International Journal of Agriculture and Biosciences 2024 13(3): 313-317.
https://doi.org/10.47278/journal.ijab/2024.116

RESEARCH ARTICLE
eISSN: 2306-3599; pISSN: 2305-6622

Digital Photographs of Vascular Plants' Organs using Smartphones: A Methodological Approach to Teaching in Plant Biology

Piba Serge Cherry[1]*, Monyn Ebalah Delphine Epse Kouame[1], Koffi Kouamé Christophe[1], TA Bi Irié Honoré[1], Kouame Amoin Gervaise[2] and TRA Bi Fezan Honora[2]

[1]Université Polytechnique de Man, UFR Ingénierie Agronomique, Forestière et Environnementale, BP 20 Man, Côte d'Ivoire
[2]Université Nangui Abrogoua, UFR Sciences de la Nature, 02 BP 801 Abidjan 02, Côte d'Ivoire
*Corresponding author: serge.piba@univ-man.edu.ci

ABSTRACT

Modern and digital technology is becoming increasingly important to facilitate teaching in our universities and colleges. The smartphone represents a considerable advantage for photography and image transfer. Given its accessibility and the relative scarcity of teaching aids in developing countries, it could be a valuable tool for practical plant biology work. This study aims to present a methodology for producing digital photographs of anatomical sections obtained during practical work in the histology of vascular plants. It was carried out between March 2019 and November 2023. The approach consisted of pairing a smartphone with an optical microscope to photograph anatomical sections. It enabled the creation of 246 images of stems, roots, and leaves. The results showed that smartphone sensors can take detailed images on optical microscopes not connected to the computer. These images make it easier to describe the primary and secondary histological structures of plant organs with learners. Tissues present in the cortex, and central cylinder of stems and roots, both young and old, and in the leaf blade and central vein of monocotyledons and dicotyledons are better observed and commented on. While facilitating collaboration and discussion, this methodology helps illustrate and understand the lessons learned quickly. It should be disseminated to other universities in Côte d'Ivoire and other developing countries to compensate for the lack of teaching materials.

Keywords: Smartphone, Photography, Practical work, Cytology, Histology, Anatomy.

Article History
Article # 24-611
Received: 08-May-24
Revised: 18-Jun-24
Accepted: 25-Jun-24
Online First: 16-Jul-24

INTRODUCTION

In sub-Saharan Africa, many countries are below the poverty line. Despite the efforts made by our governments, financial resources for the education-training system remain insufficient. In Côte d'Ivoire, the inadequacy and dilapidation of school and social infrastructures, overcrowding in universities, and the inadequacy and obsolescence of equipment, teaching, and research materials are just some of the dysfunctions observed in the higher education sector (Djede and Adon, 2021). For many years, in most universities, observations in Practical Work in Plant Biology (cytology, histology, and anatomy of vascular plants) have mostly been made using optical microscopes, made available individually to each student or in pairs. With the increase in the number of students and the decrease in the ratio of microscopes to students in laboratories, several students are expected to use a single microscope. The consequence is poor observation of anatomical sections for some students and no observation at all for others. This makes it extremely difficult for most learners to identify and describe the various tissues of plant organs. To overcome this shortcoming, combining a digital camera with a microscope would help take the best images (Bruneton, 1997; Oulad, 2014) and faver projection for better description. Unfortunately, this equipment is even more expensive. With recent technological innovations and the evolution of digital technology, the smartphone offers an alternative for photography and image sharing. According to Mrabbi (2022), smartphones provide new learning opportunities as their capabilities increase in power and their prices fall. The use of

Cite this Article as: Cherry PS, Kouame MEDE, Christophe KK, Honoré TBI, Gervaise KA and Honora TBF, 2024. Digital photographs of vascular plants' organs using smartphones: a methodological approach to teaching in plant biology. International Journal of Agriculture and Biosciences 13(3): 313-317. https://doi.org/10.47278/journal.ijab/2024.116

A Publication of Unique Scientific Publishers

smartphones to enhance learning is well-documented (Djeumeni and Batchakui, 2014; Villemonteix et al., 2014). UNESCO (2013) defines m-learning as "a method that uses mobile technology, alone or in combination with any other information and communication technology, to facilitate learning anytime, anywhere." Despaux et al. (2023) found that smartphones offer a variety of features that enable students to deepen their knowledge and enhance their learning experience. Moreover, smartphones are widely used by students and teachers alike (Attenoukon et al., 2015; Fotsing et al., 2017; Dagnogo and Samasse, 2022) and are widely available among the population of Sub-Saharan Africa. In 2012, the number of smartphones worldwide exceeded that of the global population, and over 70% of subscriptions are currently from developing countries (Cisco, 2012). In sub-Saharan Africa, smartphone connections reached 302 million in 2018 (GSMA, 2018). In 2022, the telecommunications regulatory authority estimated the number of mobile internet subscribers in Côte d'Ivoire to be 23 million (ARTCI, 2022). Numerous studies have proven that digital technology motivates learners, sparks creativity, and encourages autonomy (Depover et al., 2007). The smartphone could, therefore, help implement practical work in plant biology. This work proposes an alternative for creating digital photographs of transverse and longitudinal anatomical sections taken during practical work in Cytology, Histology, and Anatomy of Vascular Plants for the university community.

MATERIALS & METHODS

Plant Material, Chemicals, and Techniques

Our examination of plant material encompassed various parts of young and mature plants, including roots, stems, leaves, monocotyledons, and dicotyledons angiosperms. To facilitate our research, we used technical equipment, including razor blades, polystyrene packaging, microscopic observation slides, and coverslips, paired with a JEULIN optical microscope N°1717253 (as seen in Fig. 1), and two smartphones. We specifically employed a Tecno CANON 12 Pro smartphone with a 26-megapixel front camera and a SAMSUNG GALAXY A73 5G smartphone outfitted with a 108-megapixel front camera. In addition, we used certain chemicals, such as diluted Sodium hypochlorite (NaClO), acetic acid (CH_3COOH), carmine-green, and glycerin.

Methods

The work was conducted from 2020 to 2023 at the Polytechnic University of Man in Côte d'Ivoire as part of the Practical Work of Cytology, Histology, and Anatomy of Vascular Plants. The initial step of the methodology involved creating transverse and longitudinal sections of plant organs and then staining them. The standard double carmine-green staining technique (Oulad, 2014) was used during Practical Work, and the sections were cut into polystyrene using a razor blade. Next, the resulting organ sections were immersed in a Sodium Hypochlorite solution (NaClO) for 10 minutes and then rinsed with tap water. The sections were then immersed in dilute acetic acid (CH_3COOH) for 5 minutes, rinsed with water, and finally, immersed in carmine-green for 3 minutes. The sections were finally rinsed and mounted between the slide and coverslip in glycerin water, which served as the mounting liquid. The second step involved observing under the optical microscope and selecting the pedagogically correct cuts. The final stage consisted of taking photographs using smartphones.

Fig. 1: Observation, by a student, of a section using an optical microscope.

RESULTS

Technical Itinerary for Photographing Transverse and Longitudinal Anatomical Sections

A smartphone can take photographs for illustrations and presentations during practical work sessions in cytology, histology, and plant anatomy studies. Obtaining clear anatomical sections during the initial manipulation is essential for satisfactory results. To this, it is important to have focus and optimal lighting on the optical microscope to take photographs. The sections were viewed at a magnification of 100x for a complete image. To take a photograph, align the smartphone lens with the microscope eyepiece (Fig. 2). Ensure the light beam emitted by the microscope is aligned with the smartphone lens. The lens, eyepiece alignment, and the light volume between them were crucial to an excellent-quality image. Right-handed people use the left hand to reduce or adjust the amount of light (Fig. 3). After each focus, a digital intensity photography series was taken to save the best photos. You can transfer the images to a laptop and view them via video projection.

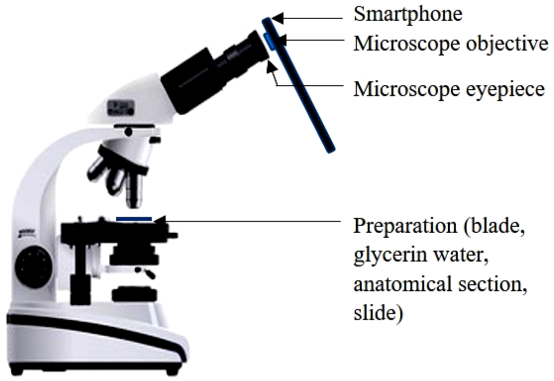

Fig. 2: Couple overview optical microscope and smartphone.

Fig. 3: Capture of image an anatomical section of plant organ using a smartphone.

Smartphone Images and Descriptions

In this experiment, 246 photographs were taken using a specific methodology. Among these, 94 photographs were of stems, 85 of roots, and 67 of leaves. Some examples of these photographs are presented in Fig. 4-7. After transferring the photographs to a laptop, they were projected on a board using a video projector. The photographs provided clear insights into the tissues in the cortex and central cylinder of stems and roots, as well as in the leaf blade and central vein of both monocots and dicots, whether young or old. The photographs have helped in identifying various primary tissues such as suberoid, collenchyma, sclerenchyma, cortical and medullary parenchyma, endodermis, primary phloem, and primary xylem, as well as secondary tissues such as secondary phloem and secondary xylem, phelloderm and suber. These photographs have enabled better observation, tissue recognition, and organ identification.

DISCUSSION

Based on the obtained photographs, smartphones, through their cameras, can be a valuable tool for practical work in cytology, histology, and plant anatomy. According to OECD (2005), cited by Ben Youssef and Hadhri (2009), the Technology of information and communication presents real opportunities to dramatically improve the quality of higher education and transform our relationship to knowledge. Tamer (2019) also suggested that digital technology is one of the most effective ways to change traditional higher education. Many publications have shown that mobile technology can be helpful in education (Kouakou, 2019; UNESCO, 2012a, 2013, 2015).

Photos of cross-sections provide a better understanding and description of primary and secondary tissues, different organs in monocots and dicots, and a deeper knowledge for learners. Sharing images between smartphones or projecting them using a video projector leads to equitable knowledge distribution. Additionally, image captures encourage personal or organized revision between learners. Mrabbi (2022) demonstrated that using smartphones in the classroom can promote learning while energizing collaborative learning communities. When utilized for learning purposes, the smartphone opens prospects for democratizing knowledge and creating inclusive education through its functionalities, availability, and accessibility.

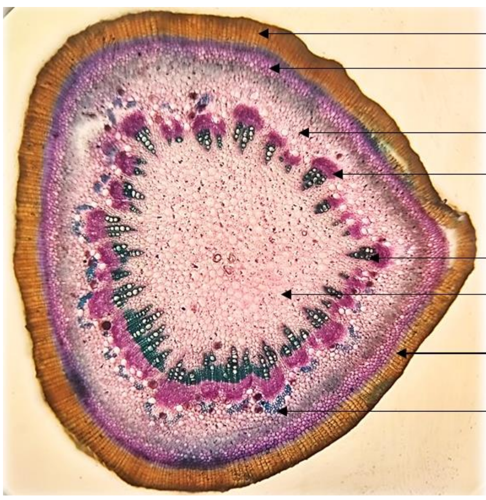

Fig. 4: Illustrative photo of an old dicot Angiosperm stem portion in cross-section. Mounting fluid: glycerin water; Dye: Carmine green; Magnification x 100.

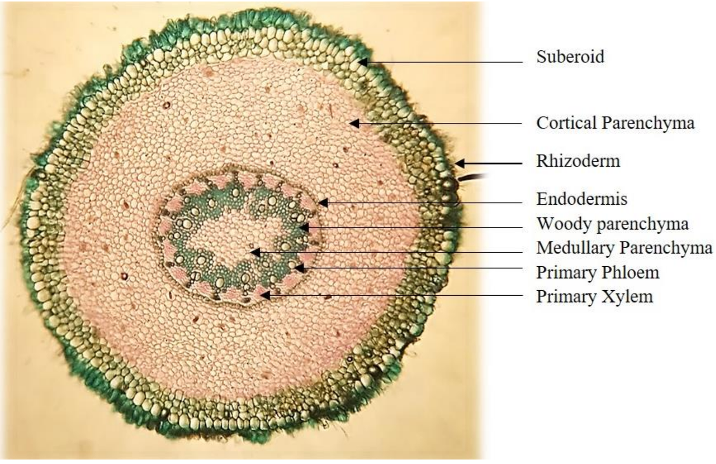

Fig. 5: Illustrative photo of a monocot Angiosperm root portion in cross-section. Mounting fluid: glycerin water; Dye: Carmine green; Magnification x 100.

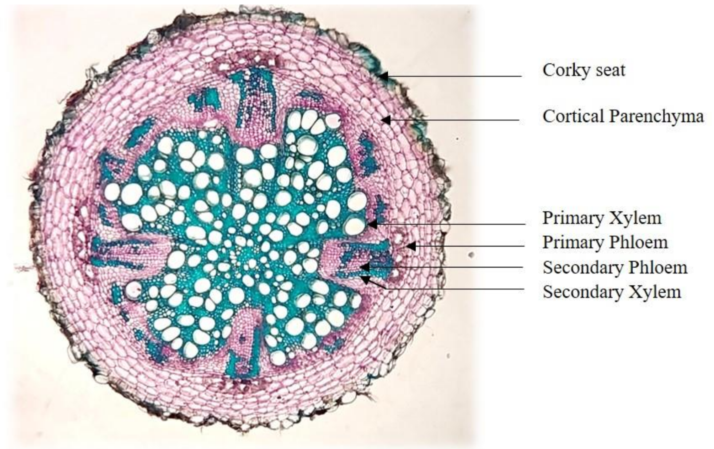

Fig. 6: Illustrative photo of a dicot Angiosperm root old portion in cross-section. Mounting fluid: glycerin water; Dye: Carmine green; Magnification x 100.

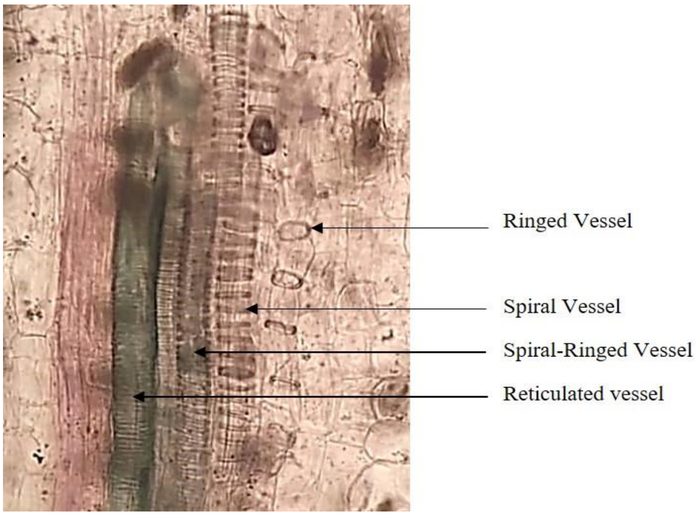

Fig. 7: Illustrative photo of a dicot Angiosperm young stem portion in the longitudinal section. Mounting fluid: glycerin water; Dye: Carmine green; Magnification x 100.

UNESCO (2012a) has noted that mobile technology can expand and enrich educational opportunities for learners in diverse contexts. Mobile learning platforms like Moodle can facilitate open or distance learning offerings, open online training, or Massive Open Online Courses (MOOC). Wagner (2005) argued that using mobile technologies for learning and teaching was not only obvious but inevitable. However, smartphones need to be used rationally in practical classrooms. According to UNESCO, which has published a series of documents on mobile learning, this approach presents several pedagogical and personal advantages but also perceived disadvantages to using these devices in a learning context (UNESCO, 2012b; 2013). Yéo et al. (2020) showed that mobile technologies play a crucial role for students and are particularly important in teaching and learning. While mobile learning presents risks of distraction, dispersion during learning, disruptions, and technical problems, it also offers many benefits. Dagnogo and Samassé (2022) suggested that using smartphones and artificial intelligence can facilitate and adapt academic activities as part of pedagogical continuity but could also hinder student socialization. To maximize the benefits of mobile technologies for education, researchers, practitioners, and teachers must continue demonstrating their usefulness to skeptical audiences, as emphasized by UNESCO (2012a).

Taking smartphone images will also facilitate the study and publication of much research on the anatomy and cytology of many plants from tropical African regions.

Conclusion

Mobile technology can contribute to improving the quality of teaching in universities and colleges. This paper presents a comprehensive alternative for generating digital photographs in teaching plant histology and anatomy. Our research has demonstrated that utilizing a photonic microscope with a smartphone can mitigate the shortage of microscopes and digital cameras in practical workrooms. Furthermore, smartphones offer several possibilities for research and the creation of digital databases. With their accessibility, power, and functionality, they can enhance the way we learn.

Competing Interests

The author declares that they have no conflict of interest.

Acknowledgment

The authors are grateful to the University of Man for material and technical support. They also warmly thank laboratory technician Bignon Guy for collecting plant organs and making a great contribution to the study.

Author's Contribution

This work was carried out in collaboration with all the authors. PIBA Serge Cherry designed the project. PIBA Serge Cherry, MONYN Ebalah Delphine Epse KOUAME1, KOFFI Kouamé Christophe, and TA Bi Irié Honoré produced the anatomical sections and photographs and refined the protocol. KOUAME Amoin Gervaise and the previous authors contributed to the writing of the paper. TRA Bi Fezan Honora supervised the realization of the project and the publication's writing. All the authors reviewed and approved the manuscript.

REFERENCES

ARTCI, 2022. Statistiques du marché des télécommunications en Côte d'Ivoire, 35 p.

Attenoukon, S.A., Karsenti, T., and Lepage, M. (2015). L'apprentissage avec des supports mobiles dans l'enseignement supérieur au Bénin: analyse des usages des apprenantes. Revue internationale des technologies en pédagogie universitaire. International Journal of Technologies in Higher Education, 12(3) : 62–74. https://doi.org/10.18162/ritpu-2015-v12n3-05

Ben Youssef, A., and Hadhri, W. (2009). Les dynamiques d'usage des technologies de l'information et de la communication par les enseignants universitaires: Le cas de la France. Réseaux, 155(3) : 23-54. https://doi.org/10.3917/res.155.0023

Bruneton, J. (1997). Pharmacognosie. Phytochimie, plantes médicinales, 2ème édition. Tec & Doc éditions. Paris. France. 915 p

Cisco, (2012). Cisco visual networking index: Global mobile data traffic forecast update, 2011-2016. San José, CA: Cisco. https://www.cisco.com/c/en/us/solutions/collateral/executive-perspectives/annual-internet-report/white-paper-c11-741490.html

Dagnogo, G.L.B., and Samassé A. (2022). « Jeunesse de l'Université de Bouaké et socialisation, à l'ère de l'Intelligence Artificielle », Communication, Technologies et Développement [En ligne], 11 | 2022, mis en ligne le 15 février 2022, consulté le 16 mars 2022. URL: http://journals.openedition.org/ctd/7529, DOI: https://doi.org/10.4000/ctd.7529

Depover, C., Karsenti, T., and Komis, V. (2007). Enseigner avec les technologies: favoriser les apprentissages, développer des compétences. PUQ. 286 p

Djede, A. J., and Adon, K. P. (2021). La relance de la politique numérique dans l'enseignement supérieur ivoirien pendant la crise sanitaire de la COVID-19. RITPU, 18(1) : 75-88. https://doi.org/10.18162/ritpu-2021-v18n1-08

Djeumeni, T.M., and Batchakui, B. (2014). Téléphone portable et apprentissage mobile du français en Afrique subsaharienne (TEPAMF): une étude de cas au Cameroun. Adjectif.net. [En ligne], URL: http://www.adjectif.net/spip/spip.php?article321

Fotsing, J., Fonkoua, P., Tchamabe, M.D., Tankam T.N., Tagne F.E., and Tonye, E. (2017). Usages des technologies mobiles en milieu universitaire africain: Cas des universités camerounaises. Journal of Research in Open, Distance and Elearning, 1(1): 57-71 https://doi.org/10.26841/2017f03

Despaux, G., Delaunay, T., and Le Clézio, L. (2023). Smartphonique et enseignement ou comment utiliser un smartphone comme aide à l'apprentissage. EDP Sciences, 22(1): 1-5 https://doi.org/10.1051/j3ea/20231032

GSMA, (2018). Stimuler l'utilisation de l'internet mobile en Côte d'Ivoire et en Tanzanie, www.gsma.com/ connected-society 60 p.

Kouakou, K.S. (2019). Les déterminants de l'adoption de l'apprentissage mobile par les étudiantes de l'université Cheikh Anta Diop de Dakar: Determinants affecting acceptance level of mobile learning among schoolgirls of the Cheikh Anta Diop university of Dakar. frantice.net, 15. Récupéré du site de la revue: http://frantice.net/index.php?id=1534.ISSN2110-5324.

Mrabbi, F.Z. (2022). Les enjeux du numérique dans l'enseignement, apprentissage du français à l'université marocaine: cas de l'usage du smartphone. Education. Université de Haute Alsace - Mulhouse, theses.hal.science, 312 p.

OECD (2005). ICTS for Development: Financing Activities of DAC Members. *OECD iLibrary, 5(1),* 1-41. https://doi.org/10.1787/oecd_papers-v5-art5-en

Oulad, B.A. (2014). Synthèse bibliographique sur les protocoles utilisés pour l'étude anatomique des épidermes de plantes. Université Kasdi Merbah, Ouargla Faculté des Sciences de la Nature et de la vie et sciences de la terre et de l'univers, Département des Sciences Biologiques, Mémoire de licence, 53 p

Tamer, H., Bouchra, L., and Abaaoukide, K. (2019). L'impact de la digitalisation des universités sur la motivation des usagers : Revue de littérature, Revue Internationale des Sciences de Gestion, 265-279. www.revue-isg.com

Villemonteix, F., Hamon, D., Nogry, S., Sejourné, A., Hubert, B., and Gélis, J-M. (2014). Extate: Expérience tablettes tactiles à l'école primaire. Université Cergy-Pontoise : Ministère de l'Education Nationale, 86 p.

UNESCO (2012a). Mettre en marche l'apprentissage mobile: Thèmes généraux; UNESCO; Paris. http://unesdoc.unesco.org

UNESCO (2012b). Turning on mobile learning in North America: Illustrative initiatives and policy implications. 42 p. https://unesdoc.unesco.org/ark:/48223/ pf0000216083

UNESCO (2013). UNESCO Policy Guidelines for Mobile Learning. 42 p. http://unesdoc.unesco.org/images/ 0021/002196/219641E.pdf

UNESCO (2015). Mobiliser les technologies de l'information et de la communication pour réaliser l'objectif d'éducation post-2015. Rapport de la Conférence internationale sur les TIC et sur l'éducation post-2015 ; Qingdao, République populaire de Chine. 38 p. https://unesdoc.unesco.org/ark:/48223/ pf0000243076fre

Wagner, E.D. (2005). Enabling mobile learning. EDUCAUSE Review, 40(3): 40-53. http://er.educause.edu

Yéo, S., Kéi, M. and Kablan, B.N. (2020). Perceptions du mobile learning chez les étudiants inscrits en master 2 de pédagogie des sciences de la santé à l'institut de formation des agents de santé (infas) d'Abidjan. Revue semestrielle de l'ULSHB, 007 (87-104).