

Instructional and learning needs in evolution education: a multi-stakeholder needs assessment

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ABSTRACT

Evolution is a foundational concept in biology, yet it remains challenging for learners and teachers alike. This study conducted a descriptive convergent mixed-methods needs assessment to examine instructional and learning needs in evolution education from the perspectives of students, teachers, and administrators. A total of 50 participants (35 students, 10 teachers, and 5 administrators) from a public senior high school completed researcher-developed questionnaires containing Likert-scale and open-ended items. Quantitative data were analyzed using descriptive statistics, while qualitative responses underwent thematic analysis, with integration occurring at interpretation. Findings indicate that students possess moderate conceptual understanding but struggle with abstract processes such as natural selection, long-term species change, and evidence interpretation, alongside gaps in science process skills. Teachers report difficulties addressing misconceptions, integrating inquiry-based practices, and accessing contextualized instructional materials. Administrators emphasize the need for laboratory resources, curriculum-aligned materials, and sustained professional development. Overall, results highlight that strengthening evolution education requires coordinated strategies that integrate structured science process skills, targeted teacher training, and institutional support systems. The study provides a multi-stakeholder framework to guide evidence-based instructional and systemic improvement in evolution education.

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1. INTRODUCTION

Evolution education plays a central role in contemporary science education because it provides the conceptual framework that unifies biological knowledge and supports scientific literacy. As societies confront complex challenges related to health, environmental sustainability, and biodiversity loss, understanding evolutionary principles becomes increasingly important. Evolution enables students to explain mechanisms of life and the interconnectedness of organisms, offering a scientific basis for interpreting conservation, adaptation, and ecological change [1]–[3]. Beyond content mastery, learning evolution cultivates essential competencies such as inquiry, reasoning, and evidence-based analysis—skills necessary for informed participation in modern society [4]. Research also shows that linking evolution to real-world issues, including climate change and public health, enhances student engagement and relevance [5], [6].

Thus, evolution education is not only about biological change over time but also about developing reflective learners capable of applying scientific reasoning to societal concerns [7]–[10].

In the Philippine context, strengthening evolution education aligns with ongoing curriculum reforms, particularly the MATATAG curriculum, which emphasizes conceptual understanding, higher-order thinking skills, and the integration of science process skills. These reforms call for coherent instructional strategies, contextualized materials, and systematic skill development. However, despite policy emphasis on scientific literacy and inquiry-based learning, evolution remains one of the most challenging topics in school science. Students frequently struggle with abstract processes such as natural selection, genetic variation, and long-term biological change. Misconceptions persist regarding evolutionary mechanisms and the interpretation of scientific evidence [11]. Cognitive barriers are further compounded by tensions between scientific explanations and personal or cultural beliefs, which may influence engagement and acceptance.

Instructional challenges also extend to teachers. Many report difficulty correcting misconceptions, facilitating respectful dialogue, and integrating science process skills into evolution lessons [12]–[14]. Institutional factors—including access to laboratory resources, contextualized materials, and sustained professional development—also shape instructional quality [15]. While previous studies have examined student misconceptions, teacher preparedness, or instructional strategies independently, these investigations often focus on a single stakeholder group. Few studies have integrated student, teacher, and administrator perspectives within a unified needs assessment framework. Moreover, limited empirical research explicitly connects these multi-level perspectives to coordinated instructional improvement and systematic development of science process skills in evolution education.

This gap highlights the need for a comprehensive, multi-stakeholder needs assessment that examines conceptual, pedagogical, and institutional dimensions simultaneously. Addressing evolution education through an integrated lens is particularly relevant in the context of curriculum reform, where alignment among classroom practice, teacher capacity, and school-level support is essential. The present study responds to this need by synthesizing quantitative and qualitative evidence from students, teachers, and administrators to generate a systemic understanding of instructional and learning needs. By linking stakeholder perspectives with actionable domains—conceptual understanding, science process skills, instructional practices, and institutional support—this research provides a coordinated framework for evidence-informed instructional and professional development planning.

Accordingly, this study is guided by several interrelated research questions that frame the multi-stakeholder needs assessment. First, it seeks to determine the students' learning needs in evolution education, particularly in terms of conceptual understanding, learning challenges, instructional preferences, and science process skills. Second, the study examines the instructional needs identified by teachers, with specific attention to teaching challenges, resource requirements, professional development needs, and the integration of science process skills into evolution lessons. Third, it explores the institutional and instructional support needs perceived by school administrators as necessary to strengthen evolution education within the school context. Finally, the study analyzes the common and unique needs that emerge across students, teachers, and administrators, and considers how these findings can inform coordinated, evidence-based improvements in evolution education. By addressing these questions, the research clarifies the interconnected challenges of evolution instruction and provides practical directions aligned with curriculum reform priorities and broader scientific literacy goals.

2. METHOD

2.1. Research design

This study employed a descriptive convergent mixed-methods needs assessment design to examine instructional and learning needs in evolution education from the perspectives of students, teachers, and administrators. Quantitative and qualitative data were collected concurrently during the same phase and analyzed independently. The quantitative component used descriptive statistics (mean scores and domain summaries) to determine the level of perceived needs across predefined categories. The qualitative component applied thematic analysis to open-ended responses to identify recurring patterns and contextual explanations. Integration occurred after separate analyses were completed. Quantitative results and qualitative themes were organized by stakeholder group and directly compared through side-by-side interpretation. Convergent findings were identified where statistical trends aligned with thematic patterns, while qualitative data were used to explain or expand numerical results. This systematic comparison produced integrated conclusions regarding instructional, pedagogical, and institutional needs in evolution education.

2.2. Participants and setting

The study was conducted in a public senior high school that offers Earth and Life Science (ELS), a subject in which evolution is a central component of the curriculum. This setting was selected because evolution is explicitly taught as part of the core competencies required in senior high school science. Conducting the research in this context ensured that participants had direct exposure to evolution instruction and related learning experiences. As a result, the site provided an appropriate environment for examining instructional and learning needs in evolution education. Participants were selected through purposive sampling based on their direct involvement in the teaching and learning of evolution-related topics. This sampling strategy ensured that only individuals with relevant experiences and responsibilities in ELS were included in the study. By intentionally choosing participants who were actively engaged in evolution instruction or supervision, the study strengthened the relevance and credibility of the data collected. The approach also supported the goal of obtaining informed and experience-based perspectives across stakeholder groups. A total of 50 participants took part in the study, representing three key stakeholder groups within the school community. The sample included 35 grade 12 students who had either completed or were currently enrolled in ELS, 10 science teachers responsible for teaching ELS or related life science subjects, and 5 school administrators, including the principal, department heads, and academic coordinators. Including these three groups allowed the research to capture perspectives from learners, instructional implementers, and institutional decision-makers. This multi-level representation enhanced the comprehensiveness of the needs assessment and provided a more holistic understanding of instructional and institutional challenges in evolution education.

2.3. Instruments

Table 1 presents a summary of the research instruments, including the specific questionnaires administered to students, teachers, and administrators. It outlines the key domains measured by each instrument, such as conceptual understanding, instructional challenges, professional development needs, and science process skills integration. The table also describes the validation procedures undertaken to ensure content relevance, clarity, and reliability, including expert review, revision, and pilot testing. This structured overview demonstrates the systematic development and validation of the instruments used in the research.

Table 1. Summary of research instruments and validation

Instrument	Key domains measured	Validation steps
Student needs assessment questionnaire	Conceptual understanding; learning challenges; instructional preferences; science process skills needs	Expert review for clarity, relevance, and curriculum alignment; revision based on feedback; pilot testing for reliability and item refinement
Teacher needs Assessment questionnaire	Teaching challenges; instructional practices and resource needs; professional development needs; science process skills integration	Expert content validation; revision following recommendations; pilot testing to ensure clarity and internal consistency
Administrator needs assessment questionnaire	School-level challenges; instructional and resource needs; institutional support for science process skills development	Expert review for institutional relevance; instrument refinement; pilot testing with non-participating respondents

2.4. Data collection procedure

Approval to conduct the study was obtained from the school administration before data collection. Participants were informed about the purpose of the study, and informed consent was secured. Participation was voluntary. The questionnaires were administered in person during scheduled sessions. Respondents completed both Likert-scale and open-ended items within the same instrument. Completed questionnaires were collected immediately after administration to ensure a high response rate and minimize data loss.

2.5. Data analysis

2.5.1. Quantitative analysis

Quantitative data were analyzed using descriptive statistics, specifically mean scores, to determine the level of perceived needs for each item and domain. The computed mean values were interpreted using a predefined scale to classify the degree of need, ranging from very low need to very high need, as seen in Table 2. The results were then organized according to the major domains reflected in the research instruments, including knowledge and learning needs, instructional challenges, instructional support needs, and science process skills needs. Organizing the findings in this manner facilitated clarity in presentation and allowed for structured interpretation of patterns within each category. This analytical approach enabled systematic comparison of perceived needs across students, teachers, and administrators, thereby supporting cross-stakeholder analysis.

Table 2. Mean values scale

Mean range	Interpretation
4.21–5.00	Very high need
3.41–4.20	High need
2.61–3.40	Moderate need
1.81–2.60	Low need
1.00–1.80	Very low need

2.5.2. Qualitative analysis

Responses to the open-ended questions were analyzed using thematic analysis to identify recurring patterns and meaningful insights. The analysis began with familiarization through repeated reading of the responses to gain a comprehensive understanding of the data. This was followed by the initial coding of significant statements, after which related codes were grouped into broader themes. The themes were then reviewed and refined to ensure coherence, clarity, and accurate representation of participants' perspectives. Themes were generated separately for students, teachers, and administrators before being compared across groups to identify both common and unique needs. This cross-group comparison enhanced the interpretive depth of the findings and supported a more comprehensive multi-stakeholder analysis.

2.6. Ethical considerations

The study was conducted in accordance with ethical standards for educational research. Prior to data collection, institutional approval was obtained from the school administration to ensure compliance with school policies and research guidelines. Participants were fully informed about the purpose, procedures, and voluntary nature of the study. Written informed consent was secured from teachers and administrators. For student participants, informed consent and assent procedures were implemented in accordance with institutional and school regulations. Participants were assured that their involvement was voluntary and that they could withdraw at any time without consequence. Confidentiality and anonymity were strictly maintained; no identifying information was included in the analysis or reporting of findings. All data were used solely for research purposes and were securely stored, accessible only to the researchers.

3. RESULTS AND DISCUSSION

Table 3 presents students' perceived needs in learning evolutionary biology across conceptual understanding, learning challenges, instructional preferences, and science process skills. Overall, students report moderate to high understanding of basic concepts and real-world examples. However, moderate ratings in explaining long-term species change and confidently answering evolution-related questions indicate limited explanatory depth. This pattern reflects prior findings describing surface-level recognition without fully integrated conceptual coherence [16]–[19]. Learning difficulties are most evident in abstract processes such as natural selection and in interpreting evolutionary evidence, which require reasoning across deep time and probabilistic mechanisms—well-documented cognitive barriers in evolution education [16], [20]. Confusion with technical terminology further supports research indicating that scientific language can hinder conceptual clarity without appropriate visual or contextual scaffolding [20]. Despite these challenges, belief-related discomfort is relatively low, and students' value respectful and inclusive instruction, consistent with calls for culturally responsive evolution teaching. Students express very high preferences for interactive activities, visual tools, real-life examples, and clearer explanations. These preferences align with evidence that learner-centered and visually enriched approaches enhance understanding in complex scientific domains [20], [21]. Additionally, high science process skills-related needs—particularly in data interpretation, hypothesis formation, and investigative design—highlight the importance of structured inquiry and data-driven tasks, which are essential for evaluating evolutionary evidence and constructing scientific explanations [21], [22]. Strengthening science process skills integration may therefore support deeper conceptual understanding and evidence-based reasoning.

Table 4 summarizes teachers' perceived instructional needs in teaching evolution. Teachers report very high challenges in helping students understand abstract concepts such as natural selection and speciation. This aligns with prior research identifying the probabilistic and abstract nature of evolutionary mechanisms as persistent barriers to student comprehension [23], [24]. Teachers also acknowledge the influence of students' personal or cultural beliefs and note that evolution topics require additional instructional time and pedagogical sensitivity to address misconceptions effectively [24], [25]. These findings highlight the intersection of cognitive complexity and socio-cultural factors in evolution instruction. Teachers further identify a lack of contextualized and ready-to-use instructional materials as a major constraint, consistent with research pointing to limited localized and adaptable resources in evolution education [26]. In response, they strongly favor integrative and inquiry-based approaches, emphasizing visual representations

and hands-on activities. Such strategies are supported by evidence demonstrating the effectiveness of active and multimodal learning in complex biological domains [27], [28]. Professional development emerges as a critical need, particularly in facilitating evidence-based discussions and systematically integrating science process skills into lessons. Research indicates that targeted training can strengthen teacher confidence and instructional effectiveness in addressing misconceptions and guiding inquiry [29]. Teachers also perceive student weaknesses in data interpretation, hypothesis formulation, and investigative design—skills essential for evaluating evolutionary evidence [30], [31]. Although these findings reflect teacher perceptions, they underscore the importance of structured inquiry and data-analysis tasks in strengthening conceptual understanding and scientific reasoning.

Table 3. Students' needs assessment in learning evolutionary biology

	Criteria	Mean	Description
Knowledge and understanding of evolutionary biology	I understand the basic concepts of evolution	4.06	High
	I find evolution topics difficult to understand (R)	2.83	Moderate
	I can explain how species change over long periods	3.17	Moderate
	I can identify examples of evolution in the natural world	3.60	High
Learning challenges in evolution (ELS)	I feel confident answering questions related to evolution	3.34	Moderate
	I struggle to understand natural selection, adaptation, and speciation	2.74	Moderate
	I find it difficult to connect evolution topics to prior learning	2.43	Low
	I am confused by many scientific terms used in evolution lessons	3.29	Moderate
	My personal, cultural, or religious beliefs influence my understanding of evolution	2.97	Moderate
	I find it hard to analyze evolutionary evidence	2.74	Moderate
	I sometimes feel discomfort discussing evolution	1.91	Low
Learning preferences and instructional needs	I feel more confident learning evolution when teachers respect diversity	3.94	High
	I learn evolution better through hands-on activities	4.06	High
	I prefer visual tools (videos, animations, diagrams, models)	4.31	Very high
	I want more interactive activities to help me understand evolution	4.37	Very high
	I understand evolution better when lessons include real-life examples	4.49	Very high
Science process skills needs	I need clearer explanations of difficult evolution topics	4.46	Very high
	I learn better when teachers explain evolution scientifically while respecting beliefs	4.51	Very high
	I need more practice in observing natural phenomena	3.83	High
	I want to improve my skill in interpreting graphs, charts, and evidence	4.29	Very high
	I need help forming hypotheses or predictions	4.03	High
	I find it challenging to plan or conduct investigations	3.66	High
	I want more opportunities to practice science process skills	4.20	High

Table 4. Teachers' needs assessment in teaching evolution

	Criteria	Mean	Description
Challenges in teaching evolution (ELS)	Students struggle with abstract concepts like natural selection and speciation	4.30	Very high
	Students' cultural or personal beliefs influence acceptance of evolution	4.10	High
	Evolution topics require more time to teach	3.90	High
	It is challenging to correct students' misconceptions about evolution	3.50	High
	There is a lack of contextualized teaching materials for evolution	3.90	High
Instructional practices and needs	I prefer integrative and inquiry-based strategies in teaching evolution	4.70	Very high
	I need ready-made activities aligned with science process skills and ELS competencies	4.40	Very high
	I need more training on facilitating evidence-based discussions	4.40	Very high
	Visual and hands-on activities help students understand evolution	4.50	Very high
Science process skills needs	I need clearer guidelines on integrating science process skills in evolution lessons	4.40	Very high
	Students need improvement in observing and describing phenomena	4.60	Very high
	Students have difficulty interpreting data, graphs, and evidence	4.30	Very high
	Students struggle to formulate hypotheses or predictions	4.20	High
	Students need more opportunities to conduct investigations	4.80	Very high
	Integrating science process skills in evolution lessons will improve learning outcomes	4.60	Very high

Table 5 presents administrators' perceptions of institutional and instructional needs in evolution education. Nearly all indicators are rated at a very high level, indicating strong demand for systemic support. Administrators recognize that both teachers and students struggle with evolution concepts and affirm that evolution remains one of the most challenging areas in the science curriculum, consistent with studies documenting systemic barriers to effective evolution instruction [32], [33]. A major priority identified is the expansion of instructional resources, particularly contextualized materials aligned with curriculum standards and research-based teaching tools [34], [35]. Administrators also emphasize limited professional development opportunities, highlighting the need for sustained training that strengthens evolution content

knowledge and the integration of science process skills [36], [37]. This aligns with evidence that institutional commitment to teacher learning significantly influences instructional quality in complex scientific domains. In addition, administrators stress the importance of improved laboratory facilities and hands-on learning resources to support inquiry-based instruction [38]. They advocate for structured, school-wide instructional programs and stronger collaboration among teachers, experts, and school leaders. Overall, administrators frame evolution education as a system-level responsibility requiring coordinated resource allocation, professional learning, and instructional leadership [39], [40]. These findings suggest that sustained improvement depends on institutional structures that actively support teachers and promote collaborative professional cultures.

Table 5. Administrators' needs assessment on school support for teaching evolution

	Criteria	Mean	Description
School-level challenges in teaching evolution	Teachers need more resources and materials for teaching evolution	4.60	Very high
	There are limited training opportunities for teachers on evolution	4.60	Very high
	Students struggle with evolution concepts based on school assessments	4.60	Very high
	Additional instructional support is needed to strengthen science process skills	5.00	Very high
Instructional and institutional needs	Evolution is one of the most challenging topics for teachers and students	4.20	High
	The school needs contextualized instructional materials aligned with MATATAG	4.60	Very high
	Integrative science process skills-based activities will improve ELS instruction	5.00	Very high
	Teachers will benefit from research-based evolution materials	4.60	Very high
	The school needs more laboratory or hands-on resources	5.00	Very high
	Collaboration among teachers, experts, and administrators is needed	5.00	Very high

Table 6 synthesizes the shared priority needs identified by students, teachers, and administrators, revealing both strengths and areas requiring improvement in evolution education. A central strength across stakeholders is the clear recognition of the value of visual and interactive instructional materials. Students demonstrate strong motivation toward multimedia and engaging tasks, teachers affirm the effectiveness of hands-on and visual strategies in enhancing conceptual understanding, and administrators support the provision of updated instructional resources [41], [42]. This alignment reflects an existing foundation for implementing multimodal and experiential approaches to address the abstract and cognitively demanding nature of evolutionary concepts. At the same time, the expressed need for improved and expanded materials indicates that current resources may be insufficient or inconsistently implemented. Similarly, there is broad agreement on the importance of strengthening science process skills. While stakeholders recognize science process skills as essential for meaningful evolution learning, students report difficulties in data interpretation and investigation, teachers observe weaknesses in analyzing evidence and hypothesis formulation, and administrators identify science process skills development as an institutional priority [43], [44]. This suggests both awareness of science process skills significance and persistent gaps in systematic integration. Effective evolution instruction, therefore, requires not only conceptual clarity but also structured opportunities for inquiry and evidence-based reasoning.

Contextualized and real-life learning emerges as another shared priority. Students seek relatable examples; teachers acknowledge the scarcity of localized materials, and administrators advocate for curriculum-aligned resources that connect evolution to familiar contexts [45], [46]. These responses indicate a strong collective understanding of contextualization as a pedagogical strength, yet they also reveal limitations in the availability of appropriate materials. Furthermore, stakeholders consistently emphasize the importance of teacher support and sustained professional development. Teachers show openness to improving pedagogy and addressing misconceptions, and administrators recognize the need for continued training—an emphasis supported by literature on content-focused professional learning in complex science domains [47], [48]. Finally, respectful and inclusive teaching approaches are widely valued. Students appreciate culturally responsive dialogue, teachers acknowledge belief-related sensitivities, and administrators recognize the need for careful instructional leadership [49], [50]. This shared awareness reflects a positive disposition toward inclusive practice, though it also signals the need for clearer guidelines and structured support. Overall, the convergence of perspectives demonstrates existing strengths in stakeholder commitment and awareness, alongside persistent instructional and institutional gaps. Meaningful improvement in evolution education therefore requires coordinated, multi-level efforts integrating resource development, systematic skill-building and inclusive pedagogical practices [51], [52].

Table 6. Synthesis of common needs across stakeholders in evolution education

Category of need	Students	Teachers	Administrators	Implications for improvement
Visual and interactive instructional materials	Strong preference for videos, animations, diagrams, and interactive tasks	Report that visual and hands-on strategies improve understanding	Emphasize need for updated instructional and visual resources	Develop multimedia-rich, visually supported evolution modules and interactive learning materials
Science process skills development	Need support in data interpretation, hypothesis formation, and investigations	Identify weak science process skills and request structured integration	Prioritize science process skills strengthening at the institutional level	Embed structured inquiry tasks, data analysis activities, and investigation-based lessons in evolution instruction
Contextualized and real-life learning	Prefer relatable and real-world examples	Report limited localized teaching materials	Call for curriculum-aligned, contextualized resources	Design context-based materials linking evolution to local and familiar examples
Teacher support and professional development	Need clearer explanations and structured guidance	Request training on evolution content, pedagogy, and misconception handling	Recognize limited training opportunities	Provide targeted professional development on evolution pedagogy and science process skills integration
Respectful and inclusive teaching approaches	Value respectful discussion of diverse beliefs	Observe belief-related influences on learning	Acknowledge sensitivity of evolution topics	Establish guidelines and training for culturally responsive and inclusive instruction

Table 7 presents stakeholder-specific strengths and challenges in evolution education, indicating that while shared priorities exist, each group requires differentiated support. Students demonstrate interest in collaborative and hands-on learning and show openness to active engagement. However, they continue to struggle with abstract and long-term evolutionary processes. These patterns suggest the need for scaffolded explanations, visual models, and simulations that make invisible mechanisms more cognitively accessible [53], [54]. Such supports can help move learners from basic recognition toward deeper conceptual understanding. Teachers exhibit strong awareness of instructional gaps and a willingness to strengthen their practice. At the same time, they report difficulty addressing misconceptions, limited access to ready-made materials, and uncertainty in systematically integrating science process skills. These concerns reflect well-documented challenges associated with teaching conceptually complex and socially sensitive topics, where strong content knowledge must be paired with aligned pedagogical strategies [55]. Structured lesson frameworks and adaptable instructional resources may therefore enhance teacher confidence and instructional effectiveness [56].

At the administrative level, leaders demonstrate commitment to strengthening institutional systems but identify gaps in laboratory resources, coordinated instructional programs, and structured professional collaboration (e.g., learning action cells). These mechanisms are essential for sustaining improvement and ensuring shared instructional vision and expertise among teachers [57], [58]. Overall, Table 7 suggests that meaningful advancement in evolution education requires both leveraging stakeholder strengths—such as student engagement, teacher openness to development, and administrative commitment—and addressing persistent gaps through role-specific interventions. Coordinated strategies that combine scaffolded classroom practices, pedagogical reinforcement, and institutional leadership can foster a more sustainable and system-wide improvement in evolution instruction [59], [60].

Table 7. Unique needs by stakeholder group

Stakeholder	Unique needs identified	Implication
Students	Difficulty understanding abstract and long-term evolutionary processes; preference for collaborative and hands-on learning.	Provide scaffolded explanations, models, simulations, and active learning strategies.
Teachers	Need ready-made instructional materials; difficulty correcting misconceptions; need clearer science process skills integration guidelines.	Develop teacher guides, misconception-focused materials, and structured science process skills lesson frameworks.
Administrators	Need for laboratory resources, institutional instructional programs, and stronger professional collaboration (e.g., LAC).	Strengthen school-level support systems, resource allocation, and professional learning communities.

3.1. Implications for practice and future research

For teachers, the results underscore the need to move beyond lecture-dominated approaches toward structured integration of visual scaffolds, contextualized examples, and deliberate science process skills instruction. Practical steps include embedding data-analysis tasks, guided investigations, and hypothesis-building exercises within evolution lessons; using simulations and models to explain abstract processes; and applying misconception-focused questioning strategies. Teacher professional development programs should prioritize evolution-specific pedagogy, strategies for addressing belief-related sensitivities, and systematic

science process skills integration. For school administrators, the findings highlight the importance of institutional support mechanisms. Actionable measures include allocating funds for laboratory and multimedia resources, developing school-based repositories of contextualized evolution materials, and strengthening professional learning communities such as learning action cells (LACs) focused on inquiry-based science teaching. Structured mentoring and collaborative lesson study can further support consistent implementation. For policymakers and curriculum planners, the study reinforces the need to align evolution instruction with national reform priorities, such as the MATATAG curriculum's emphasis on conceptual understanding and higher-order thinking. Policy-level actions may include developing standardized science process skills-integrated evolution modules, funding sustained teacher training programs, and embedding evolution-specific assessment frameworks that measure both conceptual understanding and scientific reasoning.

Future research should extend this work through longitudinal studies that examine how sustained integration of science process skills influences students' conceptual understanding, acceptance of evolution, and scientific reasoning over time. Cross-school and multi-site comparative studies are also recommended to determine whether identified instructional and institutional needs are consistent across diverse educational contexts. In addition, experimental and quasi-experimental designs should be employed to test the effectiveness of science process skills-integrated evolution modules, targeted professional development programs, and school-level support interventions. Such designs would allow for stronger causal inferences regarding the impact of structured instructional and institutional reforms. By validating these findings across varied settings and research designs, future studies can translate identified needs into evidence-based strategies that support sustained, system-wide improvement in evolution education.

3.2. Limitations of the study

Several limitations should be considered when interpreting the findings of this study. First, the research was conducted in a single public senior high school, which limits contextual diversity. Institutional culture, leadership practices, resource availability, and student demographics may differ across schools and regions. As such, the findings should be interpreted as context-specific rather than broadly generalizable. Second, the sample size was relatively small ($n=50$), particularly within the teacher and administrator groups. While sufficient for a descriptive needs assessment, the limited number of participants may restrict statistical robustness and the transferability of conclusions to larger populations. Third, the study employed a descriptive convergent mixed-methods design. Although this approach allows for comprehensive stakeholder perspectives, it does not establish causal relationships or measure the effectiveness of specific interventions. The results therefore identify perceived needs rather than experimentally validated solutions. Despite these limitations, the inclusion of multiple stakeholder groups strengthens the exploratory value of the findings. Future research should involve larger, multi-site samples, incorporate longitudinal or experimental designs, and examine the impact of targeted instructional and institutional interventions on student outcomes.

4. CONCLUSION

This study examined instructional and learning needs in evolution education from the perspectives of students, teachers, and school administrators. Findings indicate that challenges in evolution instruction are interconnected across classroom, teacher, and institutional levels. Students demonstrate moderate conceptual understanding but struggle with abstract evolutionary processes and evidence interpretation. Teachers report difficulties addressing misconceptions, integrating science process skills, and accessing contextualized instructional materials. Administrators emphasize the need for sustained professional development, improved laboratory and multimedia resources, and curriculum-aligned instructional support.

Collectively, these findings highlight the necessity of coordinated, multi-level reform. For curriculum developers and policymakers, the results support embedding science process skills-integrated and context-based evolution modules within national frameworks such as the MATATAG curriculum. For teacher education and training institutions, the study underscores the importance of targeted professional development focused on evolution pedagogy, inquiry facilitation, and inclusive dialogue. For school leaders, the findings emphasize strengthening institutional systems through resource allocation, collaborative professional structures, and sustained instructional support. By aligning curriculum design, teacher capacity-building and institutional leadership, education systems can foster more coherent, inquiry-driven, and evidence-based evolution instruction.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing -Original Draft

E : Writing - Review &Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [VAM], upon reasonable request.

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