

# Socratic Circles as a Pedagogical Strategy: Enhancing Critical Thinking and Discussion Skills among Third-Year Biology Teacher Training College Students in a College in Rwanda

<sup>1</sup>Enock Panganayi Mawuye, <sup>2</sup>Emmanuel Munyemana

<sup>1</sup>Rwanda Education Board

<sup>2</sup>Nyamata Teacher Training College

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**Abstract:** This study examines the use of Socratic Circles as a learner-centred pedagogical strategy for enhancing critical thinking and discussion skills among third-year Biology students in a Teacher Training College (TTC) in Rwanda. Grounded in constructivist and sociocultural learning theories, the study employed a qualitative case-study design to explore how dialogic instruction supports competence-based learning. Data were collected through semi-structured interviews with biology lecturers, classroom observations of Socratic Circle sessions, and document analysis of lesson plans and assessment rubrics. Findings indicate that Socratic Circles enhanced students' analytical reasoning, evidence-based argumentation, and confidence in scientific discussions. Peer collaboration and lecturer facilitation were key enablers of effective learning, while challenges included large class sizes, limited prior exposure to dialogic pedagogy, and time constraints. The study concludes that Socratic Circles are an effective strategy for preparing pre-service biology teachers to implement learner-centred pedagogy aligned with Rwanda's Competency-Based Curriculum.

**Keywords:** Socratic Circles; Biology education; Teacher training; Critical thinking; Discussion skills.

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## 1. INTRODUCTION

The cultivation of critical thinking, effective communication, and collaborative skills has become a central priority in contemporary education systems worldwide (Facione, 2015; Paul & Elder, 2020). These competencies are particularly significant in teacher education, where pre-service teachers are expected not only to acquire subject knowledge but also to develop pedagogical skills that foster active and reflective learning among their future students. In Rwanda, the introduction of the Competency-Based Curriculum (CBC) reflects a national commitment to learner-centred education, problem-solving, and lifelong learning across all levels of schooling (Rwanda Education Board [REB], 2019).

Teacher Training Colleges (TTCs) occupy a strategic position in the successful implementation of the CBC. As institutions responsible for preparing future secondary school teachers, TTCs must model pedagogical practices that align with curriculum expectations. However, evidence from classroom observations and policy reviews suggests that teaching practices in many TTCs remain largely teacher-centred, particularly in science subjects such as biology. Lecture-based instruction, rote memorisation, and limited student participation continue to dominate classroom practice, restricting opportunities for dialogue, inquiry, and higher-order thinking (Zohar & Dori, 2019).

Biology education requires learners to engage with abstract concepts, interpret experimental data, and apply scientific reasoning to real-life contexts. These cognitive demands necessitate instructional approaches that promote analysis, evaluation, and evidence-based argumentation rather than passive reception of information (Chin, 2021). For pre-service biology teachers, the ability to engage in scientific discussion and critical reasoning is essential, as they are expected to model these practices in their future classrooms.

Dialogic pedagogies such as Socratic Circles provide a structured approach to learner-centred instruction by placing discussion, questioning, and reflection at the core of learning. In Socratic Circles, students engage in guided dialogue around a shared problem, concept, or text, while lecturers facilitate discussion through probing questions rather than direct instruction (Paul & Elder, 2020). This approach aligns closely with the principles of the CBC, which emphasises active participation, collaboration, and critical thinking.

Despite their potential, there is limited empirical research examining the use of Socratic Circles in Rwandan TTCs, particularly in science education. This study addresses this gap by exploring how Socratic Circles are implemented in a third-year Biology TTC classroom and how they influence students' critical thinking, discussion skills, and collaborative learning. By focusing on both lecturer and student experiences, the study provides insights into the pedagogical value and practical challenges of dialogic instruction in teacher education.

## 2. LITERATURE REVIEW

### 2.1 Socratic Circles and Dialogic Pedagogy

Socratic Circles are grounded in the Socratic method, which emphasises disciplined questioning, dialogue, and critical reflection as pathways to deeper understanding (Paul & Elder, 2020). In educational settings, Socratic Circles involve structured discussions in which learners examine ideas, challenge assumptions, and justify claims through reasoned argumentation. Unlike unstructured classroom discussions, Socratic Circles rely on clear protocols, guiding questions, and reflective roles that promote equitable participation and sustained dialogue.

Dialogic pedagogy has been widely recognised as an effective approach for promoting deep learning and higher-order thinking. Mercer and Dawes (2014) argue that classroom talk, when carefully structured, serves as a powerful cognitive tool that enables learners to articulate ideas, test reasoning, and co-construct knowledge. Research indicates that dialogic instruction enhances learner engagement, metacognitive awareness, and conceptual understanding across subject areas.

In science education, dialogic approaches support core scientific practices such as hypothesising, interpreting evidence, and evaluating explanations. Chin (2021) notes that discussion-based instruction allows learners to engage in scientific reasoning by verbalising thought processes and negotiating meaning with peers. Socratic Circles, therefore, provide an instructional structure that aligns well with the epistemological nature of science.

### 2.2 Critical Thinking in Biology Education

Critical thinking is a fundamental competency in biology education, encompassing skills such as analysis, evaluation, inference, and explanation (Facione, 2015). Biology concepts often involve complex systems, abstract processes, and multiple interacting variables, requiring learners to move beyond memorisation toward conceptual understanding. Traditional lecture-based instruction has been criticised for limiting opportunities for critical engagement, particularly in science classrooms.

Empirical studies demonstrate that instructional strategies promoting dialogue and inquiry enhance students' critical thinking skills. Zohar and Dori (2019) found that students exposed to higher-order questioning and discussion-based tasks demonstrated improved reasoning and problem-solving abilities. In biology, discussion-based learning enables students to explain mechanisms, justify conclusions, and evaluate competing explanations, all of which are essential components of scientific literacy.

For pre-service teachers, critical thinking skills are doubly important. Not only must they understand biological concepts deeply, but they must also be able to design learning experiences that promote critical thinking among their future students. Exposure to dialogic pedagogies during teacher training increases the likelihood that pre-service teachers will adopt similar approaches in their professional practice.

### 2.3 Peer Collaboration and Sociocultural Learning

Peer collaboration is a defining feature of Socratic Circles. Sociocultural learning theory emphasises that cognitive development is mediated through social interaction, language, and cultural tools (Vygotsky, 1978). Through dialogue with peers, learners operate within their zones of proximal development, benefiting from shared reasoning and scaffolding.

Research on collaborative learning indicates that structured peer interaction enhances conceptual understanding, motivation, and communication skills (Mercer & Dawes, 2014). In Socratic Circles, students listen actively, respond to peers' ideas, and build collective understanding through dialogue. Such interactions are particularly valuable in teacher education, where collaborative reflection and professional discourse are essential competencies.

### 2.4 Challenges in Implementing Dialogic Pedagogy

Despite their pedagogical benefits, dialogic approaches face several implementation challenges in teacher education contexts. Large class sizes, limited instructional time, and insufficient lecturer training are frequently cited barriers (Zohar & Dori, 2019). Additionally, students accustomed to teacher-centred instruction may initially feel uncomfortable participating in open discussions.

In the Rwandan context, Nsengiyumva and Ndiokubwayo (2021) note that while the CBC promotes learner-centred pedagogy, many teachers struggle to translate policy into practice. Addressing these challenges requires deliberate scaffolding, professional development, and institutional support.

### 2.5 Socratic Circles in the Rwandan TTC Context

The integration of Socratic Circles into TTC biology education aligns strongly with Rwanda's CBC objectives, which emphasise inquiry, reflection, and active participation (REB, 2019). However, limited research has examined how such strategies are implemented in TTCs. This study contributes to the literature by providing empirical evidence on the pedagogical value of Socratic Circles in preparing future biology teachers.

## 3. RESEARCH METHODOLOGY

This study employed a qualitative case-study design to explore the implementation and perceived impact of Socratic Circles on third-year Biology TTC students in Rwanda. A case study approach was selected because it allows for an in-depth investigation of complex social and pedagogical processes within their real-life context (Creswell & Poth, 2018). This design is particularly suitable for understanding how learners and lecturers experience dialogic instruction and how such practices influence critical thinking, discussion, and collaboration skills.

### 3.1 Participants

Participants were selected using purposive sampling to ensure relevance to the study objectives. The study included:

8 biology lecturers who regularly facilitate third-year biology courses

24 third-year biology students who participated in Socratic Circle sessions

2 academic administrators who provided contextual information on curriculum implementation

Participants were chosen based on their experience with Socratic Circle facilitation or participation, ensuring rich and relevant data.

### 3.2 Data Collection Methods

Data were gathered using three complementary methods:

#### 1. Semi-structured Interviews:

Interviews were conducted with all eight lecturers and two administrators. Questions explored experiences with Socratic Circles, strategies used for facilitation, observed student engagement, and challenges encountered. Interviews were audio-recorded and transcribed verbatim for analysis (Braun & Clarke, 2021).

#### 2. Classroom Observations:

Six Socratic Circle sessions were observed. Observations focused on student participation, questioning patterns, argumentation, peer interaction, and lecturer facilitation strategies. Detailed field notes documented student engagement and discourse quality.

### 3. Document Analysis:

Lesson plans, assessment rubrics, and teaching guides were examined to assess alignment with Socratic Circle implementation and critical thinking objectives. Documents were analysed for inclusion of discussion prompts, assessment criteria, and evidence of learner-centred pedagogy.

#### 3.3 Data Analysis

Data were analysed using thematic analysis as outlined by Braun and Clarke (2021). The process involved:

Familiarisation with data through repeated reading of transcripts, observation notes, and documents

Initial coding of meaningful units of text

Development of themes based on patterns across data sources

Triangulation to ensure credibility, by comparing interviews, observations, and documents

Ethical approval was obtained from the relevant institutional review board. Informed consent was secured from all participants, and confidentiality was maintained through pseudonyms and secure data storage.

## 4. LIMITATIONS OF THE STUDY

Several limitations were acknowledged:

1. Contextual limitation: The study focused on a single TTC, which may limit the generalizability of the findings to other colleges or subject areas.
2. Methodological limitation: The study relied primarily on qualitative data, capturing perceptions and experiences rather than quantifiable learning outcomes. This means conclusions about critical thinking improvement are based on observed and reported evidence rather than standardised tests.
3. Temporal limitation: Only six Socratic Circle sessions were observed, which may not fully reflect long-term implementation or sustainability of dialogue-based learning practices.
4. Participant experience: Some students had limited prior exposure to discussion-based learning, which may have influenced engagement and initial performance.

Despite these limitations, the study provides valuable contextual insights into the pedagogical potential of Socratic Circles in Rwandan TTC biology education, offering evidence to inform curriculum planning, lecturer training, and future research.

## 5. FINDINGS

Findings are presented under six major themes: critical thinking development, discussion skills, peer collaboration, lecturer facilitation, curriculum integration, and implementation challenges.

### 5.1 Development of Critical Thinking Skills

Lecturers consistently reported that Socratic Circles significantly enhanced students' ability to analyze and justify biological concepts. For example, in genetics sessions, students were observed debating Mendelian inheritance patterns, explaining why certain traits appeared in offspring, and justifying hypotheses with scientific reasoning. Lecturer comments included:

“Students now justify their answers with examples and evidence, particularly during genetics and physiology discussions” (Lecturer 3).

Observation notes confirmed that students moved beyond memorisation, articulating connections between concepts and reasoning through experimental data. Document analysis of lesson plans indicated that discussion prompts explicitly encouraged evaluation, comparison, and reflection, demonstrating alignment with critical thinking objectives (Facione, 2015; Chin, 2021).

Students also recognised the shift in their learning approaches:

“I used to memorize facts, but now I explain why and how processes occur, and I question my own assumptions” (Student 7).

### 5.2 Enhancement of Discussion and Communication Skills

Socratic Circles fostered confidence and clarity in scientific discussions. Structured roles, such as discussion leader and summariser, ensured equitable participation and prevented domination by a few students. Observations revealed that all students actively contributed when roles rotated, enhancing inclusivity and dialogue quality. Assessment rubrics explicitly measured both reasoning depth and engagement, reinforcing the connection between instruction and competence-based outcomes.

Students reflected on their growth:

“At first, I was shy, but in the circle, I can discuss biology topics without fear and learn from my peers” (Student 12).

These findings align with prior research showing that dialogic instruction improves communication skills and fosters learner autonomy (Mercer & Dawes, 2014).

### 5.3 Peer Collaboration and Knowledge Co-Construction

Students frequently supported one another during problem-solving tasks. Stronger students scaffolded understanding for peers by explaining experimental outcomes, ecological relationships, or physiological processes. Observation notes highlighted active co-construction of knowledge, illustrating Vygotsky’s (1978) principle that social interaction mediates cognitive development.

For example, during an ecology debate on conservation strategies, groups collectively reasoned through ecosystem impacts and justified their positions using evidence from prior field studies. Laboratory guides encouraged reflection and group discussion, reinforcing collaborative reasoning.

### 5.4 Lecturer Facilitation and Scaffolding

Lecturer intervention was critical for maintaining productive dialogue. Rather than providing answers, lecturers posed probing questions to challenge misconceptions, extend reasoning, and encourage evidence-based explanations:

“I guide students with questions rather than giving answers, prompting them to explore and justify ideas” (Lecturer 6).

Observation notes indicated lecturers balanced guidance with autonomy, allowing students to lead discussions while intervening strategically when necessary. This approach aligns with constructivist and sociocultural principles emphasizing facilitation over didactic instruction (Piaget, 1952; Vygotsky, 1978).

### 5.5 Curriculum Integration

Document analysis revealed explicit alignment between Socratic Circle activities and CBC objectives. Examples include:

Genetics: Hypothetical cross-breeding exercises requiring justification of predicted outcomes

Ecology: Debates on conservation strategies and human impacts on ecosystems

Physiology: Case-based reasoning on organ function and homeostasis

Assessment rubrics evaluated argument construction, clarity of reasoning, and collaborative engagement, illustrating integration of learner-centred and competence-based pedagogy.

### 5.6 Implementation Challenges

Despite benefits, several challenges were reported:

1. Class Size: Large groups limited opportunities for each student to speak.
2. Student Readiness: Some students lacked prior exposure to discussion-based learning, leading to initial hesitation.
3. Time Constraints: Discussions were limited to 30–40 minutes per session, sometimes insufficient for in-depth engagement.

Lecturers employed strategies such as rotating discussion roles, pre-discussion preparation, and structured questioning to mitigate these challenges.

## 6. DISCUSSION OF FINDINGS

The findings of this study demonstrate that Socratic Circles effectively enhance critical thinking, discussion, and collaborative skills among third-year Biology TTC students in Rwanda. The triangulation of interview data, classroom observations, and document analysis strengthens the credibility of these results and aligns with prior research on dialogic pedagogy in science education (Chin, 2021; Mercer & Dawes, 2014).

### 6.1 Critical Thinking and Argumentation

Socratic Circles promoted higher-order cognitive skills, including analysis, evaluation, and justification of biological concepts. Students consistently moved beyond memorisation, engaging in reasoning that reflected scientific literacy and evidence-based thinking. These findings are consistent with Facione's (2015) conceptualisation of critical thinking and prior studies in science classrooms demonstrating that structured dialogue improves analytical reasoning (Zohar & Dori, 2019).

By engaging in structured debates and evidence-based discussions, students learned to articulate reasoning clearly and defend claims. The development of these skills is particularly important for pre-service teachers, who must model critical thinking in their future classrooms. This supports research suggesting that teacher education should provide opportunities for experiential engagement with learner-centred, inquiry-based methods (Nsengiyumva & Ndiokubwayo, 2021).

### 6.2 Discussion and Communication Skills

Socratic Circles improved students' confidence in speaking and presenting arguments. Observation data indicated that structured discussion roles and clear facilitation protocols ensured equitable participation, preventing dominance by more outspoken students. Students' reflections suggest that repeated exposure to dialogue-based instruction fosters comfort, self-efficacy, and autonomy in communicating scientific ideas (Mercer & Dawes, 2014).

Moreover, the integration of discussion into assessment criteria reinforced the importance of communication skills as part of the learning process. This aligns with CBC objectives emphasising holistic development, including reasoning, reflection, and collaborative skills (REB, 2019).

### 6.3 Peer Collaboration and Social Learning

Peer interaction emerged as a crucial factor in learning. Students co-constructed knowledge by sharing reasoning, asking questions, and clarifying misunderstandings. These interactions reflect Vygotsky's sociocultural theory, where cognitive development is mediated by social collaboration and scaffolding (Vygotsky, 1978). Observed collaborative problem-solving in ecology and physiology exemplified the co-construction of understanding, illustrating that discussion-based learning strengthens both content mastery and social learning competencies.

### 6.4 Lecturer Facilitation and Scaffolding

The role of the lecturer as a facilitator was critical for sustaining productive dialogue. Effective facilitation involved strategic questioning, monitoring, and selective intervention, supporting students without undermining autonomy. These practices exemplify constructivist pedagogy, highlighting the lecturer's role in guiding learners while allowing them to actively construct knowledge (Piaget, 1952; Paul & Elder, 2020).

Lecturers' ability to scaffold learning enabled students to navigate complex biological concepts, justifying their reasoning and building confidence in discussion. This finding confirms prior research on the importance of lecturer competence in implementing dialogic pedagogy successfully (Chin, 2021).

### 6.5 Curriculum Alignment and Pedagogical Implications

Document analysis demonstrated that Socratic Circle activities were aligned with CBC learning objectives, integrating content mastery with critical thinking and collaborative learning. Examples included cross-breeding scenarios in genetics, conservation debates in ecology, and case-based reasoning in physiology. Assessment tools explicitly measured argumentation, reasoning clarity, and peer engagement, reinforcing the competence-based approach.

These findings indicate that Socratic Circles not only enhance individual cognitive skills but also prepare pre-service teachers to implement learner-centred, discussion-oriented pedagogy in their future classrooms. By experiencing dialogic methods firsthand, students are more likely to adopt similar strategies in their professional practice, promoting active and reflective science education.

## 6.6 Challenges and Mitigation

Despite the benefits, implementation challenges were evident. Large class sizes limited participation, and time constraints sometimes curtailed depth of discussion. Some students initially struggled with discussion-based learning due to prior exposure to teacher-centred methods. Lecturers mitigated these issues through role rotation, pre-discussion preparation, and structured questioning, ensuring maximum engagement and productive dialogue.

Overall, findings support the pedagogical value of Socratic Circles while highlighting the need for institutional support, professional development, and systematic scheduling to overcome practical constraints.

## 7. RECOMMENDATIONS AND CONCLUSION

### 7.1 Recommendations

#### 1. Lecturer Training:

Provide targeted professional development for biology lecturers on Socratic facilitation, discussion management, and scaffolding strategies to ensure effective implementation.

#### 2. Curriculum Integration:

Systematically incorporate Socratic Circles into both theory and laboratory lessons, ensuring alignment with CBC objectives and learning outcomes.

#### 3. Time Allocation:

Allocate sufficient instructional time for discussion, reflection, and argumentation, particularly in complex topics such as genetics, ecology, and physiology.

#### 4. Equitable Participation:

Implement strategies such as role rotation, preparatory questions, and peer facilitation to promote equitable participation, especially in large classes.

#### 5. Assessment Tools:

Develop and employ assessment instruments that explicitly evaluate reasoning, argumentation quality, and peer collaboration, reinforcing dialogue as a core competency.

#### 6. Further Research:

Conduct longitudinal studies to assess the long-term impact of Socratic Circles on pre-service teachers' classroom practices and student learning outcomes.

### 7.2 Conclusion

Socratic Circles are an effective pedagogical strategy for enhancing critical thinking, discussion skills, and collaborative learning among third-year Biology TTC students in Rwanda. By engaging students in structured, peer-led dialogue, this approach develops higher-order cognitive skills and prepares pre-service teachers to model learner-centred pedagogy in their future classrooms. Lecturer facilitation and peer scaffolding emerged as critical enablers of meaningful learning, while challenges such as large class sizes and limited experience with dialogic methods can be mitigated through careful planning and training. Alignment with CBC principles underscores the relevance of Socratic Circles as a transformative instructional approach in Rwandan teacher education. Integrating such strategies consistently into TTC biology courses holds promise for fostering reflective, competent, and discussion-oriented educators capable of sustaining learner-centred science classrooms.

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