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Assessing the Need for the Development of a Problem-Posing Multimedia Package for Teaching Hydrocarbon Concepts: Perspectives from Secondary School Chemistry Teachers

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Abstract

This study presents a need analysis conducted as the first phase of the ADDIE instructional design model to justify the development of a problem-posing multimedia package for teaching hydrocarbons in organic chemistry. This investigation is rooted in the documented complexity of hydrocarbon concepts for secondary students, including abstract molecular structures and reaction mechanisms, which often lead to persistent misconceptions and low engagement. Coupled with the increasing emphasis on interactive, student-centered pedagogies and digital integration in modern science curricula, there is a pressing need to explore innovative instructional solutions. A preliminary study was conducted involving interviews with six experienced chemistry teachers with teaching qualifications and at least 10 years work experience. The teacher interviews explored current pedagogical practices, challenges in teaching hydrocarbons, student misconceptions, and perceptions of multimedia and problem-posing approaches. Five themes emerged from teacher interviews: importance of hydrocarbon concepts, challenges in teaching and learning hydrocarbons, student misconceptions in Organic chemistry, teaching methods resources, and strategies for improving engagement. Findings revealed significant gaps in foundational knowledge, limited use of interactive pedagogies, persistent misconceptions, and inadequate laboratory and digital resources. The results justify the need for a problem-posing multimedia package to support conceptual understanding and active student engagement. Recommendations include integrating visualizations, contextualized problem-posing tasks, inquiry-based activities, and improved resourcing. The study contributes to literature on chemistry education by providing evidence-based justification for multimedia-supported problem-posing pedagogy in the teaching of hydrocarbons.

Keywords: Problem-Posing Strategy, Organic Chemistry, Multimedia, Learning Difficulties, Hydrocarbons

INTRODUCTION

Chemistry plays an essential role in scientific and technological advancement, yet it continues to be perceived by many secondary school students as a difficult subject. This difficulty is often attributed to its abstract concepts, symbolic language, and the requirement to think across macroscopic, submicroscopic, and symbolic levels of representation (Johnstone, 2021). Within the chemistry curriculum, hydrocarbons stand out as a particularly challenging area. Students frequently struggle with visualizing molecular structures, differentiating among homologous series, and understanding key ideas such as bonding, nomenclature, and isomerism (Taber, 2013; Orgill & Bodner, 2020). These challenges are intensified by the predominance of teacher-centered, lecture driven instructional methods widely used in Nigerian secondary schools. The heavy reliance on chalk-and-talk pedagogy often limits opportunities for active learning and

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provides minimal support for visualizing abstract chemical phenomena. Research in chemistry education emphasizes that multimedia tools including simulations, animations, and interactive visualizations can significantly enhance students' comprehension by making invisible or abstract processes more accessible (Kafanabo, 2022; Akpan & Andre, 2023).

Parallel to advancements in multimedia learning, problem-posing pedagogy has gained recognition as a powerful learner-centred approach that promotes deeper conceptual engagement. By encouraging students to generate, reformulate, and solve their own problems, problem posing enhances analytical reasoning, creativity, and higher-order thinking skills (Winarso, & Haqq, 2020). Combining multimedia tools with problem-posing strategies provides an innovative instructional model capable of addressing the complexities of topics like hydrocarbons. Despite evidence supporting these approaches, the teaching and learning of hydrocarbons in Nigerian secondary schools continue to be hindered by limited integration of technology and insufficient use of student-centred pedagogies (Temilade, & Tijani, 2025). Persistent misconceptions and difficulties with abstract chemical representations remain widespread (Olarewaju, Bello, & Amuda-Kannike, 2025). These gaps underscore the need for interventions that leverage multimedia resources and problem-posing strategies to improve conceptual understanding. Given these challenges, a systematic needs analysis becomes crucial for informing the design of contextually relevant instructional materials.

Understanding the specific learning difficulties students encounter, as well as the pedagogical constraints faced by teachers, is essential for developing an effective multimedia package tailored to the SS II chemistry curriculum. Organic chemistry, particularly hydrocarbons, remains one of the most challenging topics in the secondary school chemistry curriculum, despite its foundational importance for advanced studies in science, medicine, and industry. National examination reports, such as those from the West African Examinations Council (WAEC, 2019–2023), consistently reveal alarmingly low performance and widespread misconceptions in topics such as valency, bonding, classification of hydrocarbons, nomenclature, and isomerism. For instance, in the 2022 WAEC Chief Examiner's report in Nigeria, hydrocarbon-related questions recorded a mean score of 37%, with isomerism and IUPAC nomenclature identified as the most poorly attempted items. Teachers frequently attribute these difficulties to pedagogical and resource-related constraints. Surveys indicate that over 70% of chemistry teachers in Nigerian public schools rely predominantly on conventional methods such as lecture with limited integration of visual or digital instructional aids (Adeniran & Ojo, 2021).

Furthermore, instructional materials for chemistry experiments in Nigeria are often inadequate or inaccessible, depriving students of experiential and inquiry-based learning opportunities (Bala & Musa, 2022). These instructional limitations tend to hinder teachers from simplifying the abstract, spatial, and relational nature of hydrocarbon concepts such as isomerism, nomenclature, and electronic configurations, among others that need to be conceptually understand rather rote memorization.

Emerging research underscores the potential of multimedia-enhanced and problem-posing pedagogies to improve learning outcomes in science. Multimedia packages that incorporate animations, simulations, and interactive problem-solving have been shown to enhance visualization, engagement, and conceptual retention in chemistry (Okoro & Eze, 2023). Similarly, problem-posing strategies where students generate and solve their own questions promote critical thinking, ownership of learning, and deeper content integration (Akinola & Yusuf, 2022). However, there is a notable absence of contextually designed, teacher-informed multimedia resources that combine these approaches specifically for hydrocarbon instruction in Nigerian secondary schools.

This gap points to a critical disconnect between existing teaching practices and the cognitive demands of organic chemistry. Without targeted, innovative instructional support, students' persistent difficulties are likely to perpetuate, affecting both academic progression and national scientific literacy. Therefore, this study was conducted to systematically assess the instructional needs and challenges faced by secondary school chemistry teachers in teaching hydrocarbons, and to gather their perspectives on the potential value and design of a problem-posing multimedia instructional package. This study explored teachers' views on the importance of hydrocarbon concepts, identified challenges in teaching and learning them, and examined common student misconceptions. It also reviewed current teaching methods and resources, documented strategies for boosting student engagement, and assessed the need for a problem-posing multimedia package.

Objectives of the Study

The main objective of the study is to explore chemistry teachers' perspectives on the teaching and learning of hydrocarbon concepts in Senior Secondary Schools. The specific objectives were to:

1. examine teachers' views and perceptions regarding hydrocarbon concepts and to identify the challenges associated with teaching and learning hydrocarbons.
2. identify and describe the common misconceptions students exhibit in learning hydrocarbon concepts.
3. investigate the teaching methods and instructional resources currently employed in the teaching of hydrocarbon concepts.
4. explore instructional strategies perceived to enhance student engagement in learning hydrocarbon concept

Research Questions

The study sought to answer the following questions:

1. What are teachers' views on hydrocarbon concepts? What challenges exist in teaching and learning hydrocarbons?
2. What common misconceptions do students hold?
3. What teaching methods and resources are currently used?
4. Which strategies enhance student engagement?

METHODOLOGY

This study adopted a qualitative research design using a semi-structured interview protocol, aligned with a phenomenological orientation. The phenomenological approach is appropriate as it seeks to explore and interpret the essence of a phenomenon through the lived experiences and perspectives of individuals directly involved (Creswell & Clark, 2017).

The participants comprised six Senior Secondary School chemistry teachers, randomly selected from public secondary schools across Katsina State, Nigeria. All participants had direct teaching experience with hydrocarbon concepts at the senior secondary level, making them suitable informants for the study.

Data were generated using an instrument titled Chemistry Teachers' Interview Protocol, which consisted of nine semi-structured interview questions focusing on the teaching and learning of hydrocarbon concepts. Sample interview prompts included: "Which hydrocarbon topics do students find most challenging and why?", "What misconceptions do students commonly exhibit when learning hydrocarbons?", and "How do you typically address these difficulties during instruction?" These prompts were designed to elicit in-depth reflections while allowing flexibility for probing and clarification.

The interviews were conducted face-to-face in a quiet school environment to ensure minimal distraction and richer interaction. Each interview lasted approximately 30–45 minutes. With the consent of the participants, all interviews were audio-recorded and later transcribed verbatim. The transcribed verbal responses constituted the primary data for analysis.

Data analysis was carried out using thematic analysis following the six-phase framework proposed by Braun and Clarke (2006). This involved familiarisation with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and finally producing the report. This systematic and rigorous analytical process ensured that the identified themes, including instructional challenges and students' misconceptions, were firmly grounded in the teachers' authentic responses, thereby enhancing the credibility and trustworthiness of the findings.

RESULTS AND DISCUSSION

Results

To further justify the need for the development of the Package, four broad themes emerged from the needs analysis, which are: Importance of Hydrocarbon Concepts, Challenges in Teaching and Learning Hydrocarbons, Student Misconceptions in Organic Chemistry Teaching Methods, Resources and Strategies for Improvement and Student Engagement in Hydrocarbon Education.

Theme 1: Importance of Hydrocarbon Concepts

Hydrocarbons form the foundational backbone of organic chemistry, playing a pivotal role in both scientific disciplines and real-world applications. Research underscores their significance in fields such as biochemistry, medicine, and environmental science (Tauber et al., 2020). Given their prevalence in everyday products such as fuels, plastics and pharmaceuticals. Understanding hydrocarbons is essential for students pursuing careers in STEM (Brown et al., 2019). This theme explores teachers' perspectives on hydrocarbons as foundational knowledge and their interdisciplinary relevance.

Teachers emphasized hydrocarbons as a cornerstone of organic chemistry, with implications for advanced studies. Teacher 1 noted, "*It is the key part of organic chemistry... if there is no hydrocarbon, organic chemistry cannot be completed*," highlighting its structural necessity. Teacher 3 extended this to biology, stating, "*It helps in understanding metabolic activities... which have a direct relationship with hydrocarbons*," reinforcing cross-disciplinary connections. Teacher 5 added that hydrocarbons serve as "*a critical site for advanced courses in chemistry, biology, and medicine*," suggesting their role in higher education.

Beyond academia, teachers stressed hydrocarbons' practical relevance. Teacher 2 remarked, "*It has real-life application, especially nowadays, where we interact with many hydrocarbon compounds*," pointing to their ubiquity in modern life. Teacher 4 broadened this view, citing applications in "*biochemistry, pharmacy, medicine, and agriculture*," illustrating their industrial and medical significance.

Teachers unanimously viewed hydrocarbons as indispensable, bridging theory and practice. Their insights suggest that effective pedagogy should emphasize both conceptual depth and applied relevance, preparing students for scientific literacy and career readiness. This aligns with literature advocating for context-based learning in STEM education (Lesnefsky, 2025). Future curricula could integrate case studies (e.g., pharmaceuticals, renewable energy) to enhance engagement and retention.

Theme 2: Challenges in Teaching and Learning Hydrocarbons

Teaching and learning hydrocarbon concepts pose significant pedagogical challenges due to their abstract nature and the prerequisite knowledge required in atomic structure and chemical bonding (Agwu, & Nmadu, 2023). Students often struggle with nomenclature, isomerism, and three-dimensional molecular visualization, which are foundational to organic chemistry. Research indicates that these difficulties stem from prior misconceptions, inadequate preparation in basic chemistry, and confusion between similar hydrocarbon classes (Brown et al., 2019). The transition from general to organic chemistry is particularly problematic, with many students failing to grasp valency rules, functional group identification, and structural representation (Taylor & Clark, 2021). Two codes were identified under this theme as follows: Student Foundational Knowledge Gaps and Conceptual Difficulties in Hydrocarbon Topics.

Teachers highlighted that students often lack essential prior knowledge, particularly in valency and atomic bonding, leading to persistent errors. For instance, many learners struggle to differentiate between alkanes, alkenes, and alkynes or fail to satisfy carbon's tetravalency when drawing structures. Similarly, Nomenclature, isomerism, and structural numbering emerged as recurring hurdles.

Students frequently misidentify functional groups, incorrectly position substituents, or misunderstand aromaticity, compounding their difficulties in mastering organic chemistry.

The teachers' observations collectively paint a comprehensive picture of the multifaceted challenges students face in hydrocarbon chemistry, revealing a clear progression from fundamental gaps to complex conceptual hurdles. Their insights align closely with educational research while demonstrating interconnected learning barriers that compound upon one another.

Teacher 1 identified the most foundational issue: *"First of all, I can say students' background, especially on valency of atoms."* This remark highlights a critical prerequisite knowledge gap as students struggle with valency rules, which are essential for understanding hydrocarbon structure and bonding. Research by Tauber, Schweiker and Levonis, (2020) supports this observation, showing that pre-existing knowledge deficits in atomic theory persist and hinder progression in organic chemistry. Without a firm grasp of valency, students cannot accurately construct or analyze even the simplest hydrocarbon molecules, setting off a cascade of misunderstandings.

Building upon this foundational challenge, Teacher 2 noted a common point of confusion: *"Some of them get confused between alkane, alkene, and alkynes."* This indicates that students not only lack prerequisite knowledge but also struggle with classification and differentiation, key skills in organic chemistry. The inability to distinguish between hydrocarbon classes suggests a need for comparative teaching strategies, such as side-by-side property tables or flowcharts that systematically contrast saturation levels, bonding types, and naming conventions. Without such interventions, this confusion likely exacerbates later difficulties in reaction mechanisms and functional group recognition. Moving from classification errors to structural inaccuracies, Teacher 3 and Teacher 4 provided concrete examples of student mistakes.

Teacher 3 observed: *"Sometimes they draw structures not satisfying carbon's valency,"* directly linking back to Teacher 1's point about valency misconceptions. This demonstrates how initial gaps in atomic theory manifest in incorrect spatial representations students may draw tetravalent carbon with three bonds or misplace hydrogen atoms, leading to chemically impossible structures. Teacher 4 added another layer: *"Students struggle with numbering carbon chains,"* which ties into systematic rule application. Incorrect numbering reflects a poor understanding of IUPAC conventions, likely stemming from weak foundational skills (as noted by Teacher 1) and classification struggles (Teacher 2). Together, these errors suggest students need more scaffold practice in molecular construction and nomenclature logic.

The challenges then escalate to higher-order conceptual hurdles, as described by Teacher 5 and Teacher 6. Teacher 5 noted: *"Understanding isomerism and substituent positions is difficult,"* indicating that students falter when applying their (often shaky) knowledge of structure and naming to three-dimensional and positional variations. Isomerism requires not only rule recall but also spatial visualization, a skill many learners lack without targeted interventions like modeling kits or digital simulations. Finally, Teacher 6 highlighted perhaps the most abstract barrier: *"Aromaticity recognition is a major* *challenge."* Aromaticity demands an integration of electron delocalization concepts, resonance structures, and stability rules a topic that build upon all prior areas of struggle (valency, structure, and isomerism). Without addressing earlier gaps, students hit a "conceptual wall" when encountering these advanced themes

The teachers' views collectively suggest that hydrocarbon instruction must address two key areas: (1) reinforcing foundational concepts (valency, bonding) and (2) employing targeted pedagogies (visualization tools, stepwise nomenclature drills) to mitigate persistent errors. Without intervention, these challenges may hinder progression in organic chemistry, reinforcing the need for diagnostic assessments and remedial strategies in introductory courses.

Theme 3: Student Misconceptions in Organic Chemistry

Student misconceptions in organic chemistry are well-documented in educational research, often described as deeply rooted alternative conceptions that hinder the acquisition of accurate scientific knowledge (Duma, 2025; Taber, 2019). These misconceptions frequently arise from cognitive conflicts between prior knowledge and new concepts, leading to confusion in areas such as molecular structures, functional group identification, and hydrocarbon classification (Nakiboglu, 2003, Üce & Ceyhan, 2019). Studies suggest that without targeted intervention, these misunderstandings persist, impairing students' ability to grasp advanced chemical principles (Talanquer, 2011, Branchini. (2022.). Two related codes emerged from teachers' responses: Confusion in Hydrocarbon Classification and Interference from Prior Knowledge.

Teachers consistently observed that students face significant challenges in differentiating between the three fundamental classes of hydrocarbons, the alkanes, alkenes, and alkynes. These struggles manifest in several ways, including confusion over structural features, nomenclature, and electronic configurations. For instance, Teacher 1 explained: "*Especially when talking about the aliphatic, the spread chain. Some of them get confused between alkane, alkene, and alkynes*." This indicates that even at the most basic level, identifying straight-chain hydrocarbons, students mix up these categories. The confusion deepens when considering functional groups and molecular orbitals, as Teacher 6 elaborated: "*Differentiating between alkanes, alkenes, and alkynes functional groups and filling electrons into their respective orbitals relating to ground and excited state*." Here, the difficulty extends beyond mere naming conventions to the underlying electronic structures that define each hydrocarbon type. This suggests that students struggle not only with surface-level recognition but also with the conceptual foundations that distinguish these compounds.

A compounding factor in these misunderstandings is hydrocarbon nomenclature, which introduces additional layers of complexity. Teacher 5 highlighted this issue when discussing common naming errors: "*2-2 dimethyl vs. 2-3 dimethyl."* Such mistakes reveal that students often misapply IUPAC rules, leading to incorrect structural interpretations. The similarity in naming conventions between different hydrocarbons (e.g., -ane, -ene, -yne) likely exacerbates the problem, making it harder for learners to retain distinctions. This lexical overlap means that even when students memorize naming rules, they may still misclassify compounds due to superficial resemblances in terminology.

Beyond nomenclature, teachers noted that prior misconceptions actively interfere with students' ability to grasp new hydrocarbon concepts. Teacher 3 described this cognitive conflict vividly: "*The student might want to say this, but he might be confused. Is this what I learned, or is it that? Okay, interference. Surely yes, knowledge interference*." This "knowledge interference" suggests that students' partial or incorrect prior understanding competes with new information, leading to hesitation and errors. Teacher 4 further linked this issue to foundational gaps in atomic theory: "*Even in* *drawing the structure, these misconceptions were mainly due to poor understanding of the valency of atoms*." If learners do not fully comprehend how carbon forms four bonds (or how double/triple bonds function), they cannot accurately represent or classify hydrocarbons. This deficiency in valence comprehension cascades into broader difficulties, particularly in distinguishing saturated (alkanes) from unsaturated (alkenes/alkynes) hydrocarbons, as Teacher 8 later emphasized. The culmination of these challenges is evident in students' structural drawing errors. Misconceptions about valency and hybridization lead to incorrect Lewis structures, bond placements, and even molecular geometry. For example, a student might draw an alkene with too many hydrogen (violating the double bond rule) or an alkyne with misplaced triple bonds. These mistakes are not merely graphical; they reflect deeper conceptual gaps in understanding how bonding defines hydrocarbon behaviour.

The teachers' collective observations uncover a layered set of learning challenges that students face when studying hydrocarbons. At the most immediate level, students struggle with terminology confusion, where the similar-sounding naming conventions for different hydrocarbon classes (-ane, -ene, -yne) blur critical distinctions between these compounds. This surface-level difficulty cascades into deeper issues when prior knowledge interference comes into play, as students' pre-existing misconceptions actively compete with and obstruct new learning. Most fundamentally, valency misunderstandings where learners fail to properly grasp bonding concepts, lead directly to structural representation errors that permeate all aspects of hydrocarbon chemistry.

To effectively overcome these interconnected barriers, instruction must adopt a scaffolded pedagogical approach. The foundation must first be laid through explicit clarification of core concepts like valency and hybridization the atomic-level understanding that underpins all hydrocarbon chemistry. With this base established, instruction should then employ comparative modelling techniques, such as side-by-side structural comparisons of alkanes, alkenes and alkynes, to help students visualize and internalize the distinguishing features of each hydrocarbon class. Finally, this conceptual understanding must be reinforced through structured active learning techniques, including targeted naming exercises and problem-solving drills that allow students to apply their knowledge in progressively more complex contexts.

This tiered approach recognizes that hydrocarbon education presents not isolated difficulties, but rather a sequence of cognitive hurdles that build upon one another. By systematically addressing terminology confusion, prior knowledge interference, and valency misunderstandings in this scaffolded fashion, educators can help students develop a robust, interconnected understanding of hydrocarbon chemistry that withstands the challenges inherent in learning this conceptually dense subject area.

The teachers' perspectives underscore the need for explicit conceptual clarification using models, analogies, and incremental learning strategies to address these misconceptions. Their insights align with literature advocating for active learning interventions (Agwu & Nmadu, 2023) to correct deeply held errors. Future instructional approaches should incorporate diagnostic assessments and visual aids to mitigate these persistent challenges.

Theme 4: Teaching Methods and Resources, Strategies for Improving Students' Engagement in Hydrocarbon

The effectiveness of chemistry education, particularly in complex topics such as hydrocarbons, is significantly shaped by pedagogical approaches and resource availability. Research in science education underscores the limitations of traditional lecture-based methods, which often fail to foster active engagement or accommodate diverse learning styles (Hofstein & Lunetta, 2004; Johnstone, 2006). Passive learning environments hinder deep conceptual understanding and problem-solving skills, while insufficient instructional materials, such as laboratory equipment, visual aids, and digital tools, further constrain teachers' ability to make abstract concepts tangible (Gabel, 1999). This dual challenge of outdated methodologies and resource deficiencies contributes to student disengagement and poor knowledge retention.

Two key codes identified under this theme were Over-reliance on Lecture Method and Lack of Teaching Materials and Laboratories. The dominance of lecture-based instruction emerged as a recurring concern among teachers. Teacher 1 noted, "*Like I say, majority of teachers have no option but to use lecture method," suggesting structural constraints that limit pedagogical flexibility*. Teacher 2 added, "*Very few have the time and opportunity to maybe apply demonstration method*," highlighting time pressures as a barrier to interactive teaching. Teacher 3 further lamented, "*That is what we do without any demonstration, any physical interaction, which even lacks students' participation*," emphasizing the passive nature of such instruction.

Scarcity of resources was another critical issue. Teacher 4 stated, "*With lack of maybe materials. In education, some schools don't even have laboratory*," pointing to infrastructural deficits. Teacher 5 observed, "*Their reaction sometimes you see that the students are getting tired about the class because of lack of adequate instructional materials and lack of captivating approaches*," linking resource shortages to declining student motivation. Teacher 6 summarized the predicament: "So, normally, we use some charts and lecture methods because of lack of adequate instructional materials and conducive environment for learning coupled with time constraints," illustrating how material deficiencies reinforce reliance on less effective methods.

The teachers' responses reveal a cyclical problem: limited resources compel reliance on lectures, which in turn diminishes student engagement and comprehension. While some educators attempt to integrate demonstrations Teacher 5: "*Most of the teaching method practiced by chemistry teachers is demonstration and sometimes lecture method*", systemic barriers such as insufficient laboratories, time constraints, and inadequate materials restrict consistent implementation.

The teachers' views collectively underscore an urgent need for institutional support in two key areas: Professional development programs should equip educators with student-centered strategies (e.g., inquiry-based learning) to mitigate over-reliance on lectures and Schools must prioritize funding for laboratories, digital tools, and hands-on materials to facilitate active learning.

Without addressing these gaps, chemistry education risks perpetuating disengagement and superficial understanding, particularly in abstract topics like hydrocarbons. The testimonies of these six teachers highlight not just a methodological dilemma, but a systemic one demanding policy-level interventions to foster meaningful learning experiences.

Hydrocarbon chemistry presents unique challenges due to its abstract nature Students often struggle with visualizing molecular structures, reaction mechanisms, and nomenclature. Research underscores the effectiveness of active learning (Johnstone, 1991), where students engage in problem-solving rather than passive absorption. Visual aids (Wu & Shah, 2004) and problem-posing techniques (Khandekar, 2021)) further enhance comprehension by making concepts tangible and stimulating inquiry. This theme explores how teachers integrate these strategies, revealing a cohesive pedagogical approach through their shared insights.

The teachers' responses weave together a natural progression of strategies, beginning with visualization, extending into problem-based engagement, and culminating in collaborative reinforcement. Their words demonstrate a logical flow, each method builds on the last to deepen understanding. "*The teacher has to think of a way to do it better, maybe using improvisation. Modelling. Teachers should model*." (Teacher 1). This sets the foundation: improvisation and modelling make abstract concepts concrete.

Teacher 2 immediately builds on this idea with a practical example: "*You can use maybe a tennis ball and some thread to demonstrate a structure*." (Teacher 2). Here, the focus shifts from theory to tactile learning, reinforcing Teacher 1's emphasis on visualization. "*The use of pictures, videos, and animations can immensely help a lot and this will make the student ask more questions*." (Teacher 3). Teacher 3 expands the discussion to digital visual aids, noting their role in stimulating curiosity. This connects to Teacher 4's point about leveraging student inquiry: "*You can throw a challenging question to them and ask them to do it*." (Teacher 4).

The sequence is clear: visual tools (Teacher 2 & 3) student-driven questions (Teacher 4). "*You can give them a group activity so that they will collaborate*." (Teacher 5). After visual and problem-based methods, Teacher 5 introduces peer learning, ensuring active participation. Teacher 6 then ties it all together, showing how these strategies reinforce retention: "*If you give them naming of some compound... that will significantly improve their performance and retention*." (Teacher 6). This progression mirrors constructivist theories (Vygotsky, 1978) and cognitive load reduction (Sweller, 1988). Students first see, then question and finally discuss hydrocarbon concepts.

The teachers' voices collectively advocate for a dynamic, multi-stage pedagogy in hydrocarbon education. Their strategies are interdependent; visualization sparks questions, which then thrive in collaborative settings.

DISCUSSION

The need analysis results present a clear picture of the pedagogical realities surrounding the teaching and learning of hydrocarbons in secondary school chemistry. Teachers reiterated the foundational importance of hydrocarbons in the organic chemistry curriculum, a view supported by literature identifying hydrocarbons as the entry point to more advanced concepts such as functional group chemistry and reaction mechanisms (Brown et al., 2019; Smith & Jones, 2020). Their emphasis reflects an understanding that weak mastery of hydrocarbons often leads to broader conceptual difficulties across organic chemistry.

Despite this importance, significant cognitive and instructional challenges persist. Teachers reported that many students struggle with prerequisite ideas particularly valency, bonding, and molecular structure which limits their ability to comprehend the abstract and symbolic representations characteristic of organic chemistry. These findings align with Johnstone's (2006) model of representational complexity in chemistry and Sweller's (1988) cognitive load theory, both of which highlight the difficulties students face when foundational knowledge is fragile Misconceptions emerged as dominant theme. Recurring errors in interpreting structural formulas, identifying hydrocarbon classes, and applying IUPAC nomenclature were frequently noted, echoing earlier reports of persistent misconceptions in organic chemistry (Kafanabo, 2022; Agwu, & Nmadu, 2023.). Their persistence suggests that conventional teaching approaches may not adequately diagnose or challenge students' flawed mental models.

Systemic instructional constraints further compound these issues. Teachers largely rely on lecture-based methods, reflecting long standing trends toward teacher-centered instruction in Nigerian science classrooms (Taber, 2013). Limited access to laboratory resources, molecular models, and digital visualization tools also restricts opportunities for hands-on and representational learning (Kafanabo, 2022). These limitations hinder students' ability to visualize molecular structures and understand spatial features of organic compounds. Teachers' suggested improvements including the use of simulations, animations, modeling activities, and problem-posing approaches are consistent with constructivist and inquiry-oriented pedagogy. Such methods have been widely recognized for promoting deeper understanding, metacognition, and active student engagement (Agwu & Nmadu, 2023). In particular, problem-posing has been shown to foster higher-order thinking and meaningful conceptual development.

Thus, the development of a problem-posing multimedia package is both timely and well justified. Multimedia offers multimodal advantages visual, auditory, and interactive that can reduce cognitive load, clarify structural representations, and address misconceptions through guided inquiry and feedback. These tools can also serve as virtual alternatives to inadequate laboratory facilities, supporting the development of essential representational and conceptual skills. Overall, the findings indicate a mismatch between the conceptual demands of hydrocarbon chemistry and the pedagogical resources available in schools. Teachers' strong support for interactive, problem-centered multimedia instruction underscores its relevance and potential impact. The results therefore validate the need for a problem-posing multimedia package as a strategic response to long-standing challenges in teaching hydrocarbons and organic chemistry more broadly.

CONCLUSION

This study conducted a systematic needs analysis to examine the pedagogical realities surrounding the teaching and learning of hydrocarbon concepts in secondary school chemistry. The findings reveal a clear misalignment between the conceptual demands of hydrocarbon chemistry and the instructional practices and resources currently available in schools.

Teachers unanimously affirmed the foundational importance of hydrocarbons within the organic chemistry curriculum and their relevance to advanced scientific studies and real-world applications. However, despite this recognized importance, significant challenges persist.

Students exhibit fragile foundational knowledge particularly in valency, bonding, structural representation, and nomenclature which subsequently manifests in widespread misconceptions, structural drawing errors, and confusion among hydrocarbon classes. These conceptual weaknesses are compounded by prior knowledge interference and limited capacity for molecular visualization.

Instructionally, the study exposes an over-reliance on lecture-based pedagogy, largely driven by systemic constraints such as inadequate laboratory facilities, insufficient instructional materials, limited digital tools, and time pressures. Such conditions restrict the implementation of student-centered and inquiry-based approaches necessary for mastering abstract organic chemistry concepts. Consequently, student engagement remains suboptimal, and misconceptions persist across successive cohorts.

Importantly, teachers expressed strong support for integrating visualization tools, modelling activities, collaborative learning, and problem-posing strategies to enhance conceptual clarity and engagement. Their perspectives converge on the need for interactive, multimedia-supported instructional materials capable of addressing both cognitive and resource-related barriers.

Therefore, the evidence from this needs analysis provides compelling empirical justification for the development of a problem-posing multimedia instructional package. Such a package has the potential to (i) reinforce foundational concepts, (ii) address persistent misconceptions through guided inquiry and visualization, (iii) reduce cognitive overload associated with abstract representations, and (iv) stimulate active student engagement even in resource-constrained environments.

Within the ADDIE framework, this needs analysis establishes a strong foundation for the subsequent design and development phases. By grounding the proposed intervention in teachers' lived experiences and classroom realities, the study ensures contextual relevance and practical applicability. Ultimately, the development of a problem-posing multimedia package represents not merely a technological enhancement, but a pedagogically strategic response to longstanding instructional challenges in hydrocarbon chemistry education.

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