Journal of
Education and Practice
(JEP)

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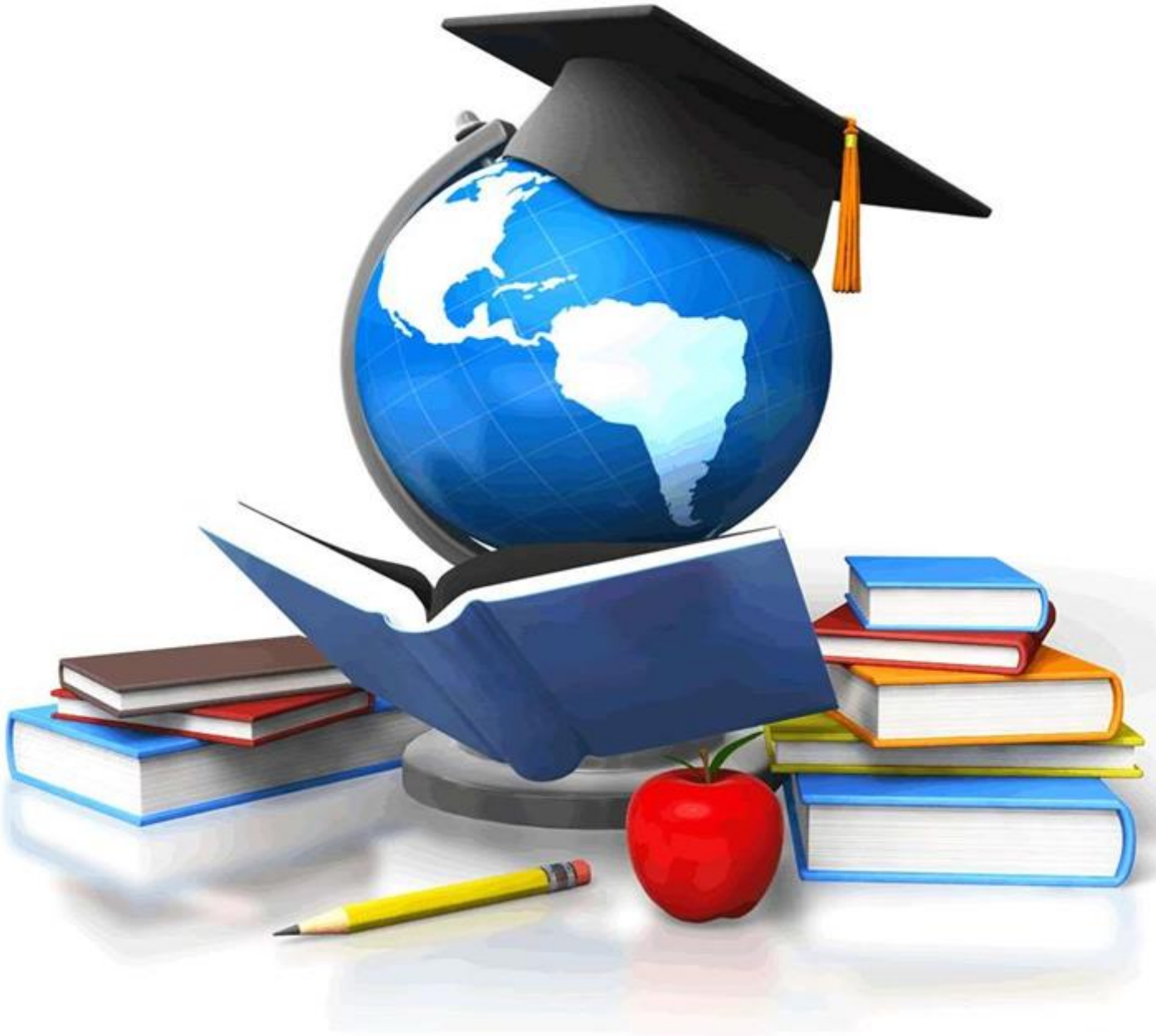

CARI Journals

Journal of Education and Practice
ISSN 2520-467X (Online)
Vol.9, Issue No.2, pp. 1 – 17, 2025
www.carijournals.org

An Examination of Cameroonian Preservice Biology Teachers' Conceptualisation of Living Organisms from philosophical and Epistemological Perspectives

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Accepted: 2nd Feb 2025 Received in Revised Form: 2nd Mar 2025 Published: 2nd Apr 2025

Abstract

Purpose: This study investigates the conceptualisation of living organisms among 53 preservice biology teachers at the Higher Teacher Training College in Yaoundé, Cameroon.

Methodology: Drawing from historical and contemporary paradigms, such as animism, vitalism, finalism, determinism, evolutionism, and interactionism, the research seeks to identify dominant conceptions and epistemological obstacles. A cross-sectional descriptive survey design was used on a convenient sample of 53 student teachers.

Findings: Results revealed that 83% of respondents had scientifically correct interactionist conception of living organisms. However, the study nobserved the coexistence of historical and modern paradigms, with persistent epistemological obstacles such as finalism (69.8%) and animism (46.5%) affecting their understanding. One way ANOVA showed no statistically significant differences in the conceptualisation of living organisms based on sex and academic levels. Additionally, bivariate correlation revealed mixed conceptions, as the dominant interactionist view had a statistically significant, strong, and positive correlation with other historical and contemporary conceptions.

Unique Contribution to Theory, Policy and Practice: The study contributes to theory by highlighting epistemological obstacles in preservice biology teachers' understanding of living organisms and reinforces the role of the Nature of Science (NOS) framework in promoting conceptual change. It informs policy by advocating for curriculum reforms that incorporates epistemological reflexivity and interdisciplinary approaches in teacher education. In practice, it emphasizes active learning strategies, explicit NOS instruction, and continuous professional development to improve teachers' conceptual clarity and instructional effectiveness in biology education. The study highlights the need for targeted educational reforms to promote a scientifically accurate and integrative understanding of biological concepts among preservice teachers.

Keywords. *Interactionism; Evolutions; Determinisms, Finalism; Animism; Conceptualisation; Preservice Biology Teachers.*

1. Introduction

The evolution of biological concepts from Aristotle to contemporary discussions, illustrates how philosophical perspectives have both shaped and been shaped by biological discoveries (Grene & Depew, 2004; Méthot, 2023; Viejo & Sanjuán, 2023). The understanding of life and living organisms has evolved over centuries, moving from metaphysical and teleological interpretations to empirically grounded scientific paradigms.

However, historical perspectives such as Aristotelian animism, Galenic finalism, Cartesian mechanism, and Lamarckian transformism continue to influence learners' conceptualizations, often conflicting with modern scientific frameworks like evolutionism and interactionism.

While the conceptions were foundational in their respective eras, many are now considered obsolete. Yet, they persist as obstacles in modern scientific thought, influencing educational practices and learners' comprehension. For instance, animism views life as a vital force distinct from non-living matter, while finalism attribute's purpose to biological functions. Mechanism reduces living organisms to mechanical systems governed by physical laws. Vitalism argues life processes are controlled by spiritual forces in addition to physical and chemical forces. These paradigms historically provided frameworks for understanding life but are misaligned with contemporary insights, such as evolutionary theory and interactionism.

Preservice biology teachers are crucial intermediaries in science education, shaping future generations' understanding of biology. However, research has shown that these educators often retain misconceptions and epistemological obstacles that hinder their ability to effectively teach contemporary scientific concepts. Studies by Simard et al., (2014) and Thouin, (1998) have highlighted the persistent misconceptions, such as finalism and animism, which act as epistemological obstacles, preventing learners from adopting contemporary scientific perspectives such as interactionism. Ngwana, (2002) further suggests that challenges such as culturally embedded beliefs, along with resource limitations and traditional teaching methods, complicate the integration of modern biological concepts in teacher training in Cameroon. This has motivated the investigation of preservice biology teachers' conceptualisation of living organisms within the unique multi-sociocultural and educational context of the Higher Teacher Training College in Yaoundé, Cameroon, where limited studies have been conducted.

This study aims to fill this gap by examining the dominant conceptions of living organisms among preservice biology teachers, identifying persistent epistemological obstacles, and assessing the influence of their academic training on their understanding.

2. Literature Review

2.1. Historical Paradigms

Aristotle's work "*De Anima"* (On the soul), gave birth to Animism - the belief that living organisms possess an intrinsic vital force, often attributed to a "soul." According to Dupouey

(2005) and Lennox (2001), this view established early distinctions between living and non-living matter and emphasised the importance of empirical observation and scientific inquiry in classifying living things. However, animism hinders the acceptance of concepts like natural selection and the role of genes and environmental factors, as these require an understanding of life through mechanisms rather than metaphysical forces.

Galen's work *The Usefulness of the Parts of the Body* argued that every feature of every part of the body has a specific function, reflecting a teleological perspective that aligns with the idea of nature's purposeful design. It lead to finalism - the teleological perspective that biological functions exist to fulfil specific purposes, often linked to divine intent (Pichot, 1993).

Mechanism, developed by Descartes holds the reductionist view that living organisms function as mechanical systems governed by physical laws (Riskin, 2016), while Lamarck's theory of transformism posits the inheritance of acquired characteristics as a mechanism for evolutionary change (Bowler, 1989).

2.2. Contemporary Paradigms

Determinism focuses on genes as primary determinants of traits and behaviours, often criticized for oversimplification (Keller, 2000). Genetic determinism posits that biological characteristics and behaviours are predetermined by genetic information (Griffith, 2019). It is grounded in the idea that an organism's traits are dictated by its genetic code, with minimal influence from external factors. This paradigm provides a framework for predicting traits and disorders based on an organism's genetic composition and has driven progress in genomics, biotechnology, and personalized medicine. Morange (2005) and Keller (2000) criticised the gene-centric view that dominated 20th-century biology, arguing determinism oversimplifies the complexity of living systems by attributing traits solely to genetic factors while ignoring environmental influences. Jablonka & Lambs (2005) and Carey (2012) challenge determinism foe excluding plasticity, as it disregards the organism's ability to adapt and evolve through interactions with its environment, thereby undermining the importance of epigenetics and gene-environment interactions.

Evolutionism explains the diversity of life as a product of evolutionary processes, particularly natural selection, genetic drift, mutation, and gene flow (Futuyma, 2013). It views living organisms as interconnected through common ancestry and shaped by adaptive pressures (Coyne, 2009, Darwin, 1859; Futuyma, 2013, and Mayr, 2001).

Evolutionism unifies biology by providing explanations for the diversity of life and its adaptation to different environments. It has gain empirical support from fossil records, comparative anatomy, molecular biology, and genetic studies, all of which consistently validate evolutionary theory. Its principles guide research in fields like conservation biology, epidemiology, and biotechnology. However, Gould (2002), Pigliucci, & Müller (2010) criticise evolutionism for its overemphasis on adaptation, which can lead to the neglect of non-adaptive traits or random processes, such as

genetic drift. Moreover, evolutionism is sometimes misconstrued as a purposeful process, which contradicts its foundational principle of randomness.

Interactionism emphasizes the interplay between genes and environmental factors, integrating insights from epigenetics (Morange, 2005; Noble, 2006). It rejects the dichotomy of "nature versus nurture," focusing instead on their combined influence. Interactionism accounts for the complexity of biological systems by recognizing the bidirectional relationships between genes and environment. This paradigm aligns with discoveries in epigenetics, where environmental factors influence gene expression without altering DNA sequences. However, critics argue that the broad scope of interactionism can make it difficult to delineate specific mechanisms or causal relationships. Interactionism is increasingly seen as a bridge between determinism and evolutionism, offering a more nuanced understanding of biological processes. It is particularly relevant in areas like developmental biology, systems biology, and ecology, where context-dependent interactions are critical (Gilbert & Epel, 2015; Odum & Barrett, 2005).

3. Methodology

A cross-sectional descriptive research design was employed to gain a comprehensive understanding of participants' conceptual frameworks. Fifty-three preservice biology teachers at the Higher Teacher Training College in Yaoundé were purposefully sampled to ensure representation of diverse academic and cultural backgrounds. A structured survey questionnaire, containing items reflecting historical and contemporary paradigms (e.g., animism, vitalism, determinism, evolutionism, and interactionism) was used to collect data after being tested for reliability. The questionnaire was designed such that strong agreement with items in specific sections indicates adherence to the associated conception. The data was coded, and similar Likert Scale items measuring similar construct were summed for analysis. Correlation and group differences were analysed using descriptive and inferential statistics to identify dominant paradigms.

4. Results

4.1. RQ1 - What are the different conception held by preservice Biology Teachers about living organisms?

The Cronbach's Alpha value of 0.891 revealed that the questionnaire was reliable. Of the 53 respondents, 16 were males (30.2%) and 38 were females (69.8%); 15 were in the first year (28.3%), 13 in the third year (24.5%), and 25 in the fifth year (47.2%).

The survey revealed the coexistence of multiple paradigms in how preservice biology teachers conceptualize life, including outdated views that act as epistemological obstacles to contemporary understanding. The seven key conceptual components are shown in table 1.

Table 1. Prevalence of Various Conceptualisation of Living Organisms

Conception	% adherence	Mean	SD
Interactionism (L13-15)	83%	12.2	2.852
Finalism (L7-9)	69.8%	11.13	3.403
Vitalism (L4-6)	62.9%	10.66	2.941
Evolutionism (L10-12)	53.5%	9.98	2.906
Animism (L1-3)	46.8%	9.13	2.929
Hereditary determinism (L16-158)	47.2%	9.36	2.863
Behavioural determinism (L19-21)	55.3%	9.60	2.769

A majority of participants adhere with interactionism (83%), finalism (69.8%), and vitalism (62.9%). There was mixed adherence to evolutionism (53.5%), animism (46.8%), hereditary determinism (47.2%), and behavioural determinism (55.3%).

Many preservice biology teachers demonstrated overlapping and contradictory beliefs, reflecting the complexity of integrating historical and contemporary ideas. For example, while most respondents (83%) embraced interactionism, a significant majority (69.8%) also accepted finalism, a historical obstacle that contradicts the randomness central to natural selection. Similarly, 46.8% of participants adhered to animist-vitalist perspectives, attributing a metaphysical essence to life.

4.1.1. Historical Paradigms of Living Organisms

The high prevalence of historical conception of finalism, animism, and vitalism indicates the presence of epistemological obstacles to understanding current contemporary scientifically correct views of living organism. These paradigms suggest teleological reasoning, a limited understanding of randomness in evolution, and the role of gene-environment interactions.

Table 2a: Historical Paradigms of Living Organisms

Questions	Statement about conceptualisation of living organisms	SD		D		N		A		SA		Percentage	Concept
		F	%	F	%	F	%	F	%	F	%		
1	Living organisms have a unique energy or spirit that distinguishes them from non-living entities.	8	15,1	4	7,5	2	3,8	20	37,7	19	35,8	73,6	
2	Plants and animals can sense human emotions and intentions.	12	22,6	12	22,6	8	15,1	17	32,1	4	7,5	39,6	
3	The behaviour of living organisms is influenced by forces beyond physical or biological explanations.	11	20,8	16	30,2	12	22,6	10	18,9	4	7,5	26,4	**46.5%**
4	Life is governed by a vital force that cannot be explained by biology alone.	9	17,0	16	30,2	3	5,7	15	28,3	10	18,9	47,2	
5	The complexity of living organisms requires more than just chemical and physical explanations.	3	5,7	9	17,0	7	13,2	22	41,5	12	22,6	64,2	
6	Artificial life forms (e.g., robots) will never truly replicate living organisms due to the absence of a life force.	4	7,5	6	11,3	2	3,8	12	22,6	29	54,7	77,4	**62.9%**
7	Each living organism has a predetermined purpose in nature.	5	9,4	6	11,3	5	9,4	18	34,0	19	35,8	69,8	
8	The evolution of species occurs to fulfil specific roles in ecosystems.	6	11,3	6	11,3	2	3,8	25	47,2	14	26,4	73,6	
9	Adaptations in organisms are intentional responses to environmental challenges.	5	9,4	7	13,2	6	11,3	15	28,3	20	37,7	66,0	**69.8%**

While **Animism and Vitalism's** attribute a "vital force" to living beings, contemporary biology views life as a result of physical and chemical processes, without the need for metaphysical

entities. As an obstacle**, finalism** promotes the idea of purpose and intentionality in biological evolution, which contradicts the randomness and non-teleological nature of evolutionary theory. Natural selection explains adaptation as the result of differential survival and reproduction, not as the fulfilment of a purpose. The finalistic view can lead to misconceptions, such as organisms evolving traits "because they need them," which oversimplifies and misrepresents evolutionary processes. These historical paradigms, deeply embedded in cultural and historical contexts, persist as intuitive beliefs, complicating the teaching of contemporary biology and fostering resistance to modern theories.

This study therefore recommends in table 2b below, scientific corrections to the obstacles or misconception amongst respondents after analyses of responses in table 2a above. Advanced coursework in molecular biology in the teacher's training curriculum is necessary to overcome these epistemological obstacles.

Table 2b. Suggested explicit corrections to misconceptions

Q	Common Misconception Identified	Proposed Scientific Corrections
1	*Living organisms have a unique energy or spirit that distinguishes them from non-living entities - (73.6%; animism).*	Science does not support the idea of a unique energy or spirit defining life. Life is characterized by biochemical processes rather than metaphysical attributes.
5	*The complexity of living organisms requires more than just chemical and physical explanations 64.2% vitalism.*	The concept of a "vital force" is outdated. Modern biology explains life through molecular and biochemical mechanisms
6	*Artificial life forms (e.g., robots) will never truly replicate living organisms due to the absence of a life force – (77.4%; vitalism)*	Artificial life lacks the self-sustaining biochemical processes that define living organisms
7	*Each living organism has a predetermined purpose in nature – (69.8%; finalism)*	Evolution operates through random mutations and natural selection, not a predetermined purpose.
8	*The evolution of species occurs to fulfil specific roles in ecosystems - (73.6% finalism).*	Roles in ecosystems are a result of evolutionary processes and ecological interactions, not predefined goals
9	*Adaptations in organisms are intentional responses to environmental challenges- (66.0% finalism).*	Adaptations occur through random genetic variations that improve fitness, not as intentional responses.

4.1.2. Contemporary Paradigms of Living Organisms

Modern conceptions of living organisms are deeply influenced by advances in biology and the natural sciences. Table 3a shows correct scientifically accepted conception for interactionism (83%), evolutionism (53.5%), and Determinism (51%). Capra & Luisi (2014) presented a holistic approach to biology that integrates biological, cognitive, social, and ecological dimensions of life. They emphasized the interconnectedness and interdependence of all living systems and advocated for a shift from a mechanistic to a systemic view of life.

The results for **evolutionism** (Q10 to Q 12) held by 53.5% of respondents align with the philosophical and epistemological perspectives of Monod (1971), who explored the role of chance and necessity in biological processes, arguing that life is the product of random mutations (chance) filtered by natural selection (necessity).

Evolutionism is a comprehensive framework for understanding diversity, focusing on historical and adaptive with modern relevance in fields such as conservation biology.

Table 3a: Contemporary Paradigms of Living Organisms

Questions	Statement about conceptualisation of living organisms	SD		D		N		A		SA		Percentage Adherance	Concept Identified
		F	%	F	%	F	%	F	%	F	%		
10	The diversity of life can be entirely explained through evolutionary processes.	3	5,7	7	13,2	5	9,4	21	39,6	17	32,1	71,7	
11	Natural selection is the primary mechanism behind the development of complex traits.	5	9,4	7	13,2	14	26,4	16	30,2	11	20,8	50,9	
12	Evolutionary theory provides sufficient explanation for all observed biological phenomena.	8	15,1	16	30,2	9	17,0	19	35,8	1	1,9	37,7	53.5% Evolutionism
13	The characteristics of an organism are equally shaped by its genetics and environment.	5	9,4	4	7,5	5	9,4	24	45,3	15	28,3	73,6	
14	The survival of a species depends on its ability to adapt and interact with its environment.	4	7,5	0	0,0	0	0,0	23	43,4	26	49,1	92,5	
15	Life is a product of continuous interaction between physical, chemical, and biological processes.	2	3,8	4	7,5	3	5,7	27	50,9	17	32,1	83,0	83% Interactionism
16	The traits of living organisms are almost entirely dictated by their genetic makeup.	4	7,5	9	17,0	5	9,4	16	30,2	19	35,8	66,0	
17	Environmental factors play a minimal role in the development of an organism.	13	24,5	16	30,2	6	11,3	14	26,4	4	7,5	34,0	
18	The future behaviour of an organism can be accurately predicted based on its genetic code.	8	15,1	11	20,8	12	22,6	15	28,3	7	13,2	41,5	47.2% Hereditary Determinism
19	The behaviour of animals is primarily controlled by their biological instincts.	5	9,4	10	18,9	10	18,9	20	37,7	8	15,1	52,8	
20	Human behaviour is deeply rooted in evolutionary adaptations.	4	7,5	7	13,2	8	15,1	26	49,1	18	34,0	83,0	
21	Free will plays a minimal role in shaping the behaviour of living organisms	10	18,9	12	22,6	15	28,3	11	20,8	5	9,4	30,2	55.3% Behavioural determinism

The **interactionist** view (Q13 to Q 15), held by 83.0% of the respondents, aligns with the views of Gilbert and Epel (2015), who explored how environmental factors influence development, health, and evolution. They emphasized the interplay between ecological contexts and developmental processes in shaping the phenotypes of organisms. Similarly, Canguilhem (2008) explored the philosophical underpinnings of biology, focusing on the normative aspects of life. He argues that living organisms are defined by their ability to establish norms and adapt to their environment, thereby challenging the mechanistic and reductionist perspectives in favour of the interactionist view.

Interactionism emphasizes the interplay between gene and the environment, using a holistic and flexible approach, with relevance to field like epigenetics and systems biology**.**

The concept of behavioural **determinism** (Q19 to Q 21), held by 47.2% of the respondents, aligns with the views of Kauffman (1993), who explored how complex biological structures and functions can arise spontaneously through self-organization, independent of natural selection. He argued that certain forms of order are intrinsic to complex systems and can emerge naturally under specific conditions. Determinism (whether hereditary or behavioural) focuses on genes as primary drivers, with modern relevance in genomics and biotechnology. While this concept has limitations, such as oversimplification and ethical concerns, its strength lies in its predictive and mechanistic insights.

Table 3a below shows that the scientific education received by biology students has had a limited impact on rejecting finalism or promoting interactionism and evolutionism. This suggests that while biology education reduces reliance on outdated paradigms, it does not sufficiently foster the acceptance of contemporary models. We observed low adherence, by fewer than half of the respondents, to certain scientifically accurate concepts, as indicated in table 3b below, listed in descending order of severity. These concepts have not been adequately appropriated by preservice biology teachers.

Table 3b: Suggested explicit elaboration of low adhered items

Q	Low adherence to scientific facts	Proposed Scientific Elaborations
21	*Free will plays a minimal role in shaping the behaviour of living organisms – (30.2% adherence to behavioural determinism).*	Free will and environmental factors significantly influence behaviour, particularly in humans.
17	*Environmental factors play a minimal role in the development of an organism – (34.0% adherence to hereditary determinism).*	Environmental factors play a significant role in shaping traits and adaptations.
12	*Evolutionary theory provides sufficient explanation for all observed biological phenomena – (37.7% adherence to evolutionism).*	While evolution is comprehensive, some phenomena may require additional insights from related sciences, like epigenetics.
18	*The future behaviour of an organism can be accurately predicted based on its genetic code – (41.5% adherence to hereditary determinism).*	While genetics provides a blueprint, behaviour and traits result from a combination of genetic and environmental influences.
11	*Natural selection is the primary mechanism behind the development of complex traits – (50.9% adherence to evolutionism).*	Natural selection is a foundational mechanism for the development of complex traits.
19	*The behaviour of animals is primarily controlled by their biological instincts – (52% adherence to behavioural determinism).*	Many animal behaviours are instinctual and biologically driven, though some involve learning and environmental influences

4.2. RQ2 – Bivariate Analysis

Table 4: Bivariate Pearson (r) Correlations with Summated Likert Scales

Bivariate Correlations

		Animism Conception	Vitalism Conception	Finalism Conception	Evolutionism Conception	Interactionism Conception	Hereditary Determinism Conception	Behavioural Determinism Conception
Animism Conception	r value	1	,530**	,459**	,059	,433**	,253	,457**
	P value		,000	,001	,674	,001	,067	,001
Vitalism Conception	r value	,530**	1	,606**	,175	,606**	,538**	,522**
	P value	,000		,000	,211	,000	,000	,000
Finalism Conception	r value	,459**	,606**	1	,387**	,525**	,550**	,389**
	P value	,001	,000		,004	,000	,000	,004
Evolutionism Conception	r value	,059	,175	,387**	1	,362**	,408**	,274*
	P value	,674	,211	,004		,008	,002	,047
Interactionism Conception	r value	,433**	,606**	,525**	,362**	1	,451**	,559**
	P value	,001	,000	,000	,008		,001	,000
Hereditary Determinism Conception	r value	,253	,538**	,550**	,408**	,451**	1	,474**
	P value	,067	,000	,000	,002	,001		,000
Behavioural Determinism Conception	r value	,457**	,522**	,389**	,274*	,559**	,474**	1
	P value	,001	,000	,004	,047	,000	,000	

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The dominant interactionist view, held by 83% of preservice biology teachers, showed a statistically significant moderate – to - strong positive correlation with both contemporary and historical obsolete conceptions of living organism. It has a strong correlation with scientifically accepted behavioural determinism (Pearson r = 0.559 p= 0.00), evolutionism (r = 0.362; p = 0.008), vitalism (r = 0.606; p = 0.000), finalism (r = 0.525; p = 0.008), and animism (r = 0.433; p = 0.001). It indicates a mixed conceptualisation of living organisms amongst biology teachers that needs to be addressed. It also highlights how historical epistemological obstacles, such as animists, vitalism, and finalism, continue to persist and hinder the understanding of contemporary, scientifically accepted interactionist views. Additionally, there is a significant positive correlation amongst the historical obsolete conceptions.

4.3.– RQ3 – Group Differences

The MANOVA test provided the following group difference results, as presented in table 5 below.

Table 5: Summary of MANOVA Test Results

Determinant	Wilks' Lambda Value	F Value	Sig.	Partial Eta Square
Sex	0.954	0.341	**0.911**	0.046
Level of education	0.776	0.948	**0.505**	0.014
Sex * Academic level	0.741	1.132	**0.346**	0.139

From table 5, there is no statistically significant difference between the mean scores of male and female respondents regarding their conceptions of living organisms (Wilks' Lambda value of 0.954, F = 0.341 at p= 0.911; p > 0.05). Thus, the sex of the respondents does not influence their conception of living organisms, as both males and females' respondents showed similar views.

Similarly, the academic level of the respondents nor the interaction between sex and academic level was not statistically significant. Therefore, first year preservice biology teachers, who have recently obtained their Advanced Level certificate in biology, third year student preparing for their Bachelor's degree in biology, and fifth year students preparing to obtain their Master's degree in biology education all held similar conceptions of living organisms.

5. Implications and Recommendations

The persistence of epistemological obstacles among preservice biology teachers poses challenges for science education. Teachers' conceptions of life often shape their instructional strategies, potentially perpetuating outdated views among students. For example, the dominance of finalism suggests a tendency to present evolution as goal-oriented, undermining its foundational principles.

The six tenets of the Nature of Science (NOS) could be used as a tool to efficiently teach the conceptualisation of life in order to overcome epistemological obstacles related to scientific concepts, as indicated by Ayina et al., (2024) and Nchia et al., (2024). The tentativeness of science explains why early conceptions (e.g., animism, vitalism, and finalist views) have been revised or replaced as evidence and scientific methods advanced. Conceptions that align with testable and observable phenomena (e.g., evolutionism and interactionism) better fit the framework of modern science. Cultural, philosophical, and religious contexts have shaped historical conceptions of life, reflecting the interplay between subjective beliefs and scientific progress. By linking these conceptions to NOS, we better understand the dynamic, evidence-based, subjective, and collaborative nature of scientific knowledge and its evolution over time.

An explicit emphasis on the **empirical or evidence – based** nature of science could enhance the understanding of interactionism and evolutionism, which are grounded in extensive empirical evidence, such as fossils, genetics, and observed changes in populations over time. The **tentative** NOS will explain how theory of evolution itself has evolved, with new mechanisms (e.g., epigenetics) being incorporated as evidence and understanding grows. Advances in epigenetics have challenged the deterministic view, illustrating the dynamic and evolving nature of scientific knowledge. Evolutionism and interactionism have been shaped by contributions from diverse fields, demonstrating the **collaborative** nature of science. Developing models (e.g., gene-environment interaction) to explains complex phenomena reflects the **creative** aspect of scientific inquiry

There is a need to revise the biology curricula to align biology education with contemporary scientific standards. The revised curriculum should include explicit discussions on epistemological obstacles, emphasizes the historical development of biological concepts, and address these obstacles through integrated interdisciplinary teaching methods that bridge the gaps between historical and modern paradigms.

Workshops on epistemological reflexivity could be organised to help preservice teachers critically examine their beliefs using active learning strategies, such as case studies and problem-solving tasks, to deepen conceptual understanding.

The development of professional development programs for in-service teachers to update their knowledge and teaching methods is equally necessary, as well as encouraging research into the cultural and institutional factors influencing the conceptualization of life in Cameroon.

6. Conclusion

Preservice Biology teachers exhibited elements of multiple conceptions, reflecting the complexity of human understanding of biology. Disagreements with scientifically supported answers highlight areas where further education or discussion may be beneficial. Each of these paradigms offers valuable contributions to understanding living organisms but has limitations when considered in isolation. Determinism excels in explaining heredity and molecular processes but falters in

addressing adaptability. Evolutionism provides a unifying narrative of life's history but can struggle with real-time complexity. Interactionism offers a holistic perspective but demands rigorous methodologies to quantify its principles.

The article highlights the coexistence of historical and contemporary conceptions of life among preservice biology teachers. While scientific education mitigates some epistemological obstacles, significant gaps remain in fostering a comprehensive understanding of modern biological theories. Addressing these challenges requires systemic changes in teacher training and curriculum design, ensuring that educators are equipped to convey a scientifically accurate and multidimensional understanding of life.The future of biology lies in synthesizing these paradigms, embracing the predictive power of determinism, the explanatory scope of evolutionism, and the flexibility of interactionism. This integrated approach will better capture the complexity and dynamism of living systems, advancing both theoretical and applied sciences.

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