conceptual understanding of plant taxonomy;
2. identify factors that influenced the current conceptual understanding level of undergraduate students offering plant taxonomy, including prior knowledge, teaching approaches and student interest;
3. determine the prevalent teaching methods used in plant taxonomy instruction and the extent to which they were perceived as effective by undergraduate students at the University of Benin; and
4. determine the level of undergraduate students' interest in plant taxonomy.

## **SIGNIFICANCE OF THE STUDY**

The study is significant to biology lecturers, undergraduate students, curriculum planners and researchers in science education.

The study will provide insight into students' levels of conceptual understanding, common misconceptions and the extent to which current teaching approaches support meaningful learning to lecturers. This information can guide lecturers in refining instructional strategies, emphasizing conceptual clarity and adopting teaching practices that promote deeper understanding rather than rote memorization. It would also enable lecturers to assess and identify areas for improvement in the delivery of plant taxonomy concepts, thereby supporting more effective, student-centered and conceptually focused instruction.

The study will help students realize their gaps in their understanding of plant taxonomy and get them more interested in the subject outside of just studying for tests and examinations. By highlighting the importance of conceptual reasoning and coherence, the study would contribute to improved learning approaches among students.

The study will enhance the existing knowledge regarding conceptual understanding in higher education biology, specifically in the context of plant taxonomy, an area that receives limited academic attention. The findings can also inform curriculum review and instructional planning by providing evidence on how plant taxonomy concepts are currently understood and where improvements are needed.

## **SCOPE AND DELIMITATION OF THE STUDY**

This study seeks to evaluate University of Benin undergraduate students' conceptual knowledge of plant taxonomy with a particular focus on four core areas, description, identification, nomenclature and classification. Plant taxonomy is a core course for third year students enrolled in the Biology Education and Plant Biology and Biotechnology programmes. Students from other levels or universities outside the University of Benin will not be covered nor will the study evaluate students' long-term retention of taxonomy concepts or practical skills. Qualitative approaches such as field-based assessments and interviews are also not included due to time and resource constraints.

## **DEFINITION OF TERMS**

**Evaluation:** It is the systematic process of measuring an entity in order to assess its worth or effectiveness by comparing it against established standards (Yambi & Yambi, 2018).

**Conceptual Understanding:** In the context of this study, it refers to students' ability to meaningfully comprehend, connect and certain concepts beyond rote memorization.

**Plant Taxonomy:** Plant taxonomy includes the description of the variation of plants, the investigation of the causes and consequences of this variation and the manipulation of the data obtained to produce a system of classification (Haider, 2018).

**Teaching Methods:** These are the approaches that instructors employ to ensure effective teaching and encourage active participation among students in learning (Mathur & Tiwari, 2018).

## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE**

This chapter presents a comprehensive review of articles, journals and books related to the conceptual understanding of undergraduate students in plant taxonomy. The related literature is discussed under the following headings:

- Theoretical Framework
- Concept of Conceptual Understanding
- Nature and Scope of Plant Taxonomy
- Undergraduate Students' Conceptual Understanding of Plant Taxonomy
- Influence of Teaching Approaches in Plant Taxonomy Learning
- Role of Students' Prior Knowledge and Interest in Plant Taxonomy Learning
- Summary of Reviewed Literature

#### **THEORETICAL FRAMEWORK**

Constructivism is an approach to teaching and learning based on the premise that cognition is the result of "mental construction" implying that students learn by fitting new information together with what they already know (Bada, 2015). It provides a useful framework for explaining how learners develop understanding through active involvement in the learning process. This theory emphasizes that knowledge is not simply received from the teacher but is constructed by learners through interaction with their environment and with

others. This perspective has important implications for classroom practice because it influences the way learning activities are organized, how students interact with instructional content and how their understanding is evaluated. When students build on their prior knowledge, participate in discussions, reflect on their ideas and revisit concepts over time, learning becomes more meaningful. In such situations, the role of the teacher moves from being mainly a source of information to that of a guide who supports inquiry and helps learners develop deeper conceptual understanding. This encourages independence and the development of higher-level thinking skills (Chand, 2026). Researchers also report that a constructivist approach has shown to be beneficial in promoting the active participation of students, thereby enhancing student motivation to learn science, as well as facilitating the promoting of conceptual learning, socio-scientific decision-making and even encouraging students in pursuing science-related careers (Holbrook et al., 2022).

Educational constructivism is primarily concerned with learning about knowledge set out in some form of curriculum without regarding the absolute status of that knowledge. It focuses on how individuals are able to form knowledge and an understanding of the world especially in relation to target knowledge set out in the curriculum. It suggests that learning is a process contingent on the limitations of human cognition and channeled by existing thinking and that teaching that will be effective when responding to these factors (Taber, 2024). It is known to be advantageous, as students learn by constructing science conceptualizations influenced by prior experiences which stems from a social or cultural context (Holbrook et al.,

2022). This provides the theoretical foundation for understanding how students develop conceptual understanding in plant taxonomy. Here, learners can actively construct knowledge by integrating new information with existing mental frameworks as regards plant taxonomy as a whole.

## **CONCEPT OF CONCEPTUAL UNDERSTANDING**

Concepts are the building blocks of ideas and definitions. Science considers concepts as fundamental building blocks of thoughts that have depth (Konicek-Moran & Keeley, 2015). In building concepts, concrete experiences are required and the combination and recombination of these experiences in multiple ways play an important role in promoting lasting learning (Sree, 2010). To understand is to overcome intrinsic and extrinsic difficulties by way of reasoning namely, analysis, explanation and interpretation. Thus, understanding is inseparable from explanatory competence, as it is an analytical process linked to the character, significance and context of objects (Gunga et al., 2014). Furthermore, functional Understanding, as defined by McDermott (2001), connotes the ability to apply knowledge in contexts other than that in which it was attained.

Konicek-Moran and Keeley (2015) considered the term “conceptual understanding” to mean that when students understand a concept, they can (a) think with it, (b) use it in areas other than that in which they learned it, (c) state it in their own words, (d) find a metaphor or an analogy for it, or (e) build a mental or physical model of it. In other words, the students have

made the concept their own. Students' conceptual understanding is formed through meaningful interaction between teachers, students and peers. Through well-designed concept learning experiences, learners can come to understand concepts that were previously unknown to them, either through direct or indirect engagement. In biology learning, conceptual understanding can be developed through experimentation and accurate observation which in turn enables students to engage actively and independently with the subject matter. Direct engagement creates the conditions for students to remember, internalize and construct creative ideas around the concepts being studied. This allows those concepts to be retained in long-term memory. Information stored in long-term memory is more durable because it is grounded in firsthand experience. However, the process of transferring concepts from short-term to long-term memory is not without risk, as some conceptual knowledge may be lost or distorted during this transition if not adequately reinforced (Berhиту et al., 2020).

In relation to this, learning approaches also play an important role in how students acquire and use knowledge. Deep and surface approaches to learning can be viewed as a combination of students' intentions (or motives) and the learning activities they engage in. A surface approach to learning is generally described as an intention to reproduce information, where the learning process is mainly characterized by rote learning and memorization. In contrast, a deep approach to learning involves a student's intention to truly understand the content. This is accompanied by processes such as relating ideas, organizing information

meaningfully, identifying underlying principles, examining relevant evidence and critically evaluating knowledge (Dolmans et al., 2016).

Conceptual understanding is important for determining how well undergraduate students grasp and apply the principles of plant taxonomy. Students who adopt a deep approach to learning are more likely to develop meaningful conceptual understanding of plant taxonomy while those who rely on surface learning may only memorize classifications without true understanding.

## **NATURE AND SCOPE OF PLANT TAXONOMY**

Plants are autotrophic organisms with limitless utilitarian benefits wherever they are found (Ogwu et al., 2015). They are essential to the functioning of the biosphere, occurring in all known parts of the earth in all shapes and sizes. They include green algae, mosses, ferns, vines, grasses, bushes, herbs, flowering plants and trees (Fernando, 2012). The scientific study of plants has long required a structured system of organization. In 1813, Swiss botanist Augustin Pyramus De Candolle coined the term 'taxonomy' from the Greek *ταξις* (order) and *νομος* (law, rule), defining it as the theory of classifications applied to the vegetal kingdom. He regarded it as one of three components of botany, alongside *glossology* which is the knowledge of terms used to name plant organs and *phytography*, the description of plants in the most useful way for the progress of science. Taxonomy as a component of systematics encompasses the classification of species and it involves the delimitation, description and identification of

species. This understanding of taxonomy evolved further with the rise of phylogenetics which introduced classifications based on evolutionary relationships among taxa. Taxa being defined as a group of any rank in the hierarchical classification system (Rouhan & Gaudeul, 2021). Simpson (2019) described taxa as a defined or delimited group of organisms and identified them as the general subject of taxonomic study.

Plant taxonomy involves the description of plant variation, the observation of morphological, anatomical and phylogenetic characters and the comparison and manipulation of data to arrange plants within a classification system (Sandepogu & Somineni, 2024). As the branch of botanical science concerned with the naming, describing and classifying of plants based on shared characteristics, it provides the essential framework through which scientists communicate about plant species, document biodiversity and understand evolutionary relationships. Its relevance extends to biodiversity conservation, agriculture, ecology and environmental management, offering a stable foundation for plant identification and scientific communication (Arora, 2025). Scholars differ slightly on the core activities of taxonomy. Some identify the major activities as classification, identification and nomenclature (Haider, 2018; Sandepogu & Somineni, 2024), while others recognize only identification and description as primary activities, treating nomenclature and classification as supplementary (Ogwu et al., 2015). Simpson (2019) offers a more comprehensive framework, identifying four major components which are description, identification, classification and nomenclature.

Description involves the listing of a taxon's features, particularly taxonomic characters that are useful in distinguishing it from related taxa (Ogwu et al., 2015). Simpson (2019) defined description as the assignment of features to a taxon, where those features are considered characters and two or more forms of a character become character states. These descriptive terms serve as tools of communication, enabling the concise categorization and delimitation of a taxon, a plant or any part thereof.

Identification is accomplished through descriptive keys, catalogues, illustrations and manuals that aid in the recognition of organisms. This recognition occurs when a specimen under consideration is found to be similar to a previously known plant (Ogwu et al., 2015). Correct identification is an important prerequisite in taxonomy and may be achieved by directly comparing a plant's characters with an authentic herbarium specimen or indirectly through the use of keys (Sandepogu & Somineni, 2024). Appropriate identification of plant materials is essential for the effective conservation of plant resources and helps characterize genetic diversity in germplasm collections of endangered species (Haider, 2018).

Classification is the ordering of organisms into groups based on their similarities and/or differences (Stuessy, 2009). It is made possible by the natural variation that exists among plants (Ogwu et al., 2015). This variation is phenotypic in nature and it refers to observable differences in the morphology, physiology, development and behavior among individuals of the same species which stems from genetic diversity, environmental influences and interactions

between genotype and environment (Kuznetsova, 2025). While classical taxonomy relied primarily on morphological characters, modern approaches integrate molecular genetics, phylogenomics, chemistry, anatomy and cytology to achieve more accurate classification (Arora, 2025). Conventional taxonomic classification employs three primary approaches which are the artificial, natural and phylogenetic approaches. The artificial approach also called the folk classification relies on a limited number of easily observable traits such as the number or colour of floral parts. The natural approach groups plants based on a broad range of morphological characteristics to better represent their inherent similarities and relationships as they occur in nature. The phylogenetic approach goes further by incorporating evolutionary history, classifying plants according to their developmental lineage and shared ancestry showing this relationship in a phylogenetic tree (Ogwu et al., 2015; Sandepogu & Somineni, 2024). Within any classification system, organisms are assigned to hierarchically arranged units known as ranks. The ranks in descending order are the kingdom, division, class, order, family, genus and species, with the species rank being the most fundamental (Rivera, 2014; Sandepogu & Somineni, 2024). The purpose of classification is to provide a cataloguing system that also expresses the relationships between these entities (Simpson, 2019).

Nomenclature refers to the assignment of names to objects, entities or taxa, serving as a means of easy reference. It is the scientific naming system for taxonomic units in biology such as species, genera and families, it also functions as a symbol of communication and a reference base for the storage, retrieval and documentation of information. It is also essential

for proper taxa identification. Plants have always been of use to humans; even prehistoric man could distinguish between useful, useless and harmful plants and, in doing so, they must have assigned them names (Bhattacharyya, 2012; Ogwu et al., 2015; Sandepogu & Somineni, 2024). Scientific names assigned to plants are either Latin or derived from other languages and subsequently Latinized (Haider, 2018; Sandepogu & Somineni, 2024). In written text, scientific names are italicized for clarity and it follows a binary combination where it is composed of the genus name, with its first letter capitalized, followed by the specific epithet, which is never capitalized (Haider, 2018; Rivera et al., 2014). The use of scientific names avoids the confusion that arises from different common names being applied to the same organism (Spooner et al., 2002).

The broader rationale for biological taxonomy encompasses the need to understand and conceptualize the natural world through classification; to facilitate identification and communication; to maintain a convenient information retrieval system; to preserve stable names that ensure continuity in scientific literature and to construct frameworks that support both predictive classification and an understanding of phylogenetic relationships (Spooner et al., 2002). Plant taxonomy thus provides the structural foundation for comprehending and organizing plant diversity (Arora, 2025). Its main objectives include providing a global inventory of flora through identification and description; offering a convenient method for plant identification and communication; collecting and preserving plant taxa in herbaria for future reference; constructing classifications that are as phylogenetic and universal as possible

and providing insight into the diversity and evolutionary progression among different taxa (Sandepogu & Somineni, 2024).

## **UNDERGRADUATE STUDENTS' CONCEPTUAL UNDERSTANDING OF PLANT TAXONOMY**

Studies specifically examining undergraduate students' conceptual understanding of plant taxonomy remain limited. While the broader challenges of botany education have attracted some scholarly attention, studies that directly measure the depth and quality of taxonomic understanding among university learners are rare and those that exist consistently report cause for concern. What follows is a synthesis of the available evidence which collectively points to a pattern of surface-level engagement, persistent misconceptions and significant reasoning deficits among undergraduates studying plant taxonomy.

A foundational explanation for these difficulties lies in the phenomenon of "plant blindness," a concept introduced by Wandersee and Schussler (2001) to describe students' tendency to overlook and undervalue plants relative to animals. They argued that this perceptual bias directly undermines students' motivation and depth of engagement with botanical content with taxonomy not being left out. This observation has been supported by studies in different educational contexts as it showed that plant taxonomy is widely regarded as one of the more conceptually difficult areas of undergraduate biology education.

The specific difficulties students encounter when engaging with plant taxonomy content are well documented. One of the most commonly reported barriers is the challenge of learning scientific names, particularly given that most students have no prior knowledge of Greek or Latin, which are the languages from which botanical nomenclature is principally derived (Bhattacharyya, 2012). This linguistic unfamiliarity renders taxonomic nomenclature abstract and disconnected from students' existing knowledge frameworks, making it difficult for them to move beyond rote memorization toward genuine conceptual engagement. Compounding this is students' widespread perception of the subject as dry and overly theoretical. The extensive use of technical terminology, dichotomous keys and taxonomic hierarchies can overwhelm learners, particularly when concepts are introduced without sufficient contextual grounding or connection to living organisms (Nayagam, 2026). Limited exposure to living plant specimens makes the problem even worse. Even as herbarium materials are useful, they are static and cannot fully show seasonal changes, growth patterns or how plants interact with their environment, all of which are difficult to demonstrate in a laboratory alone.

The consequences of these barriers are evident in measured learning outcomes. Strgar (2007) found that university students in Slovenia demonstrated limited ability to correctly classify plants beyond the most basic categories, revealing a pattern of surface-level rather than deep conceptual understanding. Similarly, Uno (2009) documented significantly low student interest in botany-related concepts among college biology students, explaining this disparity as

a result of the limited emphasis placed on botany within the broader biology curriculum. Uno also argued that students construct understanding of plant concepts by attempting to link new information to what they already know and when that prior knowledge contains misconceptions or naive explanations, it prevents them from achieving accurate understanding. This concern is supported by Köse (2008), who demonstrated that undergraduate students entering programmes with misconceptions acquired during prior schooling, experienced significant conceptual interference that actively hindered new learning which aligns with Piaget's notion of cognitive conflict.

The scale and persistence of these misconceptions are vividly illustrated by a large-scale study conducted in Morocco. Maskour et al. (2019) surveyed 737 undergraduate and postgraduate students across four Moroccan universities and found that over half regarded plant systematics as a difficult subject. They attributed their difficulties primarily to Latin nomenclature, the multidisciplinary nature of the subject and instructional approaches that prioritized memorization over meaningful comprehension. The study revealed a wide range of persistent misconceptions such as poor understanding of plant reproduction, double fertilization and the distinction between sexual and asexual reproductive strategies. Misconceptions were not limited to basic concepts but also extended to plant evolution and phylogenetic classification. A considerable number of students struggled to explain the evolutionary sequence of plant groups or to accurately differentiate between vascular and non-vascular plants. Particularly significant was the finding that initial training in plant biology had

little measurable effect in correcting these deeply rooted misconceptions, suggesting that conventional instructional approaches are insufficient. The authors also observed a broader problem of compartmentalized learning, whereby students failed to integrate knowledge across modules and could not apply previously acquired concepts in new taxonomic contexts.

Beyond content-level misconceptions, the literature also identifies deficits in scientific reasoning as a distinct and significant barrier. Wigati and Aini (2020) examined the reasoning skills of 36 Biology Education students enrolled in a Plant Taxonomy course at a State Islamic University in Indonesia, using Rasch Model analysis based on Toulmin's reasoning framework. Their findings revealed that the majority of students fell within the medium reasoning category, with only a small number demonstrating high reasoning ability. Students who performed poorly struggled not only with recalling taxonomic concepts but also with constructing evidence-based arguments, linking data to conclusions and providing logical justifications for their answers. The authors attributed these difficulties to students' tendency to treat plant taxonomy as a memorization-based subject, limited engagement with course material and the perception that the subject was overly theoretical. Together, these findings suggest that reasoning deficits, rather than content unfamiliarity alone, constitute a significant barrier to meaningful learning in plant taxonomy.

Despite this review, several important gaps remain in the literature. Most existing studies have been conducted in Europe, Asia and North Africa, with very little attention paid

to undergraduate learners in sub-Saharan African contexts, where institutional resources, instructional approaches and students' prior educational experiences may differ substantially. While these studies have identified what students misunderstand and how poorly they reasoning, fewer have investigated the underlying conceptual structures, that is, how students organize and apply taxonomic knowledge, that contribute to these difficulties. This study addresses that gap by examining the conceptual understanding of plant taxonomy among undergraduate students with the aim of providing contextually relevant evidence to support more effective, student centered teaching approaches.

### **INFLUENCE OF TEACHING APPROACHES IN PLANT TAXONOMY LEARNING**

Teaching methods are the approaches and strategies that educators employ to ensure effective teaching and to encourage active participation among students in learning activities (Mathur & Tiwari, 2018). They represent the structured ways through which teachers present content, guide understanding and create conditions for learning to occur. More than just a set of actions performed by the teacher, these methods are deliberate, goal-oriented processes that help students think critically, make sense of new information and apply what they have learned in practical contexts. Effective teaching methods foster a dynamic relationship between the teacher and the learner, where the teacher organizes and directs the learning experience while students explore, engage and progressively build their knowledge and skills. In this way, teaching methods serve as the bridge connecting the teacher, the learner and the subject matter, ensuring that the intended outcomes of any lesson are meaningfully achieved (Al-Taai, 2021).

Beyond individual lessons, teaching methods bear significant influence on the broader goal of producing intellectually capable and well-rounded learners within the education system (Kirubalan & Sivananthan, 2026). According to recent studies, teaching methods can be broadly grouped into three classification frameworks. These are classification based on the type of education obtained, classification based on the nature of knowledge and classification based on the respective roles of the teacher and the learner (Al-Taai, 2021). The first classification, based on the type of education, draws from Bloom's Taxonomy and its three domains of learning which are the cognitive, the affective and the psychomotor domains. Within this framework, teaching methods are organized into three corresponding categories: methods for teaching facts and concepts through extrapolation, deduction, investigation or exploration; methods for instilling desired values and attitudes; and methods geared toward skill development and capacity building (Al-Taai, 2021; Mathur & Tiwari, 2018). The classification based on the nature of knowledge is grounded in the understanding that different fields of knowledge possess a special nature that demand the use of research and thinking approaches. In light of this, teaching methods under this framework fall into three broad categories which are the methods suited to the natural sciences, the methods designed for the applied sciences and finally the methods appropriate for the humanities and social sciences (Al-Taai, 2021). The final classification, based on the roles of the teacher and learner, is perhaps the most widely recognized. It draws a clear distinction between traditional and modern teaching methods. Traditional methods, often described as teacher-centered approaches, involve the one-

directional transfer of knowledge from teacher to student, with the learner playing a largely passive role. Modern methods, by contrast, shift the focus towards the learner, with the teacher assuming a facilitative role centered and limited on guidance, supervision and counselling rather than direct instruction (Al-Taai, 2021; Chan et al., 2023).

In science education specifically, a range of teaching methods are employed to support learning across the various developmental domains. Some of these methods include the lecture method, project method, discussion method, demonstration method, laboratory method and field trips (Mathur & Tiwari, 2018; Sree, 2010). In plant taxonomy education, Maskour et al. (2022) found that the lecture method, field trips and practical or project-based work were the most commonly adopted approaches by instructors.

Lecture is a teaching method where an instructor is the central focus of information transfer and there's little class participation. In the lecture method, an instructor will stand before a class and present information for students to learn. The instructor sometimes utilizes a board or an overhead projector to provide visuals for students (Ogudo & Agwazie, 2017). While the lecture method has several advantages, it also comes with notable limitations. On the one hand, it enables a teacher to spend little or no money on teaching aids and equipment, making it a cost-effective approach. It is particularly useful for introducing new subjects or topics to learners and is often the best method when facts or problems are conflicting or confusing, as the teacher can provide clear explanations. It also benefits students who learn

best through listening. Contrarily, the method has significant drawbacks. It often does not challenge learners but instead spoon-feeds them information which could result in a low degree of knowledge transfer. It also fails to cater to individual differences among students, as all learners are taught in the same way regardless of their needs or abilities. It also provides little or no feedback to both instructors and learners, making it difficult to assess understanding during the lesson. Lectures can also struggle to maintain students' attention for long periods reducing their engagement, interest, the overall learning effectiveness and cause a poor academic achievement in science (Ogudo & Agwazie, 2017; Cleopas & Igbojinwaekwu, 2025). Teaching in biology is commonly carried out using the lecture method, where learning often becomes abstract and centered on listening, note-taking and memorization of facts. Despite its drawbacks, the lecture method remains prevalent in the education system, particularly among teachers handling large class sizes. The lecture method is widely utilized because it allows instructors to deliver a large volume of information within a short period, making it especially effective for managing large groups of students, although it can also be applied in smaller classes. Its efficiency and practicality have contributed to its continued dominance, particularly in tertiary institutions (Aina & Langenhoven, 2015; Cleopas & Igbojinwaekwu, 2025).

A field trip, also known as an instructional trip, school excursion or school journey, is a school trip, class trip or educational outing organized outside the classroom where students interact with real-life settings, displays and exhibits to gain practical understanding of concepts and subject matter (Behrendt & Franklin, 2014). It can also be described as a visit to a location

beyond the regular classroom environment, designed to achieve learning objectives that may not be effectively attained through traditional teaching methods. Field trips give students the opportunity to step outside the classroom and engage in new and meaningful experiences (Kasumu & Kasumu, 2023). Field trips are organized for several reasons. It provides firsthand experience, stimulates interest and motivation in science, makes learning more relevant, strengthens observation and perception skills and promotes social development. Teachers play important roles before, during and after the trip to ensure effective learning. Before the trip, the teacher should visit the venue to understand its layout and confirm its suitability for students. During the trip, the teacher helps students adjust to the new environment and keeps them actively engaged. After the trip, learning must be reinforced through discussions, activities or further reading. This reflection process helps students connect their experiences with prior knowledge and solidify new ideas (Behrendt & Franklin, 2014). At the undergraduate level, Papilaya (2020) examined the effect of field trip strategies combined with dichotomous key determination media on students' discovery learning abilities in lower-plant botany. The study involved 40 biology students and employed an action research design over eight instructional sessions. Data were collected using a 25-item diagnostic test and observation sheets and analyzed using multiple linear regression. Results showed that both the field trip strategy (coefficient = 0.470) and the use of dichotomous keys (coefficient = 0.247) had statistically significant positive effects ( $p = 0.001 < 0.05$ ). The study found that field trip activities increased students' curiosity and strengthened their observation skills, allowing them to engage in

cognitive processes such as grouping, measurement and estimation, which are essential for taxonomic identification. Juwita et al. (2024) also conducted a survey-based descriptive qualitative study at the State Islamic Institute (IAIN) Kerinci, Indonesia, examining the effect of field trip activities on the learning motivation of fourth-semester Biology Education students enrolled in a Plant Taxonomy course. Using a questionnaire instrument grounded in a five-indicator framework of learning motivation, encompassing passion and desire to succeed, drive and need in learning, future hopes and aspirations, appreciation in learning and a conducive learning environment, the researchers gathered data from students who had already completed field trip activities as part of their coursework. The findings were strongly positive as a combined total of 94.67% students either agreed or strongly agreed that field trip activities meaningfully increased their learning motivation. A deep dive into the different aspects showed that the strongest influence came from students feeling appreciated in the learning process, followed by their desire to succeed and the supportive learning environment created during the trips. The field experience increased motivation as it allowed students to observe plant specimens directly in their natural surroundings, an activity that classroom and laboratory settings, which depend mostly on preserved materials, cannot replicate. Students also reported that interacting with real plants, along with discussions with peers and guidance from lecturers in the field, helped improved their understanding and helped them remember taxonomic concepts and apply what they had learned. Many students developed greater interest in the

subject after the field trips. This suggests that the way a course is taught can strongly influence how interested students become in it.

Project-Based Learning is a structured learning approach in which students engage in purposeful study over a defined period of time to reach a specific goal, working either individually or collaboratively (Bilgin et al., 2014). It involves the process of collecting, researching and implementing information on a specific topic, drawing on real-life experiences as the foundation for gathering and integrating new knowledge. Project-Based Learning requires a comprehensive teaching approach in which the learning environment is deliberately designed to enable students to investigate authentic issues. Students are presented with complex, realistic projects and provided with sufficient support to successfully complete them, positioning learners as active constructors of knowledge who investigate genuine problems, make informed decisions and produce tangible outputs that reflect both understanding and creativity (Berhиту et al., 2020; Yuldashevna & Khamraevich, 2020). It follows a structured sequence that guides students from the initial development of a project idea to its final presentation. Students begin by defining the project objectives, planning methods and assigning responsibilities before gathering and analyzing information through activities such as observations, experiments and surveys. The process concludes with students presenting and defending their findings and conclusions (Yuldashevna & Khamraevich, 2020). In plant taxonomy, preparation of real herbarium specimens is one of the most effective project-based method utilized in its teaching (Maskour et al., 2022; Khosyillah & Khusnah, 2025). An

organized collection of plant specimens is called a *herbarium* (plural - *herbaria*), it is sometimes considered as a botanical library. They are often found in museums, botanical gardens or universities and are professionally cared for (Fortier et al., 2024). The dry and the wet herbarium are the two principal types of herbarium. A dry herbarium is a collection of plant specimens that have been preserved through a drying process designed to maintain the physical form of the plants so that they remain intact and available for identification and research purposes (Khosyillah & Khusnah, 2025). When preparing a dry herbarium specimen, a plant specimen is first collected from the field using appropriate tools such as clippers. The collected plant, which should contain samples from each part of a plant including its leaves, stems, flowers and/or fruit and sometimes even roots, is then placed between sheets of newspaper or blotting paper, with layers of cardboard added above and below to provide support. It is carefully arranged, flattened and dried using a plant press. Once completely dried, the specimen is mounted onto a special herbarium paper using glue and a label is attached containing important information such as the plant family, scientific name, location of collection, description of the plant, collection date and the collector's name. The prepared specimen is then stored in climate-controlled cabinets in the herbarium to ensure long-term preservation and availability for future research (Fortier et al., 2024). A wet herbarium, by contrast, involves preserving specimens in solutions such as alcohol or formalin in order to maintain tissue moisture and structural integrity, making it particularly suited to specimens of high research value or those that cannot be adequately preserved through drying. The

preparation process requires cleaning the specimen, submerging it in glass containers filled with the appropriate preservative and then ensuring that tissues remain intact for detailed morphological and physiological analysis (Khosyillah & Khusnah, 2025). Beyond their role as teaching tools, herbarium specimens serve a wide range of scientific and educational purposes, including studying the effects of global warming, studying the effect of climate and habitat change, identifying bio-diverse regions that need conservation, describing a new plant species and as sources of DNA for rare or extinct plant species. Hence, the integration of herbarium preparation as a means of learning plant taxonomy and as an essential resource in understanding the natural world increases student knowledge, awareness and appreciation of plants (Fortier et al., 2024; Krosnick & Moore, 2025).

Purnomo and Ekantini (2022) investigated the effectiveness of the Project-Based Learning (PjBL) model in enhancing student learning independence (SLI) in science education, with relevance to plant taxonomy learning. Adopting a quantitative quasi-experimental design with a pretest-posttest structure, the study involved 33 year-seven students at LHI Islamic Junior High School in Indonesia during the 2022/2023 academic year. Students engaged in a herbarium card project that required them to identify local plant species, dry plant leaves and label cards using correct Latin nomenclature. The findings revealed a statistically significant improvement in student learning independence, as confirmed by a paired t-test result of 0.001 ( $p < 0.05$ ). Average SLI scores increased from 75 in the pretest to 88.75 in the posttest. 88% of students reported that the herbarium activity enhanced their independence, while 79%

indicated that it helped them recognize and remember authentic Latin plant names. These findings suggest that hands-on, project-based engagement with plant materials not only strengthens taxonomic knowledge but also promotes learner autonomy. Khosyillah and Khusnah (2025) examined the effect of Project Based Learning (PjBL) on seventh grade students' learning outcomes in plant classification at SMP Asy-Syarifiy IEBS Lumajang, Indonesia. Using a quantitative quasi experimental posttest only control group design, the study involved 70 students divided equally into an experimental group that engaged in a herbarium making project and a control group taught through conventional lectures. Data covering the cognitive, affective and psychomotor domains were collected through tests, observation sheets and questionnaires and analyzed using an Independent Sample t test. The findings showed that students in the PjBL group achieved significantly higher cognitive scores (mean = 76.0) than those in the control group (mean = 64.285), with a statistically significant difference ( $p = 0.001 < 0.05$ ), indicating stronger conceptual understanding of plant classification. The herbarium project also promoted positive attitudes such as responsibility, cooperation and active participation, while students demonstrated strong practical and creative skills in handling plant specimens, achieving a mean psychomotor score of 22 out of 25. Overall, the study demonstrated that PjBL positively influenced students' cognitive, affective and psychomotor learning outcomes in plant classification.

Audio-visual media refers to multi-sensory, interactive applications or presentations that draw on different digital and physical media types such as text, pictures, sound and video,

to communicate messages and information to an audience. As instructional resources, they have the capacity to bring a sense of reality into the classroom by presenting abstract textbook content in concrete terms (Agada & Sam-Kayode, 2022; Atieku et al., 2023). Their effective integration into the educational process result in the achievement of planned teaching or planned learning (Nicolaou et al., 2019). While visual aids may vary considerably in content and format, effective ones share a set of defining qualities. They simplify abstract ideas, clearly illustrate relationships between concepts and make complex content more accessible to learners. They can represent objects or situations that are difficult to observe directly and they should be large and clear enough for all students to see without eye strain. Beyond clarity, good audio-visual aids are visually engaging, using appropriate colors and design to draw attention to key points while avoiding unnecessary or distracting elements. They should present only essential information, be well-organized, reflect careful preparation and be durable enough to withstand regular classroom use. To maximize the instructional value of audio-visual aids, they must be used purposefully and in alignment with clear learning objectives. The aids selected should match the goals of the lesson and be appropriate for the students' age, level of understanding and interests as accurate information is presented in a straightforward manner. Their application should also fit the specific classroom context, meaning teachers must deploy them in ways that directly support intended learning outcomes. It is equally important for teachers to assess how effective these aids are, observing how well students understand and respond during and after their use (Atieku et al., 2023). The broader educational value of audio-

visual aids lies in their capacity to provide learners with realistic, stimulating experiences that capture attention and deepen understanding. They engage the mind through both visual and auditory channels, helping to concretize knowledge and make learning feel real, relevant and meaningful (Rasul et al., 2011). The use of audio-visual media has been shown to enhance both understanding and retention of subject matter, while simultaneously facilitating the overall teaching and learning process (Agada & Sam-Kayode, 2022; Fuady & Mutalib, 2018). When used at the right moment, appropriate aids compel attention, sustain interest and motivate students. They reduce over-reliance on verbal explanation, break the monotony of teacher-dominated instruction and offer students a clearer sense of real phenomena and relationships. In doing so, audio-visual aids have the potential to make learning experiences considerably more concrete enabling better conceptual clarification (Sree, 2010). Gatarira et al. (2026) examined if the integration of an AI-powered plant identification tool could enhance student conceptual understanding and engagement beyond what traditional methods alone could achieve. Employing a sequential explanatory mixed-methods design, the study involved 149 secondary school students drawn from both rural and urban schools in Rwanda. Students were distributed into a control group that used only dichotomous keys and an experimental group that used PlantNet alongside dichotomous keys. Quantitative results demonstrated a statistically significant improvement in conceptual understanding among the experimental group, which recorded a post-test mean score of 75.03 compared to 61.83 for the control group. The effect size was also notably higher (Cohen's  $d = 0.61$  for the experimental group compared

to 0.22 for the control group). Thematic analysis of teacher interviews identified two key themes which are the enhanced student autonomy and curiosity and improved conceptual understanding despite minor technical challenges such as connectivity limitations and image quality issues. The study therefore affirms that when AI tools are embedded within structured instructional frameworks, rather than used in isolation, they can meaningfully deepen students' engagement with plant taxonomy and reduce the cognitive burden associated with manual classification.

Despite the substantial evidence supporting student-centered, project-based and technology-enhanced approaches in improving learning outcomes in plant classification, important gaps remain in the literature. Much of the existing research has been conducted at the junior and senior secondary school levels with limited empirical focus on undergraduate students, where plant taxonomy is studied in greater depth and requires higher-order conceptual understanding. While many studies emphasize academic achievement, fewer explicitly investigate students' conceptual understanding as a distinct and measurable outcome in plant taxonomy. There is also a tendency for prior studies to examine instructional strategies in isolation, with limited attention given to how integrated or context-specific approaches may influence learning. A majority of these studies are situated outside the Nigerian educational context, thereby limiting their applicability to local learning environments. In response to these gaps, the present study is designed to evaluate the effectiveness of selected student-centered instructional approaches in improving undergraduate students' conceptual understanding of

plant taxonomy as it also examines the influence of learner characteristics within a Nigerian context. By doing so, the study seeks to provide context-relevant empirical evidence that not only bridges the gap between instructional methods and conceptual learning outcomes but also informs more effective teaching practices in plant taxonomy at the university level.

### **ROLE OF STUDENTS' INTEREST AND PRIOR KNOWLEDGE IN PLANT TAXONOMY LEARNING**

Prior knowledge refers to the knowledge that learners have stored in long-term memory at the onset of learning. It comprises of the cognitive entry behaviours, prerequisite skills and competencies that are essential for acquiring new knowledge in a given domain (Binder et al., 2019; Bittermann, 2021). It is multidimensional and dynamic in nature, comprising four interrelated types which are, knowledge of facts, knowledge of meaning (these form the declarative knowledge), integration of knowledge and application of knowledge (these form the procedural knowledge). Declarative knowledge also called conceptual knowledge involves the ability to remember, recognize and reproduce factual information and it is sometimes associated with surface or rote learning. Procedural knowledge is characterized by the ability to understand relationships between concepts and apply that understanding to solve domain specific problems as it aligns with higher-order cognitive skills (Binder et al., 2019; Binder et al., 2019; Ige & Oluwasina, 2019). The amount and quality of prior knowledge positively influence both knowledge acquisition and the capacity to apply higher-order cognitive problem-solving skills, as learners construct understanding by connecting new concepts and

information to what they already know (Ige & Oluwasina, 2019). Prior knowledge helps to decrease cognitive load which leads to good learning performance (Dong et al., 2020). When prior knowledge is adequate and well-structured, it facilitates memory across all stages of learning (encoding, consolidation and retrieval) by providing a framework into which new information can be meaningfully integrated. For prior knowledge to exert this facilitative effect, it must be properly activated during learning rather than merely present (Shing & Brod, 2016; Schneider & Simonsmeier, 2025). When prior knowledge conflicts with new content, it can create conceptual interference rather than support and in some cases, learners may distort or resist new information in favour of existing but inaccurate beliefs (Brod, 2021). Consequently, inadequate or fragmented prior knowledge is a significant concern. If there is a mismatch between what instructors assume students know and what students actually bring to the learning situation, learning may be undermined from the outset and students may resort to rote memorization as a substitute for genuine understanding (Ige & Oluwasina, 2019). This dynamic is directly observable in the context of plant taxonomy education. Buck et al. (2019) conducted a large-scale study examining the prior knowledge and knowledge gain of more than 500 undergraduate students enrolled in introductory plant identification courses across eight German universities, using a standardized pre-test and post-test procedure. Their findings painted a stark picture of the prior knowledge deficit students bring to university-level botanical study. On average, students correctly identified only 2.6 of 32 common plant species in the pre-test, reaching barely 7% of possible scores. Prior knowledge was almost entirely restricted

to declarative species knowledge of the most ubiquitous plants, such as dandelion (*Taraxacum officinale*) and daisy (*Bellis perennis*), while knowledge at the level of taxonomic concepts which is basically understanding plant families and their diagnostic features, was virtually absent. The study found that the nature of prior knowledge shaped the pattern of learning gains. The consequences of weak prior knowledge extend beyond what students simply do not know. They also shape the misconceptions students bring into learning. Köse (2008) demonstrated that students entering undergraduate programmes with misconceptions acquired during prior schooling experienced significant conceptual interference that actively hindered new learning. In plant taxonomy, Maskour et al. (2019) found that misconceptions around fundamental botanical concepts, including plant reproduction, evolutionary classification and the distinction between vascular and non-vascular plants, were widespread and highly resistant to correction even after formal instruction, a finding that the authors attributed to compartmentalized learning and inadequate prior conceptual grounding. The instructional implications of prior knowledge also extend to how learning materials are designed and presented. Liu et al. (2014) conducted two experiments examining how prior knowledge interacts with different compositions of multiple representations in a mobile learning environment focused on plant leaf morphology among primary school students. In Experiment 1, students who learned with text and photographs on a tablet performed better on comprehension and application tests than those who additionally learned with real plants, a counterintuitive finding explained by a redundancy effect. Low prior knowledge students lacked the cognitive schema needed to

distinguish between the two-dimensional information in photographs and the three-dimensional information of real plants, causing one source to become redundant rather than complementary. High prior knowledge students possessed the necessary schema to perceive structural differences between representations, but suffered from a split-attention effect when forced to mentally integrate spatially separated sources. Experiment 2 demonstrated that replacing photographs with schematic hand drawings, which highlighted only essential features, enabled both low and high prior knowledge students to profit from the combination of drawings and real plants, as the hand drawings served as cognitive scaffolds that directed attention to taxonomically relevant features. Across both experiments, high prior knowledge students consistently outperformed low prior knowledge peers on both comprehension and application measures. These findings carry an important lesson for plant taxonomy instruction as the effectiveness of any given teaching method or learning resource is not absolute but conditional on the prior knowledge level of the student and instructors must therefore calibrate their use of representations, materials and learning environments to the actual knowledge base that students bring.

Interest is a multidimensional concept that encompasses both cognitive and emotional components. It represents a dynamic relationship between an individual and a particular object, topic or activity (Blankenburg et al., 2016; Wahdi et al., 2024). Interest manifests as an increase in focused attention and mental engagement directed toward something personally meaningful, functioning as an internal drive that shapes how individuals interact with their learning

environment. In learning, interest can be understood as a condition in which students develop a sense of liking and self-motivated enthusiasm for an activity, measurable through indicators such as attention, involvement and a genuine desire to explore and engage with course content (Hasanati & Purwaningsih, 2021). The role of interest in academic learning is substantial. It functions simultaneously as both a motivational variable and an emotional state, influences cognitive engagement, promotes focused attention and shape students' educational choices including the subjects they decide to pursue at higher levels of education (Blankenburg et al., 2016; Chan & Norlizah, 2017; Kahu et al., 2017). Six factors have been identified by studies that can influence interest in science learning specifically. They are self-efficacy, active learning strategies, science learning value, performance goals, achievement goals and learning environment stimulation. Interest also mediates students' construction of conceptual understanding in science. When interest is present, students engage more deeply with content and are more likely to move beyond surface-level memorization and towards meaningful comprehension. Students who lack interest in a subject find it difficult to achieve optimal learning outcomes and this deficit spreads across cognitive, affective and psychomotor domains. Therefore, strengthening student interest is not a peripheral concern but a prerequisite for successful conceptual mastery (Hasanati & Purwaningsih, 2021). In plant taxonomy, low student interest has been consistently and widely documented. Students tend to disengage from the course due to its perceived abstractness, heavy reliance on Latin nomenclature and reputation as a subject that is overly theoretical and professionally irrelevant (Bhattacharyya,

2012; Maskour et al., 2019; Juwita et al., 2024; Samsuar et al., 2025). Only a small proportion of students show genuine inclination toward conducting research in the area, and the course is frequently described as one of the least popular within Biology Education programmes (Samsuar et al., 2025). These attitudes reflect the operation of situational disinterest, students are not encountering learning conditions that activate engagement and they have measurable consequences for both motivation and conceptual understanding. However, this pattern of disengagement is not irreversible. Samsuar et al. (2025) investigated the effect of a Herbarium-STEM learning model on students' interest in plant taxonomy at Universitas Abulyatama, Indonesia, using a quasi-experimental one-group pre-test/post-test design with 35 Biology Education students. Interest was measured using a Likert-scale questionnaire across five indicators. The indicators being happiness feelings, attention, interest, motivation and involvement. Prior to the intervention, students recorded a mean interest score of 40.14 which was classified as low. Following implementation of the Herbarium-STEM approach that involved field-based plant identification in a conservation forest, hands-on herbarium creation integrating STEM principles and in-depth taxonomic literature analysis, the mean post-test score rose markedly to 80.71, placing students in the high interest category. The N-Gain value of 0.70 confirmed that this improvement was of high magnitude, while the coefficient of determination ( $R^2 = 0.614$ ) indicated that the Herbarium-STEM approach accounted for approximately 61.4% of the variance in students' interest scores, a strong effect by conventional standards. The authors attributed this shift to the project-based, real-world nature of the

learning experience, which repositioned students as active participants in authentic scientific work rather than passive recipients of abstract content, thereby disrupting the entrenched perception of plant taxonomy as memorization-heavy and irrelevant.

Prior knowledge and student interest are both important determinants of meaningful learning in plant taxonomy. Many students enter university with low, fragmented and mostly declarative prior knowledge, which limits their ability to develop conceptual understanding and often leads to misconceptions and rote learning. Student interest is also generally low due to perceptions of plant taxonomy as abstract and difficult. However, studies show that both prior knowledge and interest can be improved through well designed instructional environments that activate existing knowledge, reduce cognitive load, provide experiential learning and encourage situational interest. This interaction highlights the need for effective instructional strategies, particularly within the context of Nigerian undergraduates where both students' prior knowledge and interest in plant taxonomy remain largely underexplored.

## **SUMMARY OF REVIEWED LITERATURE**

This literature review collectively illuminates the conceptual landscape surrounding undergraduate students' understanding of plant taxonomy. What emerges from this review is a layered picture in which theory, teaching practice, learner characteristics and contextual factors all intersect in ways that have direct implications for how plant taxonomy is taught and learned at the university level. The constructivist learning theory establishes that students do not

passively receive knowledge but actively build it by connecting new information to what they already know. This makes the quality of prior knowledge and the design of learning experiences particularly consequential. Conceptual understanding, as the central outcome of interest in this study, was established not merely as the recall of facts but as the ability to think with knowledge, apply it in new contexts, explain it in one's own words and construct meaningful representations of it. This distinction between surface and deep learning runs through much of the reviewed literature and serves as a useful lens through which to evaluate both student outcomes and instructional approaches.

Plant taxonomy itself was situated within its broader scientific context. As the branch of botanical science concerned with the naming, describing and classifying of plants, it provides the structural foundation for understanding plant diversity and supports endeavors ranging from biodiversity conservation to agriculture and ecological management. Its four major components which include description, identification, classification and nomenclature, all demand a level of conceptual engagement that goes well beyond memorization, making the subject a particularly demanding one for students who arrive without adequate preparation.

The literature on undergraduate students' conceptual understanding of plant taxonomy paints a consistently concerning picture. Studies across multiple countries reveal that students tend to engage with the subject at a surface level, relying on rote memorization rather than genuine comprehension. Misconceptions around evolutionary classification and the distinction

between vascular and non-vascular plants are widespread and highly resistant to correction even after formal instruction. The phenomenon of plant blindness further compounds these difficulties, as students' tendency to overlook and undervalue plants relative to animals reduces their motivation and depth of engagement from the outset. The heavy reliance on Latin nomenclature, the perceived abstractness of the subject and inadequate exposure to living plant specimens were consistently identified as barriers to meaningful learning. In response to these challenges, the review of teaching methods revealed that student-centered, inquiry-based and experiential approaches consistently outperform traditional lecture-based instruction. Field trips, project-based learning, herbarium preparation and AI-assisted identification tools were all shown to produce stronger conceptual gains by actively engaging learners and connecting abstract taxonomic content to real-world experience. The literature also made it clear that no single method is universally effective. The prior knowledge level of the student, the quality of instructional planning and the learning environment all mediate how effective any given approach will be.

This review establishes a strong and coherent rationale for the present study. The consistent documentation of shallow conceptual understanding, persistent misconceptions, inadequate prior knowledge and low student interest in plant taxonomy points to a pressing need for empirically grounded, student-centered instructional interventions. The limited attention paid to undergraduate learners in sub-Saharan African settings, including Nigeria, makes this study both timely and necessary. By examining conceptual understanding across

teaching approaches within the University of Benin, this study aims to contribute contextually relevant evidence that can meaningfully inform more effective and equitable approaches to plant taxonomy education.

## **CHAPTER THREE**

### **METHODOLOGY**

This chapter outlines the methodology used to evaluate the conceptual understanding of University of Benin undergraduate plant taxonomy students. This will provide sufficient details that allows for study replication and to support the effectiveness of the approaches taken to address the research questions. This chapter is presented under the following sub-headings:

- Design of the Study
- Population of the Study
- Sample and Sampling Techniques
- Research Instruments
- Validity of Instruments
- Reliability of Instruments
- Method of Data Collection
- Method of Data Analysis

#### **DESIGN OF THE STUDY**

This study adopted a descriptive survey research design utilizing a quantitative approach. The design was considered appropriate because the study sought to obtain quantitative information on undergraduate students' conceptual understanding, describe the

current state of undergraduate students' conceptual understanding and identify prevalent misconceptions in plant taxonomy.

## **POPULATION OF THE STUDY**

The target population for this study comprises of all undergraduate students in the University of Benin who have taken or are currently taking plant taxonomy as an integral course. This population includes students from various departments such as Biology Education, Plant Biology, Biotechnology and related science programs where plant taxonomy is a core or elective course. Based on clearance records from the 2025/2026 academic session, the accessible population was made up of approximately 178 students who were in their fourth year of study across the two departments.

## **SAMPLE AND SAMPLING TECHNIQUES**

A stratified random sampling technique was used to ensure proportional representation of students from the two departments offering plant taxonomy. The accessible population consisted of 106 students from Plant Biology and Biotechnology and 72 students from Curriculum and Instructional Technology (Biology Education). 70 participants were selected from Plant Biology and Biotechnology and 48 from Curriculum and Instructional Technology via proportional allocation making a total sample of 118 students. Simple random sampling with a random number generator was then used to select participants from class attendance lists within each department, ensuring that all eligible students had an equal chance of selection.

## RESEARCH INSTRUMENTS

Two research instruments were used for data collection in this study, a Plant Taxonomy Conceptual Understanding Diagnostic Test (PTCUDT) which was a modelled two tier multiple choice diagnostic test designed to assess the current undergraduate students' conceptual understanding on plant taxonomy and identify their misconceptions. The second instrument was a questionnaire to check for factors that may have contributed to the current conceptual understanding level of the undergraduate students. The questionnaire examined instructional delivery methods and learner-related characteristics.

The PTCUDT comprised 20 questions, each with two tiers:

- i. Tier 1: A content question with four options (a, b, c & d) assessing factual knowledge of plant taxonomy concepts, labelled as **Q** (Question).
- ii. Tier 2: A reasoning question with four options (i, ii, iii & iv) requiring students to explain the rationale for their Tier 1 answer, labelled as **R** (Reason).

This test format was adopted from Treagust's (1988) diagnostic test methodology and has been validated in science education research for differentiating between sound understanding, partial understanding and misconceptions (Gurel et al., 2015).

Each question was scored using a diagnostic scoring rubric developed by the researcher:

- i. Tier 1 correct + Tier 2 correct = 1.0 point

- ii. Tier 1 correct + Tier 2 incorrect = 0.0 point
- iii. Tier 1 incorrect + Tier 2 correct = 0.0 points
- iv. Tier 1 incorrect + Tier 2 incorrect = 0.0 points

The point system was represented by:

- a. 1.0 point meant Sound Understanding
- b. 0.0 point meant a Partial Understanding, Flawed Concept or a Misconception

The instrument had a total score of 20.0 points. The raw scores the respondents obtained were converted to percentages for easy interpretation and analysis. Based on the percentage scores, respondents were classified into levels of conceptual understanding according to the predetermined cut-off criteria developed by the researcher as shown in Table 1. Students scoring greater than or equal to seventy percent were classified as possessing "strong or correct conceptual understanding" for the purpose of finding the proportion of students with that understanding type.

**Table 1: Percentage Ranges and Interpretation for the PTCUDT**

<b>Percentage Ranges</b>	<b>Interpretation</b>
≥ 70%	Strong Conceptual Understanding
60% – 69%	Adequate Conceptual Understanding
50% – 59%	Moderate Conceptual Understanding
40% – 49%	Inadequate Conceptual Understanding
0% – 39%	Weak Conceptual Understanding

The questionnaire was a researcher-developed instrument designed to identify the factors that may have contributed to the current conceptual understanding level of the undergraduate students. The questionnaire consisted of thirty two items organized into seven sections. Section A had two items for the Demographic Information of students while Sections B to G had five items each. They were sectioned by the factors investigated under the study which were:

- i. Section B: Instructional Delivery
- ii. Section C: Experiential Learning
- iii. Section D: Practical Tasks
- iv. Section E: Instructional Aids
- v. Section F: Learner's Interest
- vi. Section G: Prior Knowledge

The items in sections B to G were rated on a 4-point Likert scale:

Strongly Agree = 4    Agree = 3    Disagree = 2    Strongly Disagree = 1

A 4-point scale was used to force respondents to make a definite choice which helped to avoid neutral responses that provide limited information (Garland, 1991). The scores for each section were calculated by summing responses to items within each section.

## **VALIDITY OF INSTRUMENTS**

The instruments were subjected to face and content validation by the researcher's supervisor who is knowledgeable in Biology Education and research methodology to assess

clarity, readability and appropriateness of language. Minor revisions were made to improve question wording and eliminate ambiguous terms.

### **RELIABILITY OF INSTRUMENT**

The reliability of the instrument was established using Cronbach's alpha coefficient and its analysis was carried out using Microsoft Excel 2013. The Cronbach's alpha coefficient obtained for the entire instrument was 0.83, which falls within the good range based on George and Mallery (2003) classification. This indicates that the items on the questionnaire demonstrated a high level of internal consistency and were reliable for measuring the constructs under investigation.

### **METHOD OF DATA COLLECTION**

Data collection took place over two weeks in February 2026 following a systematic procedure designed to ensure consistency. The researcher visited selected departments after regular lecture periods to introduce the study, explain its purpose and obtain verbal consent from randomly selected participants. Students were assured of confidentiality, anonymity and the voluntary nature of participation, with the understanding that involvement or non-involvement would not affect their academic grades. The research instruments were administered by the researcher in a single sixty-minute session per class, beginning with a five-minute introduction, followed by a forty-minute Plant Taxonomy Conceptual Understanding Diagnostic Test (PTCUDT), a five-minute break and a ten-minute Questionnaire. Students

were seated under normal examination conditions with no textbooks, gadgets or reference materials permitted during the diagnostic test and all completed instruments were collected immediately upon completion.

Of the 118 instruments distributed across both departments, 109 were returned representing a 92.4% response rate of which 12 were excluded due to excessive missing data, resulting in a final usable sample of 97 participants for data analysis. To maintain participant anonymity, all completed instruments were assigned unique identification numbers ranging from S001 to S097.

## **METHOD OF DATA ANALYSIS**

Data collected from both instruments were analyzed using descriptive and inferential statistics with Microsoft Excel 2013. Descriptive statistics were used to summarize the data and answer research questions one, three and four, with frequencies, percentages, means and standard deviations calculated for the pertinent variables. Inferential statistics were used to answer research question two, where Pearson correlation analysis examined the relationships between conceptual understanding and various factors including teaching methods, student interest and prior knowledge. Correlation coefficients were interpreted as weak ( $r < 0.30$ ), moderate ( $r = 0.30-0.49$ ), or strong ( $r \geq 0.50$ ) to indicate the strength of relationships. All statistical tests were conducted at a significance level of 0.05 ( $\alpha = 0.05$ ).

## CHAPTER 4

### PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

This chapter presents the analysis of data and it discusses the findings that came from the study. The data gathered were analyzed in relation to the research questions that guided the study. The chapter is organized under two main subheadings:

- Presentation of Results
- Discussion of Findings

Results are presented using frequency tables to facilitate clear interpretation while the discussion situates the findings within the context of existing literature already reviewed.

#### PRESENTATION OF RESULTS

**Table 2: Mean Ranges and Interpretation for the Questionnaire**

<b>Mean Ranges</b>	<b>Interpretation</b>
3.51 – 4.00	Very Effective Method, Highly Interested and Very Strong Prior Knowledge
2.51 – 3.50	Effective Method, Interested and Strong Prior Knowledge
1.51 – 2.50	Ineffective Method, Uninterested and Moderate Prior Knowledge
1.00 – 1.50	Very Ineffective Method, Highly Uninterested and Weak Prior Knowledge

Table 2 presents the mean ranges and their corresponding interpretations used to analyze the questionnaire data. Mean scores ranging from 3.51–4.00 indicated very effective teaching methods, high interest, and very strong prior knowledge, while scores of 1.00–1.50 indicated very ineffective teaching methods, high disinterest, and weak prior knowledge. These

criteria served as the benchmark for interpreting mean scores across the relevant sections of the questionnaire throughout the study.

**Research Question 1: What proportion of undergraduate students at the University of Benin possess strong conceptual understanding of plant taxonomy?**

**Table 3: Proportion of Students with Strong Conceptual Understanding**

<b>Understanding Category</b>	<b>Frequency</b>	<b>Percentage (%)</b>
Strong Conceptual Understanding ( $\geq 70\%$ )	18	18.56%
Adequate Conceptual Understanding (60% - 69%)	10	10.31%
Moderate Conceptual Understanding (50% - 59%)	22	22.68%
Inadequate Conceptual Understanding (40% - 49%)	16	16.49%
Weak Conceptual Understanding (0% - 39%)	31	31.96%
<b>Total</b>	<b>97</b>	<b>100.00%</b>

*Category source from Table 1*

Table 3 presents the proportion of undergraduate students who demonstrated strong conceptual understanding of plant taxonomy based on their performance on the Plant Taxonomy Conceptual Understanding Diagnostic Test (PTCUDT). The results reveal that only 18 out of 97 students, representing 18.56% of the total sample, scored at or above the 70% threshold indicative of strong conceptual understanding. The remaining 79 students (81.44%) fell below this benchmark, distributed across the Adequate (10.31%), Moderate (22.68%), Inadequate (16.49%) and Weak (31.96%) understanding categories. This shows that a majority of the respondents did not demonstrate correct or strong conceptual understanding of plant taxonomy.

**Research Question 2: What factors influenced the current conceptual understanding level among the undergraduate students offering plant taxonomy?**

**Table 4: Factors responsible for the Undergraduates Current Conceptual Understanding**

<b>Factors Measured</b>	<b>Section</b>	<b>Mean</b>	<b>SD</b>	<b>Interpretation</b>
Teaching Approaches	Sections B, C, D and E	2.80	.85	Effective
Students' Interest	Section F	2.33	.91	Uninterested
Prior Knowledge	Section G	2.74	.83	Strong Prior Knowledge

***Interpretation Criteria on Table 2***

Table 4 presents the mean scores and standard deviations for the three factors identified as potential influences on students' conceptual understanding of plant. The teaching approaches factor was assessed by combining four sections of the questionnaire, Section B (Instructional Delivery), Section C (Experiential Learning via Field Trip), Section D (Practical Tasks) and Section E (Instructional Aids) into a single composite factor, yielding a combined mean of 2.80 (SD = 0.85). This falls within the 2.51 - 3.50 interpretive range and is classified as effective. Therefore, students generally perceived the teaching approaches used in their plant taxonomy instruction as functional and operational to a reasonable degree. The students' interest factor assessed through Section F, recorded the lowest mean of 2.33 (SD = 0.91). This indicates that students were generally uninterested in plant taxonomy, with the high standard deviation of 0.91 reflecting considerable variability in interest levels across the sample. The prior knowledge factor assessed through Section G, recorded a mean of 2.74 (SD = 0.83), falling within the effective range of 2.51 - 3.50, suggesting that students perceived their prior knowledge background as reasonably supportive of their plant taxonomy learning. In further

examination of the relationships between students' current conceptual understanding and the factors that influenced it, Pearson correlation analysis was conducted. The results are presented in Table 5.

**Table 5: Pearson Correlation between Students' Current Conceptual Understanding and Its Influencing Factors**

<b>Factors</b>	<b>r</b>	<b>p-value</b>	<b>Strength</b>	<b>Direction</b>	<b>Significance</b>
Teaching Approaches	0.079	0.444	Weak	Positive	Not Significant
Students' Interest	0.124	0.225	Weak	Positive	Not Significant
Prior Knowledge	0.251	0.013	Weak	Positive	Significant

*N = 97,  $\alpha = 0.05$*

The correlation analysis revealed that prior knowledge had a statistically significant positive relationship with conceptual understanding ( $r = 0.251, p = 0.013$ ). This shows that students with stronger prior knowledge backgrounds tended to demonstrate higher conceptual understanding of plant taxonomy even as the relationship was weak in strength. Teaching approaches ( $r = 0.079, p = 0.444$ ) and students' interest ( $r = 0.124, p = 0.225$ ) both showed weak positive relationships with conceptual understanding that were not statistically significant at the 0.05 level. These findings suggest that prior knowledge was only factor that demonstrated a statistically significant association with conceptual understanding. The non-significant correlations for teaching approaches and interest, while noteworthy, do not necessarily imply that these factors are unimportant, rather, they may reflect the complexity of how these

variables interact with conceptual understanding in ways that a simple bivariate correlation cannot fully capture.

**Research Question 3: What prevalent teaching methods were used to teach the concepts of plant taxonomy and to what extent were they perceived as effective to undergraduate students at the University of Benin?**

**Table 6: Teaching Methods used in Plant Taxonomy at the University of Benin**

Section	Teaching Methods	Mean	SD	Interpretation
B	Lecture Method	2.58	0.75	Effective
C	Field Trip	3.13	0.71	Effective
D	Project-Based Method	2.88	0.91	Effective
E	Audio-Visual Means	2.59	0.90	Effective

*Interpretation Criteria on Table 2*

Table 6 examined both the prevalence and perceived effectiveness of teaching approaches used in plant taxonomy instruction at the University of Benin. Experiential Learning via Field Trip (Section C) recorded the highest mean of 3.13 (SD = 0.71), indicating that students most positively perceived teaching approaches involving direct interaction with real plants as being prevalent and effective in their learning. This was followed by Practical Tasks (Section D) with a mean of 2.88 (SD = 0.91) suggesting that project-based activities were also perceived as effective components of their plant taxonomy instruction. Instructional Aids (Section E) recorded a mean of 2.59 (SD = 0.90) indicating that the use of visual resources, pictorial representations and digital tools was perceived as effective though at a more modest level. Instructional Delivery (Section B) recorded the lowest mean of 2.58 (SD = 0.75), suggesting that conventional lecture-based delivery was perceived as the least prevalent and

least effective of the four teaching approaches. Students clearly distinguished between active and passive forms of instruction based on the marginal gap between the experiential learning and the lecture-based method of teaching. Hence, they valued hands-on engagement more than conventional delivery. No teaching method reached the very effective threshold of 3.51, this indicates that there is considerable room for pedagogical improvement in how plant taxonomy is taught at the undergraduate level at the University of Benin.

**Research Question 4: What is the level of undergraduate students’ interest in plant taxonomy?**

**Table 7: Students’ Interest Level in Plant Taxonomy**

<b>S/N</b>	<b>Items</b>	<b>Mean</b>	<b>SD</b>	<b>Interpretation</b>
Q21	I did not find this class interesting, so I worked with minimal effort.	2.42	1.0	Uninterested
Q22	I was only interested in the course to pass exams.	1.98	0.92	Uninterested
Q23	I actively participated in class discussions.	2.44	0.80	Uninterested
Q24	I only learnt the course concepts by heart by repeating them several times, even if I did not understand them.	2.14	0.90	Uninterested
Q25	I find it difficult to pay attention and be attentive during the course period.	2.68	0.76	Interested
<b>Combined</b>		<b>2.33</b>	<b>0.91</b>	<b>Uninterested</b>

*Interpretation Criteria at Table 2*

Table 7 presents the mean score and standard deviation for Section F of the questionnaire which assessed the level of undergraduate students' interest in plant taxonomy across five items. The overall mean score for the section was 2.33 (SD = 0.91), falling within the 1.51–2.50 interpretive range and classified as uninterested, indicating that undergraduate students at the University of Benin generally demonstrated a low level of interest in plant

taxonomy. At the item level, four out of five items fell within the uninterested range, with 'I was only interested in the course to pass exams' recording the lowest mean of 1.98 (SD = 0.92), followed by 'I only learnt the course concepts by heart by repeating them several times, even if I did not understand them' (mean = 2.14, SD = 0.90), 'I did not find this class interesting, so I worked with minimal effort' (mean = 2.42, SD = 1.00), and 'I actively participated in class discussions' (mean = 2.44, SD = 0.80). Only one item, 'I find it difficult to pay attention and be attentive during the course period,' fell within the interested range with a mean of 2.68 (SD = 0.76).

## **DISCUSSION OF FINDINGS**

The finding that only 18.56% of 97 students demonstrated strong conceptual understanding of plant taxonomy is consistent with the study's empirical evidence. It suggests that strong conceptual understanding of plant taxonomy is not widely prevalent among the undergraduate students at the University of Benin in plant taxonomy. Strgar (2007) similarly found that university students demonstrated limited ability to correctly classify plants beyond basic categories, identifying surface-level rather than deep conceptual understanding as the norm among undergraduates. The present finding corroborates this pattern suggesting that the challenge of weak botanical conceptual understanding is not geographically isolated but reflects a trend in undergraduate plant science education. The low proportion of students with strong understanding, less than one in five, aligns with the argument that students' general tendency to undervalue and disengage from plant-related content creates a persistent barrier to

deep conceptual learning (Batke et al., 2020; Krosnick & Moore, 2025). Bhattacharyya (2012) further identified the difficulty of learning and memorizing scientific names in Latin as a specific barrier that compounds this disengagement, a challenge that is particularly acute in plant taxonomy where nomenclature forms a core component of the subject.

Findings also revealed that students were uninterested in the plant taxonomy teaching. This shows that low student interest in plant taxonomy may be a critical limiting factor in converting adequate teaching and prior knowledge into deep conceptual understanding and may partly explain the weak conceptual understanding outcomes observed in the diagnostic test results. An item-level examination of the five statements within Section F reveals that four out of five items fell within the uninterested range. The item "I was only interested in the course to pass exams" recorded the lowest mean of 1.98 (SD = 0.92), suggesting that for a significant proportion of students, engagement with plant taxonomy was driven purely by examination requirements rather than genuine intellectual curiosity. Similarly, the item "I only learnt the course concepts by heart by repeating them several times, even if I did not understand them" recorded a mean of 2.14 (SD = 0.90), further confirming that surface-level, rote-based engagement was prevalent among the sample. The item "I did not find this class interesting, so I worked with minimal effort" recorded a mean of 2.42 (SD = 1.00), while "I actively participated in class discussions" recorded a mean of 2.44 (SD = 0.80) with both falling within the uninterested range. This collectively suggests that students neither found the subject engaging nor actively invested in participatory learning. Only one item, "I find it difficult to

pay attention and be attentive during the course period," recorded a mean of 2.68 (SD = 0.76) which may indicate that students were at least physically present and attentive during instruction even if their deeper engagement remained low. The relatively high standard deviation of 0.91 across the section reflects considerable variability in interest levels among respondents, suggesting that while a significant proportion demonstrated low engagement, some students did express more positive dispositions toward plant taxonomy. The overwhelming pattern across the section points to low interest as a defining characteristic of the sampled population's relationship with plant taxonomy, with examination-driven motivation and rote memorization emerging as the dominant learning orientations in place of genuine conceptual engagement.

The approaches used in teaching were effective and students had strong prior knowledge which aided the current conceptual understanding they possess. This pattern suggests that the limiting factor in undergraduate plant taxonomy conceptual understanding at the University of Benin is not totally the absence of teaching or prior knowledge but it is the absence of genuine student interest. Hidi and Renninger (2006) established in their four-phase model of interest development that both situational and individual interest positively influence cognitive engagement and knowledge acquisition. The present finding that students are uninterested in plant taxonomy implies that students are not sufficiently engaged at either the situational or the individual interest level to facilitate the deep processing required for conceptual understanding. This finding is consistent with Wandersee and Schussler's (2001)

plant blindness framework that identifies low interest in plants as the root cause of poor botanical learning outcomes. They argued that students' inherent preference for animals over plants creates a perceptual bias that suppresses motivation to engage deeply with botanical content and Strgar (2007) empirically confirmed a significant positive correlation between interest in plant science and performance on plant taxonomy assessments. The present study adds to this body of evidence by demonstrating that low interest remains a persistent challenge even at the undergraduate level among students formally enrolled in biology-related programmes and it reinforces the argument that addressing student interest in plant taxonomy is not merely a motivational concern but a cognitively consequential one with direct implications for conceptual understanding outcomes.

The finding that Experiential Learning via Field Trip recorded the highest mean among all four teaching methods, while Instructional Delivery via Lecture Method recorded the lowest, provides important insight into students' perceptions of effective plant taxonomy pedagogy. This aligns strongly with Papilaya (2020), who demonstrated that field trip strategies and direct interaction with plant specimens significantly improved students' discovery abilities in botany courses and Khosyillah and Khusnah (2025) study that found that PjBL through herbarium preparation produced significantly superior learning outcomes compared to conventional lecture methods across cognitive, affective and psychomotor domains. The present finding that students most positively rated experiential and practical approaches while rating conventional instructional delivery lowest suggests that undergraduate students at the

University of Benin are responsive to active learning and would likely benefit from a deliberate pedagogical shift toward more experiential, hands-on forms of plant taxonomy instruction.

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSION AND RECOMMENDATIONS**

This chapter presents a summary of the study and provides extensive suggestions on how the conclusions of the research can enhance conceptual understanding of students in plant taxonomy and other related science fields where it can be applied. The conclusions are drawn from the outcomes of this research, relevant studies and existing literature. Suggestions for further studies are also provided in this chapter.

#### **SUMMARY**

This study investigated undergraduate students' conceptual understanding and teaching methods of plant taxonomy at the University of Benin, Benin City. It examined the proportion of students with strong conceptual understanding, identified factors influencing conceptual understanding and investigated the teaching methods prevalent in plant taxonomy instruction as well as the student interest levels.

The study was guided by four research questions. A descriptive survey design was adopted and the study population was made up of undergraduate students from two departments which are the Department of Plant Biology and Biotechnology (PBB) and the Department of Curriculum and Instructional Technology (CIT), at the University of Benin. A total of 97 students participated in the study after sorting and collation of usable data. Two instruments were used for data collection, one being the Plant Taxonomy Conceptual Understanding

Diagnostic Test (PTCUDT), a validated two-tier multiple choice diagnostic test comprising 20 questions and then a structured questionnaire of 30 items organized into six sections covering instructional delivery, experiential learning via field trip, practical tasks, instructional aids, learners' interest and prior knowledge. Data from the PTCUDT were analyzed using frequencies, percentages, means and standard deviations while inferential statistics such as Pearson correlation analysis were employed to examine relationships between variables. The study had findings which revealed the following:

- A low proportion of students (18.56%) demonstrated strong conceptual understanding of plant taxonomy, scoring at or above the 70% threshold on the PTCUDT. The remaining 81.44% fell below this benchmark and were distributed across adequate, moderate, weak and inadequate understanding categories.
- Among the three influential factors of the students' current conceptual understanding that were identified, teaching approaches were classified as effective and it was seen that students had strong prior knowledge in their plant taxonomy learning. Students were uninterested in the plant taxonomy learning which made it the only factor that was not at the effective threshold. Pearson correlation analysis further revealed that prior knowledge had the only statistically significant relationship with conceptual understanding even though the relationship was weak.
- All four teaching methods identified in the study, Lecture Method, Field Trip, Project-Based Method and Audio-Visual Means, were perceived as effective by students.

Experiential Learning via Field Trip recorded the highest mean while Instructional Delivery via Lecture Method recorded the lowest with no method reaching the very effective threshold range.

- Examination-driven motivation and rote memorization emerged as the dominant learning orientations in plant taxonomy learning as the undergraduate students demonstrated a low level of interest in plant taxonomy.

## **CONCLUSION**

The conceptual understanding of plant taxonomy among undergraduate students at the University of Benin is generally weak with less than one in five students demonstrating strong conceptual understanding. This weakness is not merely a reflection of knowledge gaps but is compounded by the prevalence of misconceptions across foundational domains of plant taxonomy. These suggest that students have developed alternative conceptions that actively interfere with correct taxonomic reasoning and which cannot be resolved through conventional instruction alone.

Low student interest emerged as the most critical limiting factor among the other influential factors. As teaching approaches were perceived as effective and it was noted that students' had previous knowledge about plant taxonomy and its activities. Prior knowledge of students demonstrated a significant albeit weak correlation with conceptual understanding as interest and teaching approaches were not significant and weak. This finding strongly suggests

that affective engagement which is the extent to which students truly value and are curious about plant taxonomy, is a central determinant of whether adequate instruction and prior knowledge translate into meaningful conceptual learning.

The experiential and project-based approaches were most positively rated by students while the conventional lecture-based delivery was rated lowest. This affirms the value of active, hands-on, student-centered pedagogy in plant taxonomy education.

## **RECOMMENDATIONS**

Based on the reviewed literature and the findings of this study, the following recommendations are proffered to address the challenges of weak conceptual understanding, low student interest and inadequate deep learning engagement identified among undergraduate students offering plant taxonomy at the University of Benin:

1. Instructors at the University of Benin should deliberately incorporate conceptual change strategies such as the 5E instructional model (Engage, Explore, Explain, Elaborate and Evaluate) into their teaching. These strategies are specifically designed to surface and address alternative conceptions rather than simply adding new information on top of existing misconceptions.
2. The Plant Biology and Biotechnology (PBB) department at the University of Benin should actively seek to make plant taxonomy instruction more relevant, relatable and stimulating. This could include connecting taxonomic concepts to real-world applications such as

conservation, medicine, agriculture and indigenous botanical knowledge like areas that are more likely to resonate with students' lived experiences. This could curb the low interest associated with low conceptual engagement.

3. Regular botanical excursions, herbarium visits and live specimen identification exercises should be systematically built into the plant taxonomy curriculum rather than treated as occasional supplements to academic instruction. This could increase the frequency and depth of field-based activities in plant taxonomy as seen from reviewed literature and the positive perception of students towards the field trip experience from this study.
4. The herbarium preparation activity recorded the only item-level very effective rating across the entire questionnaire, confirming students' positive reception of hands-on specimen work. The PBB department should institutionalize herbarium preparation as a core practical component of plant taxonomy instruction ensuring that all students regardless of their department have access to this learning experience.
5. Curriculum planners should review plant taxonomy assessment practices to include more application-based, reasoning-oriented questions that require students to demonstrate conceptual understanding rather than simply reproduce memorized information as the gap between students' academic achievement scores and their conceptual understanding scores suggest that the existing assessment instruments may be measuring recall rather than understanding.

6. AI-based plant identification tools like PlantNet (Gatarira et al., 2026) should be integrated into plant taxonomy instruction to support students' conceptual understanding and reduce the challenges associated with traditional classification methods. Its' utilization within a structured teaching framework can enhance engagement, promote independent learning and improve students' ability to relate observable plant features to scientific classification.
7. Instructors should be supported through regular professional development workshops on active learning pedagogies, diagnostic assessment techniques and strategies for identifying and addressing student misconceptions. This is particularly important given that conventional lecture-based delivery recorded the lowest student rating among all teaching methods investigated.

### **SUGGESTIONS FOR FURTHER STUDIES**

Based on the study's limitations and findings, the following suggestions are made for further research:

1. A similar study should be conducted across multiple Nigerian Universities to determine whether the patterns of weak conceptual understanding and high misconception rates observed at the University of Benin are representative of the broader Nigerian university context.
2. Investigation of the Pedagogical Content Knowledge (PCK) of instructors or lecturers as a factor that may influence the conceptual understanding of students in Plant Taxonomy.

3. Investigation on the effectiveness of specific conceptual change interventions such as the 5E instructional model, expeditionary learning or herbarium-based PjBL on undergraduate students' conceptual understanding of plant taxonomy using experimental or quasi-experimental designs.
4. Investigation of the specific misconceptions identified in this study and other misconceptions in greater depth, examining their origins, persistence and the most effective instructional strategies for addressing them.
5. A qualitative investigation into the factors driving low student interest in plant taxonomy at the undergraduate level.

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## APPENDIX

### TWO TIER MULTIPLE CHOICE DIAGNOSTIC TEST ON PLANT TAXONOMY AN EVALUATION OF THE CONCEPTUAL UNDERSTANDING AND TEACHING METHODS OF PLANT TAXONOMY AMONG UNDERGRADUATE STUDENTS AT THE UNIVERSITY OF BENIN

#### SECTION A: DEMOGRAPHIC INFORMATION

Please tick (✓) the option that applies to you:

Department:  CIT (EDUCATION & BIOLOGY)  PBB

#### SECTION B

READ THIS INSTRUCTION CAREFULLY BEFORE ATTEMPTING THE QUESTIONS

These questions are designed to assess your understanding of concepts in plant taxonomy. Each item consists of two parts: **Q** and **R**.

- **Q (Question):** Select the option that best answers the question.
- **R (Reason):** Select the option that best explains *why* you chose your answer in **Q**.

Please answer both **Q and R** for each item by **shading or striking** the empty space provided in front of the option you choose. There are no penalties for wrong answers, so respond honestly based on your understanding. All responses will be used strictly for academic research purposes and will be kept confidential.

Thank you.

**Q1.** The primary aim of plant taxonomy is to \_\_\_\_\_.

- a. identify and classify plants based on morphology alone
- b. identify, name and classify plants reflecting evolutionary relationships
- c. group plants according to economic utility
- d. memorize scientific and common names

**R1.** This is because Plant Taxonomy is \_\_\_\_\_.

- i. relies solely on observable traits without considering ancestry
- ii. focuses primarily on practical uses

- iii. integrates morphology, genetics and phylogenetic relationships to reflect evolutionary history
- iv. serves mainly for nomenclature convenience and establishes relationships reflecting lineage

**Q2.** In hierarchical classification, which rank immediately precedes *species*?

- O a. Genus
- O b. Family
- O c. Subspecies
- O d. Class

**R2.** Why is this?

- i. Subspecies is an informal rank below species.
- ii. Order is a broader rank above family.
- iii. Genus groups species that share key evolutionary traits.
- iv. Family encompasses only morphologically similar species

**Q3.** A monophyletic group is defined as \_\_\_\_\_.

- a. species with convergent traits
- b. an ancestor and all of its descendants
- c. morphologically similar plants from unrelated lineages
- d. organisms with similar ecological roles

**R3.** This is because \_\_\_\_\_.

- i. only monophyletic groups reflect true evolutionary history
- ii. convergent similarity is evolutionarily misleading
- iii. ecology defines groupings as it shows true family tree
- iv. morphology alone is sufficient

**Q4.** In *Ficus benjamina*, *benjamina* represents the \_\_\_\_\_.

- O a. Species
- O b. Genus
- O c. Order
- O d. Subspecies

**R4.** Because, \_\_\_\_\_.

- i. the subspecies names always follow author citations
- ii. the specific epithet distinguishes species within a genus
- iii. the genus name is always first
- iv. the specific epithet distinguishes individual organisms within a species

**Q5.** Which tool is most effective for identifying morphologically similar but closely related plant species?

- a. Dichotomous keys
- b. Field guides
- c. Herbarium specimens
- d. Molecular phylogenetic analyses

**R5.** This is because the tool \_\_\_\_\_.

- i. primarily serves historical reference
- ii. detects subtle genetic differences
- iii. is less precise than the others
- iv. only complements morphology

**Q6.** Artificial classification systems differ from natural systems because they \_\_\_\_\_.

- a. group plants based on comprehensive phylogenetic data
- b. prioritize a few convenient morphological characters
- c. integrate ecological and genetic information
- d. follow strict evolutionary lineage

**R6.** Artificial systems \_\_\_\_\_.

- i. facilitate memorization but may misrepresent relationships
- ii. provide more accurate evolutionary groupings
- iii. emphasize natural relationships over practical use
- iv. are based on molecular markers

**Q7.** In bryophytes, the inability to attain great height is mainly because they \_\_\_\_\_.

- a. lack lignified tissues
- b. reproduce by spores
- c. lack vascular vessels
- d. have dominant gametophytes

**R7.** This limitation occurs because bryophytes \_\_\_\_\_.

- i. depend entirely on diffusion for internal transport
- ii. do not possess xylem and phloem for long-distance conduction
- iii. lack chlorophyll in aerial parts
- iv. are confined to aquatic habitats

**Q8.** Herbarium specimens are mounted on standard sheets primarily to \_\_\_\_\_.

- a. ensure consistency in storage and comparison
- b. reduce physical damage
- c. enhance visual uniformity
- d. accelerate specimen drying

**R8.** Standardization in mounting is important because it \_\_\_\_\_.

- i. simplifies paper production
- ii. improves aesthetic arrangement
- iii. allows systematic filing and retrieval
- iv. prevents fungal growth

**Q9.** Leaf shape alone is generally unreliable for distinguishing angiosperms because \_\_\_\_\_.

- a. leaves are absent in many angiosperms
- b. leaf morphology varies widely within the group
- c. all angiosperms have compound leaves
- d. leaves are only found in gymnosperms

**R9.** Therefore, angiosperms are better classified using \_\_\_\_\_.

- i. vegetative traits alone
- ii. ecological adaptations
- iii. leaf venation patterns only
- iv. floral and reproductive characters

**Q10.** Cryptogamic plants include \_\_\_\_\_ only.

- a. algae and flowering plants
- b. pteridophytes and gymnosperms
- c. bryophytes and angiosperms
- d. algae, fungi, bryophytes, pteridophytes and lichens

**R10.** These plants are grouped as cryptogams because they \_\_\_\_\_.

- i. lack vascular tissues
- ii. are always aquatic
- iii. do not produce seeds or flowers
- iv. reproduce only vegetatively

**Q11.** In modern plant classification, pollen grain characteristics \_\_\_\_\_.

- a. are not primary characters used
- b. are the most important criteria
- c. are completely ignored

- d. replace vegetative characters
- R11.** This is because current classification systems emphasize \_\_\_\_\_.
- i. artificial and lineage traits
  - ii. economic usefulness
  - iii. habitat preferences
  - iv. phylogenetic and evolutionary relationships
- Q12.** The nature of the fruit is considered in the classification of seed plants because it \_\_\_\_\_.
- a. reflects reproductive and evolutionary traits
  - b. is constant in all plants
  - c. determines vegetative growth
  - d. influences photosynthetic rate
- R12.** Fruit characters are taxonomically useful since they \_\_\_\_\_.
- i. are strongly affected by environment
  - ii. vary randomly among species
  - iii. show stability and genetic control
  - iv. are unrelated to seed development
- Q13.** Tracheophytes are correctly defined as plants that \_\_\_\_\_.
- a. reproduce by seeds only
  - b. lack alternation of generations
  - c. possess vascular tissues
  - d. are exclusively terrestrial
- R13.** The defining feature of Tracheophytes is the presence of \_\_\_\_\_
- i. sclerenchyma and collenchyma
  - ii. xylem and phloem for transport
  - iii. chloroplast-rich mesophyll
  - iv. secondary growth tissues
- Q14.** Angiosperms are considered more advanced than other plant groups because they \_\_\_\_\_.
- a. lack vascular tissues
  - b. reproduce asexually
  - c. possess flowers, fruits and double fertilization
  - d. are the oldest plant group
- R14.** These features provide angiosperms with \_\_\_\_\_.

- i. greater reproductive efficiency and adaptability
- ii. reduced genetic variation
- iii. simpler life cycles
- iv. dependence on water for fertilization

**Q15.** Gymnosperms are best described as plants that \_\_\_\_\_.

- a. bear flowers and enclosed seeds
- b. form fruits after fertilization
- c. lack vascular tissues
- d. produce naked ovules and seeds

**R15.** The term *gymnosperm* refers to seeds that \_\_\_\_\_.

- i. are exposed on cone scales
- ii. develop inside fruits
- iii. are enclosed within ovaries
- iv. germinate underwater

**Q16.** A standard rule in herbarium collection requires that specimens should be collected \_\_\_\_\_.

- a. with reproductive parts whenever available
- b. with either vegetative or reproductive parts
- c. with vegetative organs mainly present
- d. with leaves fully expanded only

**R16.** This requirement exists mainly because reproductive structures \_\_\_\_\_.

- i. are easier to preserve than stems
- ii. contain stable diagnostic characters for identification
- iii. show less seasonal variation than roots
- iv. determine ecological adaptation

**Q17.** Phylogeny is best described as the study of \_\_\_\_\_.

- a. Morphological similarities among organisms
- b. Evolutionary relationships among organisms
- c. Ecological interactions between organisms and environs
- d. Practical uses of plants

**R17.** This is because Phylogeny \_\_\_\_\_.

- i. focuses exclusively on morphology
- ii. reconstructs ancestry and divergence

- iii. ignores evolutionary relationships
- iv. organizes plants by utility

**Q18.** Taxonomic hierarchy in plant classification is arranged so that \_\_\_\_\_.

- a. higher taxa contain fewer species
- b. lower taxa are more inclusive
- c. similarity increases toward lower taxonomic ranks
- d. all taxa show equal variation

**R18.** This hierarchical structure reflects the idea that \_\_\_\_\_.

- i. classification is arbitrary
- ii. variation is uniform across ranks
- iii. closely related organisms share more characters
- iv. all groups evolved independently and are with like characters

**Q19.** Bryophytes are described as rootless plants because they \_\_\_\_\_.

- a. possess adventitious roots
- b. lack true roots
- c. have poorly developed taproots
- d. possess fibrous root systems

**R19.** Instead of roots, bryophytes possess structures that \_\_\_\_\_.

- i. absorb water through leaves
- ii. arise from the sporophyte only
- iii. function like secondary roots
- iv. anchor the plant but do not conduct water efficiently

**Q20.** The rule that classification should not rely on a single character exists because \_\_\_\_\_.

- a. characters change during growth
- b. reproductive traits are unreliable
- c. all characters are environmentally induced
- d. individual characters may give false relationships

**R20.** Consequently, reliable classification depends on the \_\_\_\_\_.

- i. combined assessment of many characters
- ii. anatomical characters alone
- iii. dominant vegetative traits
- iv. ecological distribution

**TWO TIER MULTIPLE CHOICE DIAGNOSTIC TEST ON PLANT TAXONOMY**  
**AN EVALUATION OF THE CONCEPTUAL UNDERSTANDING AND TEACHING**  
**METHODS OF PLANT TAXONOMY AMONG UNDERGRADUATE STUDENTS AT**  
**THE UNIVERSITY OF BENIN**

**ANSWER KEY**

<b>QUESTIONS</b>	<b>Q (CORRECT ANSWERS)</b>	<b>REASONS</b>	<b>R (CORRECT ANSWERS)</b>
Q1	<b>B</b>	R1	<b>iii</b>
Q2	<b>A</b>	R2	<b>iii</b>
Q3	<b>B</b>	R3	<b>i</b>
Q4	<b>A</b>	R4	<b>ii</b>
Q5	<b>D</b>	R5	<b>ii</b>
Q6	<b>B</b>	R6	<b>i</b>
Q7	<b>C</b>	R7	<b>ii</b>
Q8	<b>A</b>	R8	<b>iii</b>
Q9	<b>B</b>	R9	<b>iv</b>
Q10	<b>D</b>	R10	<b>iii</b>
Q11	<b>A</b>	R11	<b>iv</b>
Q12	<b>A</b>	R12	<b>iii</b>
Q13	<b>C</b>	R13	<b>ii</b>
Q14	<b>C</b>	R14	<b>i</b>
Q15	<b>D</b>	R15	<b>i</b>
Q16	<b>A</b>	R16	<b>ii</b>
Q17	<b>B</b>	R17	<b>ii</b>
Q18	<b>C</b>	R18	<b>iii</b>
Q19	<b>B</b>	R19	<b>iv</b>
Q20	<b>D</b>	R20	<b>i</b>

## QUESTIONNAIRE

### AN EVALUATION OF THE CONCEPTUAL UNDERSTANDING AND TEACHING METHODS OF PLANT TAXONOMY AMONG UNDERGRADUATE STUDENTS AT THE UNIVERSITY OF BENIN

To respondents,

This questionnaire seeks your view on how plant taxonomy is taught and learned. Please answer the questions honestly. Your responses are confidential and will be used for research purposes only. Thank you.

#### SECTION A: DEMOGRAPHIC INFORMATION

Please tick (✓) the option that applies to you:

**Department:**  CIT (EDUCATION & BIOLOGY)  PBB

For each of the proposal below, tick the one that best suits your opinion					
		STRONGLY AGREE	AGREE	DISAGREE	STRONGLY DISAGREE
	<b>SECTION B: Based on Instructional Delivery</b>				
Q1	The explanations provided by the lecturer on Plant taxonomy concepts were sufficient.				
Q2	During the class, I had trouble taking notes.				
Q3	I easily followed the order of ideas presented in lectures.				
Q4	I could organize ideas I summed up at the end of every class.				
Q5	Verbal plant descriptions during lectures were sufficient.				
	<b>SECTION C: Based on Experiential Learning</b>				

Q6	Direct interaction with real plants during outdoor activity helped me to understand the plant taxonomy material.				
Q7	I encountered new plant species while visiting botanical gardens.				
Q8	I saw important plant features for classification when I observed real plants.				
Q9	I recognized plants and remembered their names when I encountered them outside the classroom.				
Q10	After observing plants in their natural habitat, I could describe and classify plants based on their features.				
<b>SECTION D: Based on Practical Tasks</b>					
Q11	I collected, dried and mounted some plant species during the course.				
Q12	I actively participated in group work that made the course work easier.				
Q13	I created tables and charts with which I was able to compare plant families.				
Q14	I utilized the tools for Herbaria collection at my leisure.				
Q15	I used taxonomic keys while on the field to identify unknown plants.				
<b>SECTION E: Based on Instructional Aids</b>					
Q16	Digital resources provided by the lecturers integrate real videos and images of plants.				
Q17	I was shown plant descriptions through pictorial representations.				

Q18	I compared side-by-side images of similar plant genus to see the differences between them.				
Q19	I made use of dichotomous keys to identify plants.				
Q20	Floral Formula patterns were used by lecturers to aid course delivery and I replicated them in my notes.				
<b>SECTION F: Based on Learner's Interest</b>					
Q21	I did not find this class interesting, so I worked with minimal effort.				
Q22	I was only interested in the course to pass exams.				
Q23	I actively participated in class discussions.				
Q24	I only learnt the course concepts by heart by repeating them several times, even if I did not understand them.				
Q25	I find it difficult to pay attention and be attentive during the course period.				
<b>SECTION G: Based on Prior Knowledge</b>					
Q26	I struggled with the course because I did not have an idea of what was being taught.				
Q27	I had real-life experiences related to the course concepts before its lectures started.				
Q28	I saw new ideas during the course delivery.				
Q29	I could link new information to what I already knew.				
Q30	I implemented what I already knew with the new knowledge I gained.				