



# Addressing the Challenges of Adopting a Student-Centered Approach in Teaching Plants Anatomy in Nyamasheke District, Rwanda: Insights and Solutions for Secondary School Education

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**Abstract:** *The shift from teacher-centered to student-centered (SC) learning has posed significant challenges worldwide, particularly in plant anatomy instruction. This study aims to analyze the difficulties faced in adopting a SC approach in plant anatomy education and highlights successful strategies with a focus on Nyamasheke District, Rwanda. The research employed a mixed-method design incorporating both quantitative and qualitative approaches. A purposive sampling technique was employed to select 83 from 105 targeted Biology teachers to participate in the study. Data were collected using questionnaires and observation checklist. Quantitative data were analyzed using SPSS version 25 while qualitative data underwent thematic analysis where themes were delivered by carefully reviewing the observation records to identify recurring patterns and emerging ideas. Findings indicate that the main challenges include limited resources, large class sizes, time constraints, language barriers and lack of field trip. Solutions include hands-on learning, teacher dedication, use of educational technologies and lesson improvisation. The study recommends capacity building to the teachers focusing language improvement and effective use of available resources.*

**Keywords:** *Student-Centered Approach, Plant anatomy Education, Secondary schools, Inquiry-based learning*

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## 1. Introduction

The transition from teacher-centered to student-centered learning has been a significant pedagogical shift in secondary school education worldwide, and aligns with

fourth Sustainable Development Goal (SDG 4) which establishes clear objectives in order to offer a comprehensive framework for achieving inclusive, equitable, and high-quality education for everyone (Batliwala, 2022). A student-centered approach (SCA) emphasizes active learning, inquiry based instruction and

development of critical thinking skills (Freeman et al., 2014). This approach has been particularly challenging to implement in plant anatomy education due to abstract and microscopic nature of the subject, which requires specialized resources and hands-on learning experiences (Kazempour & Amirshokohi, 2014).

The adoption of student-centered learning in plant anatomy has faced challenges such as inadequate laboratory facilities, insufficient teacher training and resistance to pedagogical changes (Kim et al. 2007). Developed countries like the United States of America and Finland have successfully addressed these barriers by integrating technology such as virtual and augmented reality into biology education to facilitate student's engagement with microscopic structures (Wu et al., 2013).

Additionally, Problem-Based Learning (PBL) strategies have been employed to encourage students to investigate plant anatomical structures through real world applications (Hmelo-Silver, 2004). These strategies have significantly improved students' conceptual understanding and retention in biological sciences.

In Sub-Saharan Africa, resources constraints pose a major hurdle to adopting SCA in plant anatomy education. Many schools lack access to laboratory equipment making it difficult for students to engage in hands-on learning experience (Maringe & Prew, 2015). Furthermore, large class size and limited teachers training opportunity reduce the effectiveness of student-centered methodologies (Mueller & Bentley, 2009). However innovative solutions have emerged such as the use of locally available plant materials for anatomical studies, paired learning initiatives and mobile learning technologies that provide access to digital plant anatomy resources (Ayeni, 2021). Countries like South Africa have also implemented Curriculum reforms that integrate indigenous knowledge system, making plant anatomy more relatable and accessible to students (Abah et al. ,2015).

Rwanda in its pursuit of education reform, has faced similar challenges in implementing SCA in biology education in plant anatomy. Limited infrastructures, a traditional reliance on rote learning and insufficient professional development for teachers have hindered the adoption of inquiry-based approach (Niyibizi et al., 2021). However, the Rwandan government have made significant strides in addressing these barriers through the implementation of competency-based curriculum (CBC) which emphasizes the active learning and critical thinking (Mugabo et al., 2018). Additionally, Rwanda has invested in digital education platforms such as the smart classroom initiatives to enhance interactive learning in science subjects (Adegoke et al. ,2023). Teachers' capacity

building programs have also been introduced to equip educators with the skills necessary to facilitate student-centered plant anatomy lessons.

By examining these global and regional effort, this study seeks to provide insight into effective strategies for overcoming the strategies of adopting SCA in plant anatomy education. Research objectives were to explore the challenges faced in teaching plants anatomy in secondary schools of Nyamasheke District and to examine strategies for effective teaching plants anatomy in secondary schools of Nyamasheke District

## 2. Literature Review

### 2.1 Challenges in teaching plant anatomy

Plant anatomy teaching needs learner-centered methods for better engagement, meeting individual needs, enhancing learning outcomes. However, Du Plessis (2020) argued that instructors value learner-centered approaches but lack knowledge, hindering establishment of learner-centered classrooms. Learning challenges, influenced by ineffective teaching strategies, lead to poor Biology achievement (Manishimwe et al., 2023).

According to Kattel and Koirala (2022) even skilled teachers need suitable resources; lacking tools like microscopes limits experiential learning in student-centered plant anatomy instruction. As per Hall and Stern (2012) asserted that challenge like insufficient technical support hampers teaching. Balancing student-centered approach with large classes challenges personalized attention and meaningful discussions in overcrowded classrooms. Additionally, Ayanwoye (2023) added that class size significantly affects secondary students' attitudes towards learning: larger classes reduce involvement, motivation, attentiveness, punctuality, interest, participation, and engagement.

Limited technology access hinders multimedia, virtual labs, which are tools that may enhance student-centered learning. According to Faustin and Wenceslas (2022), Teachers lacking ICT training show low confidence. Desire to adopt ICT affected by inadequate support, thus biology teachers need comprehensive ICT training. Faustin and Wenceslas (2022) added that teachers need comprehensive ICT training in biology education to transition from traditional to modern teaching methods and create effective learning environments. Susiyawati and Tregust (2021) claimed that despite students' difficulties with interpretation, plant anatomy classes mostly rely on

visual aids like pictures, diagrams, and sketches to facilitate learning.

## 2.2 Effective strategies in teaching plant anatomy

Educators advocate student-centered approach, fostering self-reliance, critical thinking, and passion for learning, shifting from teacher-directed to student-driven environments. Nazim et al. (2024) claimed that teachers advocate student-centered methods for enhancing critical thinking and autonomy, involving learners in discussions, problem-solving, and interactions.

According to Kerimbayev et al. (2023), modern education aims for active learning, where students engage in the process. In addition, student engagement, student interest, better retention and higher test scores are all possible outcomes of implementing active learning in the classroom. Some educators might adopt a more well-rounded approach, keep some aspects of teacher-directed learning while combining aspects of student-centered learning. They seek a middle ground that satisfies both curriculum standards and the needs of each individual learner. Veraksa et al. (2023) suggest that enough students' autonomy in their activity produces much better results than teacher-centered or didactic course work alone, but the best results for children come from a combination of the two.

Open-minded teachers adapt to student-centered approaches, embracing benefits and challenges, experimenting with new strategies, and valuing feedback. According to An et al. (2020), learner-centered education prioritizes individual needs, tailoring learning experiences, unlike traditional teacher-centered approaches, focusing on uniform material delivery. Plant anatomy teaching employs diverse methods: discussions, visuals, experiments to engage students with various learning styles. Fernández-González and Franco-Mariscal (2021) asserted that science classes foster problem-solving, critical thinking, and collaboration. Educational tech enhances plant anatomy teaching, promoting practical learning and comprehension. Jiang (2023) argued that educational technology offers diverse tools like whiteboards, software, and online platforms, enhancing teaching, fostering active learning, and individualizing instruction with care.

## 3. Methodology

### 3.1 Research paradigm and design

This study was guided by John Dewey's pragmatic paradigm which hold that classroom and schools should

reflect a real world situations so that students might actively participate in learning situation under the direction of their teachers (Williams, 2017). In this regard, this paradigm is relevant to the context of this study because it emphasizes the student-centered techniques to address challenges encountered when teaching plant anatomy. Additionally, the fourth Sustainable Development Goal (SDG) emphasizes quality education and adopts the competency-based curriculum framework, contributing to identification of best practices for improved learning outcomes, which is aligned with student-centered approach in advancing STEM education through innovative teaching methods and research. The 4<sup>th</sup> SDG recommends educators and education policy makers to serve as key channels for achieving development and industrialization in the pursuit of quality education (Ubogu, 2020).

Moreover, the study is mixed and employed descriptive research design, incorporating both quantitative and qualitative approaches. Specifically, quantitative data were collected via structural questionnaires while qualitative data were collected through observation checklist.

### 3.2 Target population, sample and sampling technique

The target population includes one hundred and five (105) Senior one biology teachers from secondary schools, sharing the same characteristics in Nyamasheke District to ensure relevant to the study' objective. From this population, 83 senior one biology teachers were selected using Solvin's formula as it is described by Friday and Leah (2024) as follows:

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the total population size and

e- Margin error.

The margin of error varies between 5% and 10%.

The researchers choose the margin error of 5%=0.05. Then, the confidence level of 95%.

Hence  $n = \frac{105}{1 + 105(0.05)^2} = 83.1 \approx 83$  teachers' respondents.

Specifically, these teachers were chosen because they teach the topic under investigation to students, possess more than one year of working experience in teaching biology and have background in education.

### **3.3 Ethical consideration**

The University of Rwanda-College of Education provided the researchers with ethical clearance and permission letters prior to the data collection process. Similarly, the Nyamasheke District officials provided a research authorization letter. Subsequently, the consent forms for participation agreement were then signed by the participants.

### **3.4 Data collection tools**

To identify the challenges and strategies associated with implementing a student-centered approach in teaching plant anatomy in secondary schools, questionnaires featuring 4-point rating scales were utilized to gather quantitative data with the question items carefully aligned to the study objectives. Furthermore, observation checklists were employed to gather qualitative data during teaching and learning activities to provide additional insights.

### **3.5 Validity and reliability of data collection tools**

The reliability of instruments was evaluated through test retest during the pilot phase, and the validity of instruments was guaranteed by aligning them with the research purpose, organizing the items in systematic manner and reviewing with expert and peers. Furthermore, to guarantee measurement consistency, a consistent group took part in the same conditions. As results, the reliability of the questionnaires was outstanding as indicated by Cronbach's Alpha of 0.947 calculated in SPSS version 25. Likewise, the reliability of observation checklist was ensured by involving a second observer using predetermined criteria. Consequently, the results showed that observers agreed, and the checklists appropriateness was confirmed with a Cohen Kappa of 0.57 computed in SPSS version 25.

### **3.6 Data analysis process**

Following the import and coding of quantitative data, a systematic statistical analysis as part of quantitative analysis process was done. Descriptive statistics, including means, standard deviations and percentage distributions were computed in SPSS version 25 to assess the prevalence and patterns of respondents' opinions. The results were subsequently presented in tabular form and chart for clarity. On the other hand, the qualitative data were analyzed thematically where themes were delivered by carefully reviewing the observation records to identify recurring patterns, trends and emerging ideas. These themes were validated by revisiting the observation records and cross-checking them with the responses from questionnaires. Finally, the quantitative and qualitative data were cross checked to validate and enrich the overall understanding of the research.

## **4. Results and Discussion**

The findings from data collected through questionnaires from biology teachers were presented using tables and charts. These results are supported by data collected from student-centered teaching and learning activities utilizing observation checklists.

### **4.1 Challenges in teaching and learning plant anatomy**

This section summarizes the data gathered to address research questions regarding the challenges in teaching and learning plant anatomy that rises in secondary school of Nyamasheke District.

The following is a summary of data collected from seven senior one biology teachers utilizing questionnaires and observation checklists.

**Table 1: Challenges in teaching plant anatomy**

Challenges	N	%	Std. Dev	Remarks
Limited knowledge about learner-centered instruction	83	75	0.5	Disagree
Limited teaching and learning resources	83	100	0	Strongly agree
Large class size and time constraint to cover a large content	83	100	0	Strongly agree
Technological barriers	83	80	0.5	Strongly agree
Lack of student' interest in science subject	83	75	0.5	Disagree
Instructional language barrier for both students and teacher.	83	87.5	0.5	Strongly agree
Lack of field trips/visit opportunity	83	80	0.5	Strongly agree

N= number of teachers who are involved in this research, Std. Dev: Standard deviation

#### Source: Primary data, 2024

The findings revealed that the challenges faced by biology teachers in teaching plant anatomy include limited teaching and learning resources (100%), aligning with Mukagihana et al. (2020) who found that absence of instructional resources hinder the effective teaching of biology subject. Furthermore, technological barriers (80%), such as the lack of essential technological tools, that can enhance science education, also pose significant challenges. This is because, as argued by Yılmaz (2023), technologies like simulations and virtual labs enhance students' understanding and prepare students for modern world. Additionally, the lack of field trips/visit opportunities (80%) leads to abstract learning. In contrast, Behrendt & Franklin (2014) argued that field trips link the theory with practice and enhance students' understanding.

Moreover, instructional language barrier for both students and teacher were reported (87.5%), aligning with findings from the study conducted by Mahoro et al. (2024), which indicated that inadequate mastery of language of instruction hinder the effective teaching and learning, contributing to low academic performance in subject. Similarly, large class size and time constraint to cover a large content were highlighted (100%), consistent with the findings by Ruffina et al. (2018), who revealed that large class size negatively affects students' performance. In such setting, teacher struggle to give individual attention to each student's learning needs.

These findings are consistent with observation records during the teaching and learning process. The findings from observation about the challenges which hinder effective teaching plant anatomy using student-centered techniques in Nyamasheke District include time constraints. For teachers it was a big issue to teach a large

content in a short period of time where some points are not discussed in depth and may these would reduce the level of students' understanding of plant anatomy related concepts. This aligns with recent studies indicating that student-centered approaches require more time for planning and implementation, making it challenging to complete the syllabus within a set academic calendar (Abdu-Raheem, 2015).

In addition, the large class size seems to be a big challenge for it is difficult for the teachers to provide individual support because of overpopulated classes such 47, 50 and more. This observation is consistent with the work of John (2025), who reported that large class sizes negatively affect the implementation of student-centered methods due to limited teacher-student interaction and classroom management challenges. Finally, the language barrier is also a challenge where some time it is difficult for students to understand English when teachers are speaking because of their gap in English language or on the other side, teachers who are not explaining things clearly because of their gaps in English language, and when teachers see students in obstacles, they try to come again to the concepts, even to translate in Kinyarwanda which may take much time. These findings are supported by Emmanuel et al. (2020), who revealed that language barriers affect classroom communication, especially in science subjects, and impede the effective use of interactive teaching approaches. This implies that some challenges may be associated to language barrier for students or teachers themselves as well as the class size.

## 4.2 Solutions to the challenges

This part describes the solutions to the challenges which may lead to effective teaching and learning plant anatomy.

**Table 2: Strategies for effective teaching and learning plant anatomy**

Strategies	N	%	Std. Dev	Remarks
Hands-on learning by using science laboratory.	83	87.5	0.5	Strongly agree
Teachers should be dedicated supporter by giving enough opportunities to students to interact and effective supervision.	83	100	0	Strongly agree
Teachers should be realistic balances by incorporating diverse teaching styles	83	80	0.5	Strongly agree
Acknowledge the importance of student-centered approach to students	83	92.5	0.5	Strongly agree
Considering the difficulties of students when learning and try to find appropriate solutions	83	100	0	Strongly agree
Use of educational technologies	83	100	0	Strongly agree
Improvisation of lessons where standard materials are missing	83	87.5	0.5	Strongly agree

N= number of teachers who participated in the study, **Std. Dev:** Standard deviation

**Source: Primary data, 2024.**

The strategies for effective teaching and learning of plant anatomy include several approaches: First, teachers should be realistic balancers by incorporating diverse teaching styles (87.5%). This aligns with Gafoor (2012), who revealed that teachers who adopt diverse teaching style cater different learning needs and enhance students' engagement and understandings. Furthermore, teachers should be dedicated supporter by giving enough opportunity to students to interact and effective supervision (100%). To achieve this, teacher needs to incorporate effective approach to support students and enhance their understanding, aligning with Islamova Zilola1 (2020) who argued that innovative teaching strategies such as use of technology facilitate teaching and learning process in a more productive manner.

Additionally, acknowledging the importance of student-centered approach to students (92.5%). This aligns with findings by Hattie (2008), who emphasized that a good learning environment involves establishing demanding learning objectives, clearly defining success, and using learning techniques to build conceptual knowledge of what educators and students already know and comprehend. Moreover, considering the difficulties of students when learning and try to find appropriate solutions and use of educational technologies is highlighted (100%), and aligns

with Anazifa (2022), who found that using technology-based media in biology classroom enhance students' understanding and performance. Similarly, students who were exposed to computer technology performed better than those who were taught using traditional method (Anazifa, 2022). Another strategy is improvisation of lessons where standard materials are missing (87.5%), and this is aligning with findings from research conducted by Berk (2009) who noted that the dynamic nature of improvisation helps maintain student interest, motivation and understanding, which are crucial aspects in achieving higher academic performance.

The findings from observation revealed that intervention (training for teachers) impacted more toward the teaching practices. As results of training, biology teachers integrated hands-on activities, use of visual aids like and technologies, suggesting the need of more training for biology teachers to ensure the effective teaching of plant anatomy related topics. These findings are supported by Ogunlowo et al. (2024) who revealed that ICT has given students access to a wide range of resources, including instructional websites, online databases, virtual labs, interactive digital textbooks and enhance the students' comprehension of biological concepts, critical thinking and problem-solving. This implies that using ICT, students'

motivation and engagement levels are raised. In addition, Chidubem & Adewunmi (2020) found that the student-centered approach by fostering an environment that encourages interaction with biological specimens, is fruitful for students because it allows students to build meaningful knowledge and gain firsthand experience with the subject.

## 5. Conclusion and Recommendations

### 5.1 Conclusion

This study highlights the challenges faced in adopting a student-centered approach in teaching plant anatomy in selected secondary schools of Nyamasheke District. The key challenges include limited resources, large class sizes and technological barriers. However, effective strategies such as hand-on learning using improvisation, teachers' support (trainings) and use of educational technologies have shown promise in overcoming challenges, enhance students' engagement in plant anatomy learning and achieve quality in science education, aligning with 4<sup>th</sup> SDG.

### 5.2 Recommendations

1. Teacher's capacity training in English as language of instruction is necessary coupled with efficient use of adequate methodology to maximize few available resources are recommended.

2. The construction of classrooms and provision of sufficient and appropriate materials are essential. These measures, in turn, can help teachers to overcome challenges that hinder the effective teaching of plant anatomy.

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