Examining Effectiveness of Pedagogical Approaches in the Implementation of Applied Sciences Curriculum in Public Junior Secondary Schools in Kiambu County.

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ABSTRACT

This study examined the effectiveness of pedagogical approaches used in implementing the Applied Sciences curriculum in public junior secondary schools in Kiambu County, Kenya. Guided by systems theory, the study focused on learner-centered pedagogical approaches, instructional resource adequacy, teachers' classroom practices, and challenges influencing implementation. A descriptive research design was adopted, involving **288 respondents: 24 headteachers, 72 teachers, and 216 students** selected from schools offering Agriculture, Home Science, and Computer Science. Data were collected through questionnaires and headteacher interview schedules. Instrument validity was ensured through expert review, and reliability analysis yielded **Cronbach's alpha coefficients of .82 for teachers and .79 for students**. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were thematically analyzed. Findings indicated that learner-centered pedagogical approaches were applied at a **moderate level,** with mean scores for hands-on activities (M = 3.12), demonstrations (M = 3.08), and problem-solving tasks (M = 3.05). However, project-based learning (M = 2.46) and inquiry-based learning (M = 2.39) were less consistently implemented. Instructional resource adequacy showed **wide disparities across schools**. Only **41%** of schools had functional Home Science rooms, **38%** had reliable computer laboratories, and **33%** maintained active Agriculture demonstration plots. Classroom practices demonstrated **partial compliance** with CBE expectations, with overall practice scores averaging **M = 2.87**, indicating moderate alignment with curriculum requirements. Major challenges included inadequate resources (reported by 78% of teachers), limited CBE training (64%), large class sizes (57%), and inconsistent supervision (49%). The study concludes that applied sciences pedagogy is significantly influenced by resource sufficiency, teacher preparedness, and institutional support. It recommends enhanced capacity-building, equitable resource allocation, and strengthened instructional supervision to improve implementation fidelity.

Keywords: Applied Sciences, learner-centered pedagogy, instructional resources, classroom practices, Competency-Based Education.

INTRODUCTION

Applied Science in Junior Secondary encompasses subjects such as Agriculture, Home Science, and Computer Science, all designed to equip learners with practical skills that connect classroom knowledge to everyday life. Agriculture introduces learners to food production, environmental stewardship, and basic agribusiness concepts, helping them understand their role in food security and sustainable development. Home Science builds essential competencies in nutrition, hygiene, textiles, and family welfare, enabling learners to make informed decisions that promote healthy living. Computer Science, on the other hand, exposes learners to digital literacy, coding, and problem-solving skills needed in an increasingly technological world.

In the United Kingdom, for example, schools have shifted toward teaching approaches that allow learners to experiment, ask questions, and apply ideas to real situations. Instead of relying on lectures alone, teachers are encouraged to use hands-on activities and inquiry-based lessons that help learners make meaningful connections

between scientific concepts and daily life (Department for Education, 2020). China is moving in the same direction. The government has heavily invested in competency-based learning, enabling junior schools to incorporate project work, digital tools, and laboratory activities across applied science subjects. Through this approach, learners are not only gaining knowledge but also developing creativity, teamwork, and problem-solving abilities that match the demands of the country's fast-growing technology sector (Zhang & Liu, 2021).

Several African countries are also restructuring how they teach applied sciences. In South Africa, the Curriculum and Assessment Policy Statement encourage teachers to use learner-centered methods such as group projects, practical tasks, and problem-solving activities that relate to the learners' environment. However, many schools still struggle with challenges like large classes, limited materials, and uneven teacher preparation, which affect how well these methods are applied (Maree, 2019). Nigeria has likewise introduced inquiry-based and participatory approaches in junior secondary schools to stimulate interest in Agriculture, Home Economics, and ICT. Yet, limited laboratory space, inadequate teacher training, and crowded classrooms continue to widen the gap between curriculum intentions and actual classroom practice (Adeyemi, 2020).

Rwanda is often praised for its ambitious reforms in competency-based education. The country has invested in teacher training, digital classrooms, and practical learning approaches that encourage learners to participate in experiments, community projects, and technology-driven tasks across applied science subjects. Even with these gains, some schools still struggle to sustain consistent quality in implementation (Ndayambaje & Byusa, 2020). In Kenya, the introduction of the Competency-Based Education (CBE) brought similar expectations. Agriculture, Home Science, and Computer Science in junior secondary are now expected to be taught through inquiry, collaboration, hands-on tasks, and real-life problem-solving. Despite this strong vision, teachers often face obstacles such as inadequate resources, limited training, and high workloads, making it difficult to fully embrace these modern teaching approaches (KICD, 2019).For Kiambu County, these issues are particularly important. As one of Kenya's rapidly urbanizing regions, schools differ widely in terms of facilities, teacher expertise, and student backgrounds. Some junior secondary schools have well-equipped computer labs, demonstration plots, or Home Science rooms, while others struggle with limited space and materials. Teachers must therefore adapt to diverse learning environments, often with varying levels of support from school leadership. As a result, the use of inquiry-based learning, project work, collaborative tasks, and ICT-supported lessons in applied sciences varies significantly across the county. This unevenness raises important questions about how effectively the Applied Sciences curriculum is being implemented and whether learners are receiving the practical, hands-on education envisioned under CBE (MoE, 2022).

Statement of the Problem

Ideally, the Applied Sciences curriculum covering Agriculture, Home Science, and Computer Science should be implemented through learner-centered pedagogical approaches that promote inquiry, hands-on experimentation, collaboration, creativity, and real-world problem-solving, as outlined in the Competency-Based Curriculum (CBC). National policy documents emphasize approaches such as project-based learning, practical demonstrations, and ICT integration to ensure learners acquire meaningful scientific and technological competencies (KICD, 2019; MoE, 2022). These methods are expected to nurture learners who can apply knowledge in authentic contexts, engage in innovation, and develop 21st-century skills necessary for personal and national development.

However, the reality in many public junior secondary schools in Kiambu County does not reflect these expectations. Teachers often struggle to translate CBC pedagogy into practice due to inadequate resources, limited practical facilities, insufficient training, heavy workloads, and inconsistent school-level support (Mware, 2021; Njagi & Wambugu, 2020). In some schools, Agriculture is taught without demonstration plots, Home Science lacks the required equipment, and Computer Science is delivered without functional computers or reliable internet, resulting in lessons that remain largely theoretical (Otieno & Gichure, 2021). This discrepancy reveals a persistent gap between curriculum theory and classroom practice, raising concerns about whether learners are developing the intended competencies. To address this gap, the current study seeks to examine the actual pedagogical approaches used in teaching Applied Sciences in public junior secondary schools in Kiambu County, identify the challenges teachers face, and determine the extent to which classroom practices align with CBC

requirements. The findings will provide evidence-based insights to guide improvements in pedagogy, teacher support, and resource allocation within the Applied Sciences curriculum (MoE, 2022).

Research Objectives

1. To identify the specific learner-centered pedagogical approaches that teachers use in teaching Agriculture, Home Science, and Computer Science in public junior secondary schools in Kiambu County.

2. To evaluate the availability and adequacy of instructional resources required for the effective teaching of Applied Sciences in public junior secondary schools in Kiambu County.

3. To determine the extent to which teachers' classroom practices in Applied Sciences comply with the pedagogical expectations outlined in Competency-Based Education (CBE).

4. To analyse the specific challenges that teachers encounter when implementing recommended pedagogical approaches in the Applied Sciences curriculum.

LITERATURE REVIEW

Learner-Centered Pedagogical Approaches

Learner-centered pedagogical approaches form the backbone of Competency-Based Education (CBE), emphasizing active engagement, critical thinking, and problem-solving. In Applied Sciences—comprising Agriculture, Home Science, and Computer Science—learners engage directly with content through practical exercises, inquiry tasks, and collaborative projects, fostering deeper understanding and skill acquisition (Smith & Brown, 2020). These approaches enable learners to bridge theoretical knowledge with real-world applications, enhancing both retention and motivation (Johnson & Lee, 2019).

Project-based learning enhances practical skills and nurtures creativity. In Agriculture, learners participate in school gardens, crop experimentation, and soil management, which cultivate not only technical competencies but also environmental awareness (Adamu & Musa, 2020). Home Science engages learners in household management, nutrition, and hygiene projects, fostering life skills essential for community well-being. Computer Science benefits from coding assignments, simulations, and ICT-driven problem-solving tasks that cultivate technological literacy and computational thinking (Chen & Zhao, 2021).

The effectiveness of learner-centered pedagogy is contingent on teacher preparedness. Competent teachers who are trained in CBE methodologies demonstrate the ability to facilitate experiential learning, manage collaborative tasks, and create inquiry-based activities. In contrast, limited training or confidence in implementing these strategies often leads to teacher-centred instruction, constraining learners' active engagement (Khan et al., 2020).

Contextual relevance amplifies the impact of learner-centered approaches. Integrating local agricultural practices, culturally relevant home management activities, and community-specific ICT applications ensures that learners can apply knowledge meaningfully within their environments (Ochieng & Wanjiku, 2020). Contextualized pedagogy strengthens the connection between classroom learning and societal needs, enhancing both competence and engagement.

The integration of digital tools further enriches learner-centered approaches. Virtual laboratories, interactive simulations, and collaborative online platforms allow learners to experiment and engage with content beyond the physical classroom (Park & Kim, 2021). However, unequal access to technology can limit participation and diminish the potential benefits, particularly in resource-constrained schools (Mukasa, 2020). Thus, effective implementation requires a balance between pedagogy, resources, and contextual adaptation.

Availability and Adequacy of Instructional Resources

Instructional resources are fundamental to translating CBE principles into practice. Applied Sciences require specialized facilities, equipment, and materials to enable learners to engage in practical experimentation and

applied problem-solving (Taylor & Francis, 2020). Agriculture, Home Science, and Computer Science demand demonstration plots, laboratory tools, kitchen and textile equipment, computers, and software, all of which directly influence learners' competence and performance (Ahmed & Bello, 2019).

In Agriculture, access to tools, seeds, fertilizers, and functioning demonstration plots allows learners to experiment with planting techniques, soil management, and sustainable practices (Nwankwo & Okafor, 2020). Home Science classrooms equipped with utensils, textiles, and hygiene kits provide learners with opportunities to practice nutrition, food preparation, and home management skills. Computer Science relies on fully functional computers, software applications, and internet connectivity to enable learners to develop programming and ICT competencies (Li & Wang, 2021).

Resource inadequacy significantly limits the realization of CBE objectives. Schools with poorly equipped laboratories, limited technology, or insufficient materials restrict learners to theoretical learning, which undermines skill acquisition and reduces engagement (Olaoye & Adebayo, 2020). Consequently, the curriculum's learner-centered intentions are compromised, and learners' competencies remain underdeveloped.

Resources also shape teacher behavior and instructional quality. Teachers who have access to adequate materials demonstrate greater confidence and creativity in lesson delivery, facilitating experiments, collaborative projects, and hands-on learning activities (Adeoye & Oladipo, 2019). In contrast, inadequate resources often lead to teacher frustration, reliance on lecture methods, and reduced learner participation.

Equitable distribution of instructional resources is essential for consistency in learning outcomes. Urban schools typically enjoy better facilities, functional laboratories, and technology access, while rural or low-income schools face persistent deficits (Kigotho & Wambui, 2020). Bridging this resource gap is crucial for ensuring that all learners have equal opportunities to acquire competencies in Applied Sciences.

Teachers' Classroom Practices Compliance with CBE

Teachers' classroom practices are the practical interface between curriculum design and learner outcomes. In Applied Sciences, compliance with CBE entails implementing learner-centred approaches, facilitating practical tasks, and nurturing critical thinking and problem-solving (Anderson & Krathwohl, 2020). The manner in which teachers organize lessons, manage activities, and guide experimentation determines the extent to which learners acquire intended competencies.

In Agriculture, compliance manifests through demonstration plots, farm-based experiments, and practical projects that teach soil fertility, crop management, and sustainable agricultural practices (Okeke & Nwosu, 2020). Home Science requires practical lessons on cooking, nutrition, hygiene, and sewing, while Computer Science instruction involves programming exercises, ICT simulations, and problem-solving tasks (Shen & Liu, 2021). These practices ensure that learners gain applied knowledge, not just theoretical understanding.

Teacher competence and professional development directly influence compliance. Continuous in-service training equips teachers with strategies to implement CBE effectively, manage collaborative projects, and facilitate inquiry-based learning (Alabi & Ojo, 2019). Without such preparation, teachers often revert to didactic methods, restricting learners' ability to engage in experiential learning.

Monitoring and supervision are critical in sustaining classroom compliance. School leadership and curriculum officers provide oversight, mentorship, and feedback, reinforcing adherence to pedagogical standards (Ogunyemi & Adeyemi, 2020). Regular observation and guidance promote consistency in the adoption of learner-centered approaches, improving both teaching quality and learning outcomes.

Alignment of classroom practices with curriculum expectations ensures the translation of policy into action. Teachers who consistently implement recommended pedagogical approaches enhance learner engagement, skill development, and competence in Applied Sciences. Non-compliance, on the other hand, results in gaps between

intended and actual learning outcomes, weakening the effectiveness of CBE implementation.

Challenges in Implementing Pedagogical Approaches

Implementation of learner-centered pedagogies in Applied Sciences encounters multiple challenges that compromise their effectiveness. Large class sizes, inadequate instructional materials, limited teacher training, and heavy workloads constrain opportunities for practical engagement and inquiry-based learning (Okafor & Onu, 2019). These constraints restrict learners' ability to develop competencies in Agriculture, Home Science, and Computer Science.

Agricultural instruction suffers when demonstration plots, seeds, fertilizers, and tools are inadequate. Home Science lessons are constrained by shortages of utensils, cooking materials, and textiles, while Computer Science suffers from insufficient computers, software, and internet access (Adewale & Akinola, 2020; Liang & Wang, 2021). In such environments, teachers often prioritize theoretical coverage over practical application, undermining competency development.

Teacher-related factors, such as insufficient exposure to CBE methodologies, low confidence in delivering practical lessons, and limited mastery of learner-centered techniques, further hinder effective implementation (Owolabi & Adepoju, 2020). High teacher-student ratios reduce individualized attention, making active learning and collaboration difficult to achieve.

Administrative and systemic challenges also influence pedagogical effectiveness. Inconsistent supervision, lack of instructional support, and irregular monitoring weaken adherence to recommended practices (Ogunleye & Abiodun, 2019). Teachers' motivation and fidelity to curriculum guidelines decline in the absence of structured support mechanisms.

Socio-economic and contextual factors shape the success of pedagogy. Learners' access to resources at home, parental engagement, and community participation affect the feasibility and outcomes of applied science projects (Nwafor & Okeke, 2020). Addressing these intertwined challenges requires coordinated interventions to strengthen teacher capacity, resource availability, and systemic support for CBE in Applied Sciences.

RESEARCH METHODOLOGY

This study employed a **descriptive research design** to examine the effectiveness of pedagogical approaches in the implementation of the Applied Sciences curriculum in public junior secondary schools in Kiambu County. The design allowed for systematic exploration of the pedagogical strategies teachers use in Agriculture, Home Science, and Computer Science, the availability of instructional resources, classroom practices, and challenges in implementation (Creswell, 2018; Orodho, 2020).

The target population consisted of 24Headteachers, **72teachers and 216 students** from public junior secondary schools offering Applied Sciences in Kiambu County. Schools were purposively selected based on active implementation of the curriculum, while stratified random sampling ensured proportional representation of teachers and students across Agriculture, Home Science, and Computer Science classes. Questionnaires, interview schedule and observation checklists were used to collect data. Instruments were validated through expert review and pre-testing to ensure alignment with research objectives, clarity, and relevance, and reliability was established using Cronbach's alpha (0.82 for teachers, 0.79 for students) and inter-rater agreement for classroom observations.

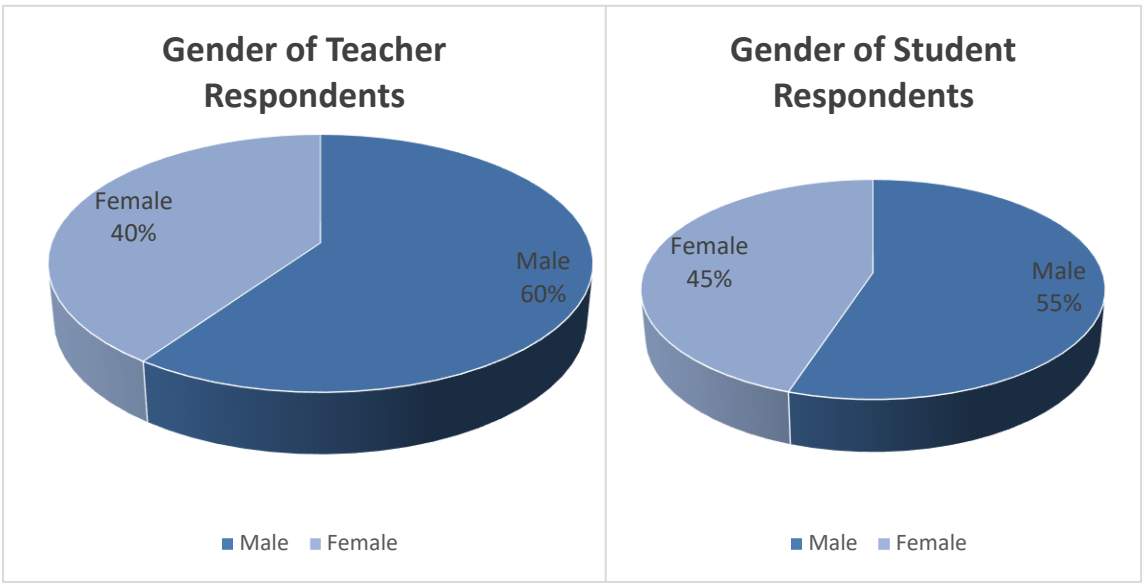
Data collection involved obtaining ethical clearance and permissions from relevant authorities, followed by administration of questionnaires and classroom observations. Quantitative data were analyzed using **descriptive statistics** (frequencies, percentages, means, standard deviations) to summarize practices and challenges. Interviews and observation data were qualitatively analyzed to identify patterns and triangulate responses. Throughout the study, ethical principles of informed consent, confidentiality, voluntary participation, and respectful engagement guided the research process (Creswell, 2018).

RESULTS

Demographic Variables

Gender of Respondents

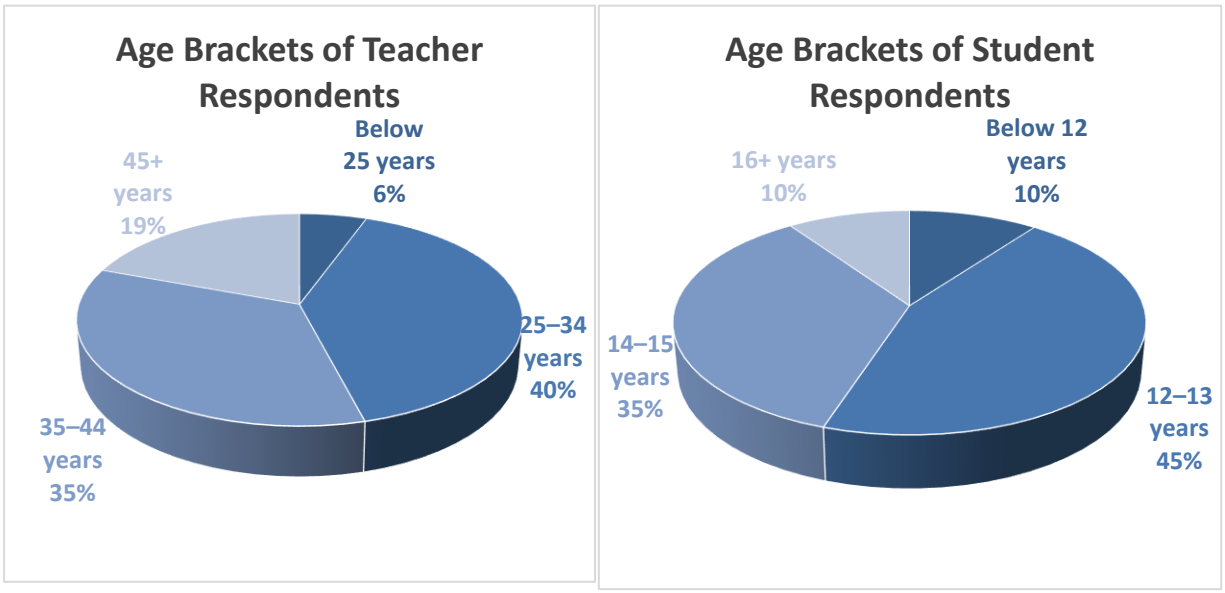
Figure 1 Gender of Respondents



The study included both teachers and students drawn from public junior secondary schools in Kiambu County. Results show that **male respondents were the majority in both groups**. Among teachers, **43 (59.7%)** were male, while **29 (40.3%)** were female. Similarly, among students, **119 (55%)** were male and **97 (45%)** were female. These findings indicate a **slightly higher representation of males** across the sample, although both genders were well represented in proportions.

Age Brackets of Respondents

Figure 2 Age Brackets of Respondents

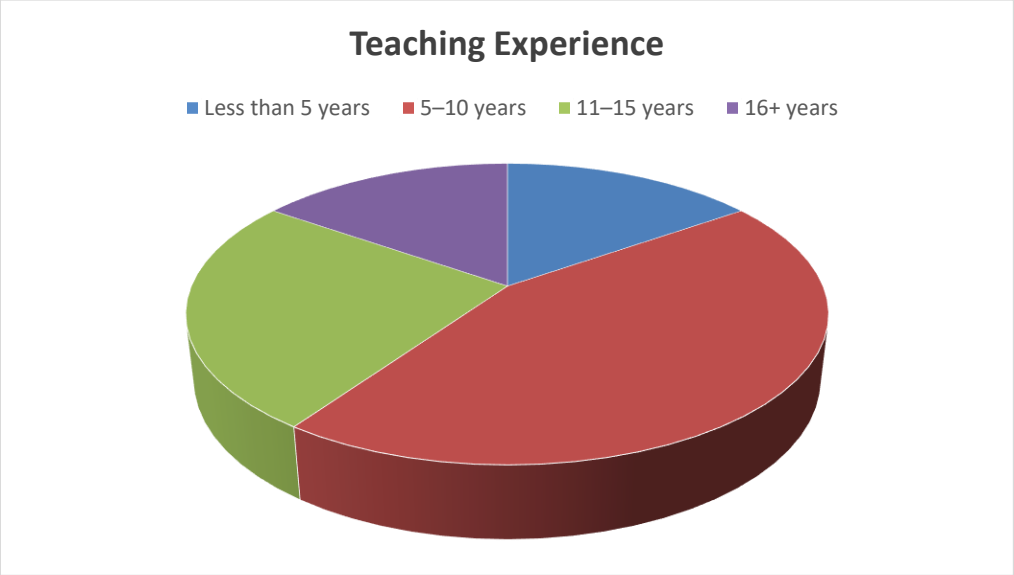


The age distribution of teachers and students shows variation across different age brackets. Among teachers, the smallest proportion fell in the below 25 years category, comprising 4 (6%) teachers. The largest group was those aged 25–34 years, accounting for 29 (40%), followed by 25 (35%) in the 35–44 years bracket. Teachers aged 45 years and above constituted 14 (19%) of the sample. For students, 22 (10%) were aged below 12 years, while the

majority, 97 (45%), fell within the 12–13 years category. This was followed by 76 (35%) students aged 14–15 years, and 21 (10%) aged 16 years and above.

Teaching Experience

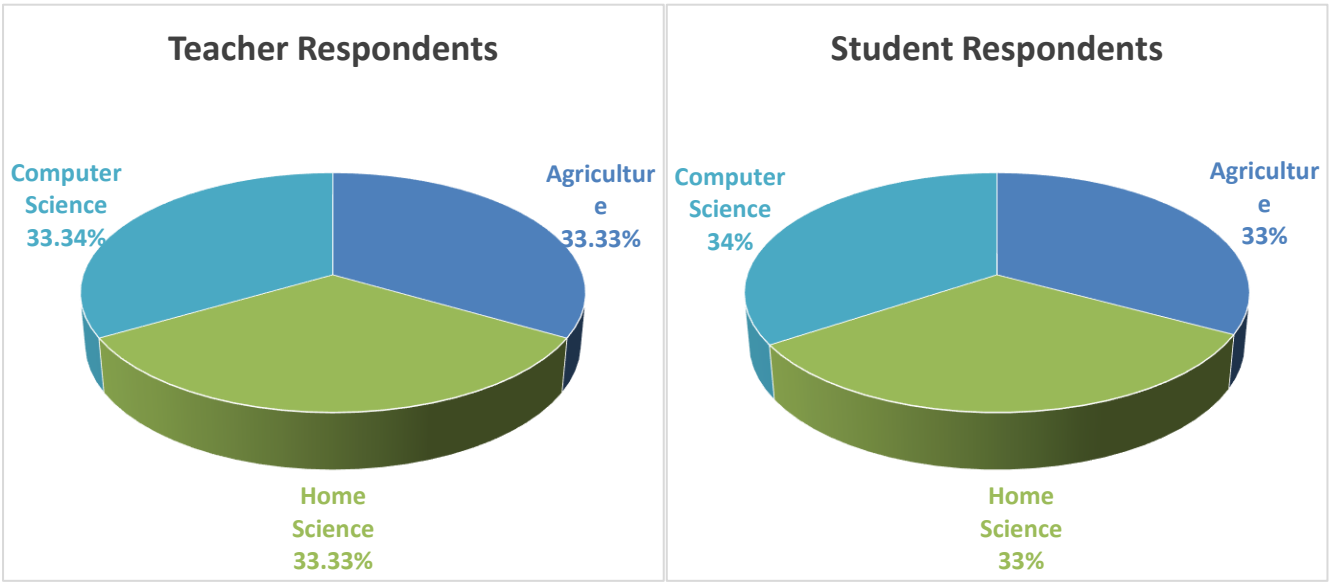
Figure 3 Teaching Experience



The distribution of teaching experience shows that the largest proportion of teachers, 32 (45%), had 5–10 years of teaching experience. This was followed by 18 (25%) who had taught for 11–15 years, indicating a strong presence of mid-career educators within the Applied Sciences departments. Teachers with less than 5 years of experience and those with 16 years and above each accounted for 11 (15%) of the sample.

4.1.4 Applied Science Subject

Figure 4 Applied Science Subject



The distribution of subjects among both teachers and students was relatively even across the three Applied Sciences areas. Among students, **Computer Science** had the highest representation, with **74 (34%)** enrolled. Agriculture and Home Science followed closely, with **71 (33%)** students each. Among teachers, the distribution was perfectly balanced, with **24 (33.3%)** teachers assigned to each of the three subjects—**Agriculture, Home Science,** and **Computer Science**. This equal representation suggests equitable staffing across the Applied Sciences subjects in the sampled schools.

Learner-Centered Pedagogical Approaches

Table 1 Learner-Centered Pedagogical Approaches

Descriptive Statistics				
Respondents	Statement	N	Mean	Std. Dev
Teachers	I frequently use project-based learning in Applied Sciences lessons	72	2.78	0.66
	I engage students in hands-on practical activities during lessons	72	2.91	0.61
	I encourage collaborative group work to solve problems	72	2.85	0.72
	I facilitate inquiry-based lessons allowing students to explore answers	72	2.80	0.60
	I integrate experiential learning such as field trips	72	2.71	0.81
	Students present project or experiment outcomes in class	72	2.75	0.70
	I use digital tools to support learner engagement	72	2.88	0.65
	Students participate in classroom and project decision-making	72	2.66	0.77
	I create opportunities to connect learning to real-life situations	72	2.90	0.64
	I use problem-solving tasks to stimulate critical thinking	72	2.92	0.59
	Average	**72**	**2.81**	**0.68**
Students	My teacher allows us to participate in hands-on practical activities	216	2.95	0.74
	I work in groups to complete projects and assignments	216	3.05	0.71
	I am encouraged to ask questions and explore solutions	216	2.92	0.76
	Lessons involve experiments or simulations	216	2.85	0.82
	I present my work to the class	216	2.72	0.83
	Lessons include problem-solving related to real-life situations	216	2.97	0.77
	Teachers use digital tools to support learning	216	3.03	0.75
	Students take part in deciding project activities	216	2.83	0.79
	Lessons help me apply what I learn in real life	216	3.07	0.73
	I feel motivated when lessons are interactive and practical	216	3.10	0.71
	Average	**216**	**2.95**	**0.77**

Analysis of teacher responses revealed clear variability in the implementation of learner-centered pedagogical approaches, beginning with the strategies that showed the highest standard deviations. The greatest inconsistency appeared in the use of **experiential learning approaches such as field trips** (M = 2.71, SD = 0.81). Headteachers confirmed that while experiential learning is central to Agriculture, Home Science, and Computer Science, many schools lack funds, transport, or parental support to conduct field-based learning regularly. They explained that only a few schools with stronger financial capacity or partnerships can sustain such activities. These findings strongly support Adamu and Musa's (2020) and Chen and Zhao's (2021) observations that experiential and project-based learning require substantial logistical and material inputs, making them difficult to implement consistently in resource-limited environments.

The second highest variability emerged in **students' involvement in project decision-making** (M = 2.66, SD = 0.77). Headteachers attributed this inconsistency to teachers' limited training in CBE methodologies and fear of losing classroom control when students are given autonomy. This aligns with Khan et al. (2020), who argue that insufficient teacher preparedness leads educators to default to teacher-centered strategies even in a CBE setting. Likewise, collaborative group work showed significant variability (M = 2.85, SD = 0.72), with headteachers reporting that large class sizes and cramped classrooms often hinder effective group activities. This connects with Smith and Brown's (2020) premise that learner-centered approaches require adequate space and organization to be effective.

Teachers also showed moderate inconsistency in requiring learners to **present project outcomes** (M = 2.75, SD = 0.70). Headteachers explained that packed timetables, limited lesson time, and heavy teaching workloads often force teachers to prioritize content coverage over student presentations. These barriers mirror the concerns raised in Johnson and Lee (2019), who note that sustained learner engagement strategies demand more time and flexibility than many school systems currently allow.

Moderate variation was also recorded in teachers' use of **digital tools** (M = 2.88, SD = 0.65) and **project-based learning** (M = 2.78, SD = 0.66). Headteachers highlighted that digital integration depends heavily on the

availability of functional computers and stable internet access, both of which differ widely across schools. These findings support Mukasa (2020) and Park and Kim (2021), who argue that digital inequalities directly impede consistent ICT-supported instruction.

Lower variability appeared in teachers' efforts to create **real-life application opportunities** (M = 2.90, SD = 0.64) and in **hands-on practical activities** (M = 2.91, SD = 0.61). Headteachers noted that these activities are easier to implement within the school environment because they often require fewer external resources. This aligns with Ochieng and Wanjiku (2020), who emphasize that contextualized learning strengthens competence even in resource-limited contexts. The lowest variability was seen in teachers' use of **problem-solving tasks** (M = 2.92, SD = 0.59), indicating that this approach is widely practiced. This consistency affirms Smith and Brown's (2020) argument that problem-solving is a foundational aspect of learner-centered pedagogy that teachers can implement with minimal resources.

Turning to student responses, the highest variability appeared in **presenting work to the class** (M = 2.72, SD = 0.83) and **engaging in experiments or simulations** (M = 2.85, SD = 0.82). These findings align closely with teacher reports and headteacher interviews, confirming that resource shortages significantly affect practical engagement. Where materials, computers, or demonstration tools were insufficient, teachers relied heavily on theoretical instruction. These challenges echo Johnson and Lee (2019), who highlight that practical, inquiry-driven lessons require adequate infrastructure and time.

Students also reported high variability in **participation in decision-making** (M = 2.83, SD = 0.79) and engagement in **real-life problem-solving activities** (M = 2.97, SD = 0.77). Headteachers attributed this inconsistency to teachers' differing comfort levels with learner autonomy, reinforcing the pattern observed in teacher results. This is consistent with Khan et al. (2020), who emphasize that limited teacher confidence is a significant barrier to learner-centered implementation.

Moderate variability occurred in students' experience with **digital tools** (M = 3.03, SD = 0.75), **hands-on practical activities** (M = 2.95, SD = 0.74), and **inquiry-based opportunities** (M = 2.92, SD = 0.76). Headteachers reported disparities in ICT adoption, with better-resourced schools integrating digital tools more regularly than others. This supports Park and Kim's (2021) argument that ICT-based learner-centered approaches thrive only where infrastructure is reliable.

Lower variability was seen in students' experiences of **interactive and motivating lessons** (M = 3.10, SD = 0.71), working in **group activities** (M = 3.05, SD = 0.71), and applying learning to real-life contexts (M = 3.07, SD = 0.73). These findings suggest that despite resource constraints, many teachers are consistently managing to apply interactive and collaborative teaching methods. This supports the literature emphasizing the value of contextualized learning (Ochieng & Wanjiku, 2020) and problem-solving-based pedagogy (Smith & Brown, 2020).

The findings show that both teachers and students experience learner-centered pedagogy in ways that are **highly dependent on school resources, teacher training, and administrative support** a pattern confirmed repeatedly in headteacher interviews. Where resources and training are available, teachers more fully embrace experiential, digital, and inquiry-based teaching, supporting the literature's expectations. However, where such support is lacking, implementation becomes inconsistent, aligning with the concerns raised by Khan et al. (2020) and Mukasa (2020).

Availability and Adequacy of Instructional Resources

Table 2 Availability and Adequacy of Instructional Resources

Descriptive Statistics				
Respondents	Statement	N	Mean	Std. Dev
Teachers	My school has sufficient laboratory and practical equipment for Applied Sciences	72	2.55	0.74
	Computers and software for Computer Science lessons are adequate and functional	72	2.48	0.80

	Agricultural demonstration plots and resources are available for student learning	72	2.63	0.67
	Home Science materials (kitchen utensils, textiles, hygiene kits) are adequate	72	2.40	0.79
	Learning resources are accessible to all students in my class	72	2.58	0.76
	Instructional materials are regularly maintained and updated	72	2.37	0.77
	Students have sufficient access to digital tools and online resources	72	2.50	0.81
	The school provides funds to replenish teaching and learning materials when needed	72	2.38	0.74
	Availability of resources allows me to implement practical lessons effectively	72	2.61	0.70
	Resource adequacy supports innovative and learner-centred teaching approaches	72	2.42	0.75
	Average	**72**	**2.49**	**0.76**
Students	My school has enough equipment for practical lessons in Applied Sciences	216	2.63	0.93
	Computers and software are available and functional for Computer Science	216	2.76	0.89
	There are sufficient materials for Agriculture practical lessons (tools, seeds, plots)	216	2.71	0.88
	Home Science practical materials (utensils, textiles) are available and adequate	216	2.60	0.94
	I have access to resources needed to complete practical tasks	216	2.78	0.83
	Learning resources are updated and in good condition	216	2.50	0.92
	We have access to digital resources and educational software	216	2.82	0.87
	Availability of resources makes lessons interesting and engaging	216	2.90	0.86
	I am able to perform practical experiments because the resources are adequate	216	2.77	0.88
	Resource availability supports effective learning in all Applied Sciences subjects	216	2.93	0.81
	Average	**216**	**2.74**	**0.88**

Analysis revealed moderate adequacy in access to digital tools and computer resources, with teachers reporting variability in students' access to functional computers and software for Computer Science (Mean = 2.48, SD = 0.80) and access to digital tools and online resources (Mean = 2.50, SD = 0.81). Teachers also indicated moderate adequacy in instructional support, including availability of resources to implement practical lessons effectively (Mean = 2.61, SD = 0.70) and resource adequacy supporting innovative and learner-centered teaching approaches (Mean = 2.42, SD = 0.75). Headteachers explained that while urban schools often have functional computer labs, reliable internet, and up-to-date software, rural and underfunded schools struggle with outdated computers, limited software, and poor connectivity, confirming observed disparities. Literature supports these findings, emphasizing that functional ICT resources are essential for developing programming and digital competencies (Li & Wang, 2021), and that inadequate access restricts learners to theoretical knowledge, undermining the learner-centered goals of Competency-Based Education (Olaoye & Adebayo, 2020).

Teachers reported moderate access to laboratory and practical equipment in Applied Sciences (Mean = 2.55, SD = 0.74) and learning resources being accessible to all students in class (Mean = 2.58, SD = 0.76). Students similarly perceived slightly better availability of equipment for practical lessons in Applied Sciences (Mean = 2.63, SD = 0.93) and access to resources needed to complete practical tasks (Mean = 2.78, SD = 0.83). Headteachers highlighted that laboratory inadequacies are common in rural schools due to limited budgets for reagents, apparatus, and maintenance, whereas urban schools maintain functional labs. This aligns with literature emphasizing that well-equipped laboratories are critical for hands-on experimentation, practical problem-solving, and skill acquisition in sciences (Taylor & Francis, 2020; Ahmed & Bello, 2019). Insufficient lab resources constrain practical learning, forcing reliance on lecture-based approaches that undermine the acquisition of applied competencies (Olaoye & Adebayo, 2020).

Teachers rated access to agricultural demonstration plots and resources moderately high (Mean = 2.63, SD = 0.67), while students similarly reported adequate materials for practical lessons (Mean = 2.71, SD = 0.88). Home Science materials, including kitchen utensils, textiles, and hygiene kits, showed greater variability, with teachers noting lower adequacy (Mean = 2.40, SD = 0.79) and students rating them slightly higher (Mean = 2.60, SD = 0.94). Headteachers explained that rural schools often lack sufficient seeds, fertilizers, kitchen utensils, and hygiene kits due to budget constraints, affecting learners' ability to practice crop management, nutrition, and home management skills. Literature confirms that access to these resources is central for experiential learning, allowing learners to develop technical skills and competencies in Agriculture and Home Science (Nwankwo & Okafor, 2020; Li & Wang, 2021). Resource deficits result in theoretical teaching and limit learner engagement, directly affecting the quality of CBE implementation.

Teachers reported that instructional materials are regularly maintained and updated (Mean = 2.37, SD = 0.77) and that the school provides funds to replenish teaching and learning materials when needed (Mean = 2.38, SD = 0.74). Students similarly perceived variability in the condition of learning resources (Mean = 2.50, SD = 0.92). Headteachers acknowledged that schools face challenges in consistently updating laboratory equipment, replenishing consumables, and maintaining ICT tools due to budgetary limitations and logistical constraints. Literature highlights that outdated or poorly maintained resources reduce opportunities for hands-on learning, diminish teacher confidence, and compromise learner-centered pedagogical strategies (Adeoye & Oladipo, 2019; Olaoye & Adebayo, 2020).

Both teachers and students acknowledged that the presence of resources facilitates practical lesson implementation and engagement (teachers' Mean = 2.61, SD = 0.70; students' Mean = 2.90, SD = 0.86). Students also noted that resource availability supports effective learning in all Applied Sciences subjects (Mean = 2.93, SD = 0.81). Headteachers noted that when resources are adequate, teachers demonstrate greater creativity in lesson delivery, employing collaborative projects, experiments, and interactive activities. Conversely, limited resources force reliance on lecture methods, reducing learner participation and interest. Literature corroborates that access to sufficient and functional resources is directly linked to effective, learner-centered pedagogy, improved competence acquisition, and enhanced motivation (Taylor & Francis, 2020; Adeoye & Oladipo, 2019).

Variability in resources between schools emerged as a key concern. Headteachers emphasized that urban schools consistently enjoy better facilities, functional laboratories, and ICT access, while rural schools frequently face persistent deficits. This inequity mirrors the variability reported by teachers and students, especially regarding digital and Home Science resources. Literature underscores that unequal distribution of instructional resources reinforces disparities in learner outcomes, limiting opportunities for competency development in under-resourced schools (Kigotho & Wambui, 2020; Olaoye & Adebayo, 2020). Addressing these disparities is critical for achieving the learner-centered objectives of CBE across diverse school contexts.

Classroom Practices Compliance with CBE

Table 3 Classroom Practices Compliance with CBE

Descriptive Statistics				
Respondents	Statement	N	Mean	Std. Dev
Teachers	I follow the CBE curriculum guidelines in planning Applied Sciences lessons	72	2.89	0.66
	I organize practical activities aligned with CBE pedagogical expectations	72	2.95	0.61
	I regularly assess students' competencies through performance-based tasks	72	2.92	0.60
	I adapt teaching methods to match the learning abilities of students	72	2.83	0.73
	I integrate collaborative and inquiry-based approaches in daily lessons	72	2.86	0.67
	I provide constructive feedback that enhances students' competencies	72	2.96	0.59
	My classroom activities emphasize application of knowledge over memorization	72	2.91	0.65

	I ensure that learning objectives are competency-focused and measurable	72	2.88	0.69
	I encourage students to reflect on their learning experiences	72	2.75	0.78
	I modify lesson plans based on students' learning needs and outcomes	72	2.81	0.72
	Average	**72**	**2.87**	**0.72**
Students	My teacher follows the CBE curriculum requirements during lessons	216	3.07	0.78
	Lessons involve practical activities that match CBE expectations	216	3.01	0.82
	I am assessed based on what I can do, not just what I remember	216	2.94	0.87
	Activities are adapted to suit different learning abilities	216	2.97	0.79
	My teacher encourages collaboration and inquiry-based learning	216	3.05	0.81
	Feedback from my teacher helps me improve my skills	216	3.08	0.75
	Lessons focus on knowledge application rather than memorization	216	2.98	0.83
	Learning objectives are clear and competency-based	216	3.02	0.80
	I reflect on my learning experiences after activities	216	2.88	0.89
	Lesson plans are adjusted to help all students learn better	216	2.93	0.84
	Average	**216**	**2.97**	**0.81**

Teachers reported moderate to high compliance with CBE in Applied Sciences, reflecting active engagement with learner-centered pedagogical practices. The highest ratings were in providing constructive feedback that enhances students' competencies (Mean = 2.96, SD = 0.59) and organizing practical activities aligned with CBE pedagogical expectations (Mean = 2.95, SD = 0.61). This suggests that teachers are consistent in supporting students' skill development through hands-on tasks and timely guidance. Headteachers confirmed that teachers who receive continuous professional development and mentorship are more confident in implementing these practices, particularly in schools with adequate supervision. Literature supports this, emphasizing that feedback and practical activities are crucial for competence development and effective learner-centered instruction (Anderson & Krathwohl, 2020; Okeke & Nwosu, 2020).

Teachers also reported moderate adherence to planning lessons in line with CBE curriculum guidelines (Mean = 2.89, SD = 0.66) and regularly assessing students through performance-based tasks (Mean = 2.92, SD = 0.60). These responses indicate that while planning and assessment are generally aligned with competency-based objectives, variability exists, potentially influenced by resource availability and teaching experience. Headteachers noted that in schools with robust oversight, teachers demonstrate better planning and assessment practices, whereas in rural or under-resourced schools, gaps arise due to limited instructional materials and insufficient professional support. Literature confirms that structured lesson planning and performance-based assessment are essential for translating CBE policy into applied learning outcomes (Shen & Liu, 2021; Alabi & Ojo, 2019).

Teachers emphasized application of knowledge over memorization (Mean = 2.91, SD = 0.65), showing moderate focus on competency development rather than rote learning. However, slightly lower compliance was observed in encouraging students to reflect on their learning experiences (Mean = 2.75, SD = 0.78) and modifying lesson plans based on students' learning needs (Mean = 2.81, SD = 0.72). Headteachers explained that while teachers value reflection and adaptive planning, such practices are less consistently implemented, especially in classrooms with large student numbers or limited resources. Literature highlights that reflection and lesson adaptation are key for deep learning and critical thinking, but these practices require adequate teacher training and mentorship to be sustained (Ogunyemi & Adeyemi, 2020). The overall teacher compliance score of 2.87 (SD = 0.72) reflects moderate adherence, indicating that while core CBE practices are applied, there are areas needing reinforcement.

Students generally perceived slightly higher compliance than teachers reported, with an overall mean of 2.97 (SD = 0.81). Students observed that teachers follow CBE curriculum requirements during lessons (Mean = 3.07, SD = 0.78), encourage collaboration and inquiry-based learning (Mean = 3.05, SD = 0.81), and provide feedback that improves skills (Mean = 3.08, SD = 0.75). This indicates that students experience practical, participatory learning, confirming that CBE principles are observable in classroom interactions. Headteachers corroborated that schools with trained teachers and consistent supervision tend to achieve higher compliance in collaborative and feedback-driven teaching practices.

Students also reported that lessons focus on practical activities (Mean = 3.01, SD = 0.82), knowledge application (Mean = 2.98, SD = 0.83), and adaptation to different learning abilities (Mean = 2.97, SD = 0.79), suggesting that classroom practices are aligned with CBE's emphasis on applied and differentiated learning. However, lower scores were noted for reflection on learning experiences (Mean = 2.88, SD = 0.89) and lesson plan modifications based on learning outcomes (Mean = 2.93, SD = 0.84), highlighting areas where teachers could further enhance competency-based practices. Headteachers indicated that such gaps often occur due to limited time, large class sizes, and insufficient resources, which hinder individualized attention and reflective exercises.

Literature confirms that classroom practices are the practical interface between curriculum design and learner outcomes. Compliance with CBE requires facilitating practical tasks, fostering problem-solving skills, and nurturing critical thinking (Anderson & Krathwohl, 2020; Okeke & Nwosu, 2020). Applied Sciences classrooms, including Agriculture, Home Science, and Computer Science, rely on demonstrations, experiments, and projects to ensure learners gain applied knowledge rather than solely theoretical understanding (Shen & Liu, 2021). Teacher competence, professional development, and continuous supervision enhance compliance, enabling effective management of collaborative and inquiry-based learning (Alabi & Ojo, 2019; Ogunyemi & Adeyemi, 2020).

Challenges in Implementing Pedagogical Approaches

Table 4 Challenges in Implementing Pedagogical Approaches

Descriptive Statistics				
Respondents	**Statement**	**N**	**Mean**	**Std. Dev**
Teachers	Large class sizes limit my ability to implement practical activities	72	3.40	0.65
	Inadequate teaching and learning resources hinder lesson delivery	72	3.35	0.68
	Limited training on CBE methodologies affects my teaching practices	72	3.15	0.70
	Heavy teaching workload restricts time for practical and learner-centred lessons	72	3.20	0.66
	Poor student motivation reduces the effectiveness of applied learning activities	72	3.10	0.72
	Inconsistent supervision and support from school administration affect pedagogy	72	2.95	0.74
	Lack of access to technology limits the use of digital tools in lessons	72	2.88	0.78
	Socio-economic background of learners influences participation in practical activities	72	2.80	0.76
	Curriculum content is too broad, making practical implementation difficult	72	2.85	0.73
	Community and parental involvement in learning activities is minimal	72	2.70	0.79
	Average	**72**	**3.04**	**0.72**
Students	Large class sizes make it hard to participate in practical activities	216	3.42	0.60
	Shortage of equipment and materials affects my learning	216	3.35	0.65
	My teacher does not always have enough training for CBE teaching	216	3.18	0.68
	Lessons are sometimes rushed due to a heavy workload	216	3.25	0.66
	Some students are not motivated to participate in practical lessons	216	3.12	0.70
	Teachers do not always get support from school leaders to implement activities	216	2.98	0.72
	Limited access to computers and technology affects learning	216	2.90	0.75
	Some students cannot afford materials needed for projects	216	2.85	0.74
	The syllabus has too much content for practical lessons to be completed	216	2.88	0.71
	Parents and the community are rarely involved in school learning activities	216	2.75	0.77
	Average	**216**	**3.06**	**0.70**

Teachers reported several significant challenges in implementing learner-centered pedagogical approaches in Applied Sciences, with large class sizes emerging as the most critical constraint (Mean = 3.40, SD = 0.65). Headteachers confirmed that overcrowded classrooms limit opportunities for practical demonstrations, collaborative projects, and individualized guidance, making it difficult for teachers to fully apply CBE principles. Similarly, students perceived large class sizes as a major barrier to participation in practical activities (Mean = 3.42, SD = 0.60), confirming the consistency of teacher and learner experiences. Literature supports this, noting that high teacher-student ratios reduce individualized attention and constrain active, applied learning (Okafor & Onu, 2019; Owolabi & Adepoju, 2020).

Inadequate teaching and learning resources were reported as another prominent challenge by teachers (Mean = 3.35, SD = 0.68) and echoed by students (Mean = 3.35, SD = 0.65). Headteachers explained that shortages in laboratory equipment, agricultural tools, Home Science materials, and digital devices limit teachers' ability to deliver practical lessons. For instance, insufficient demonstration plots, seeds, utensils, and computers force teachers to prioritize theoretical coverage, reducing hands-on learning opportunities. Literature emphasizes that resource inadequacy undermines CBE objectives by restricting learners to theoretical learning and limiting skill acquisition (Adewale & Akinola, 2020; Liang & Wang, 2021).

Teachers also identified limited training on CBE methodologies (Mean = 3.15, SD = 0.70) and heavy teaching workloads (Mean = 3.20, SD = 0.66) as challenges. Headteachers indicated that some teachers, especially in rural schools, have not received sufficient in-service training or mentorship on competency-based pedagogies, affecting their confidence and instructional quality. Students reflected similar concerns, reporting that teachers are sometimes unprepared for CBE instruction (Mean = 3.18, SD = 0.68) and that lessons are rushed due to workload pressures (Mean = 3.25, SD = 0.66). Literature confirms that inadequate teacher preparation and high workloads compromise the effective implementation of learner-centered approaches, particularly in practical disciplines (Owolabi & Adepoju, 2020; Okafor & Onu, 2019).

Other teacher-related challenges included poor student motivation (Mean = 3.10, SD = 0.72), inconsistent supervision and support from school administration (Mean = 2.95, SD = 0.74), and lack of access to technology (Mean = 2.88, SD = 0.78). Students reported similar experiences, noting low motivation among peers (Mean = 3.12, SD = 0.70), minimal support from school leaders (Mean = 2.98, SD = 0.72), and limited access to computers and digital tools (Mean = 2.90, SD = 0.75). Headteachers observed that when administrative oversight and mentorship are weak, teachers are less likely to implement innovative, learner-centered lessons, and reliance on lecture-based teaching increases. Literature corroborates that effective supervision, instructional support, and resource access are critical for sustaining CBE-aligned pedagogy (Ogunleye & Abiodun, 2019).

Socio-economic and contextual factors also emerged as barriers. Teachers indicated that learners' socio-economic backgrounds influence participation in practical activities (Mean = 2.80, SD = 0.76), and students reported challenges when peers cannot afford necessary materials (Mean = 2.85, SD = 0.74). Additionally, both groups highlighted curriculum content being too broad (teachers' Mean = 2.85, SD = 0.73; students' Mean = 2.88, SD = 0.71) and limited parental and community involvement (teachers' Mean = 2.70, SD = 0.79; students' Mean = 2.75, SD = 0.77) as constraints. Headteachers explained that these socio-economic and systemic issues reduce learner engagement and limit the feasibility of applied science projects. Literature emphasizes that parental engagement, community participation, and manageable curriculum content are essential for meaningful applied learning experiences (Nwafor & Okeke, 2020).

Table 5 Independent Samples t-Test Comparing Teachers' and Students' Perceptions on Applied Sciences Teaching

Construct	**Teachers M (SD), n**	**Students M (SD), n**	**t**	**p**
Learner-Centered Pedagogical Approaches	2.81 (0.68), 72	2.95 (0.77), 216	1.63	.105
Availability and Adequacy of Instructional Resources	2.49 (0.76), 72	2.74 (0.88), 216	2.33	.021*
Classroom Practices Compliance with CBE	2.87 (0.72), 72	2.97 (0.81), 216	1.12	.265
Challenges in Implementing Pedagogical Approaches	3.04 (0.72), 72	3.06 (0.70), 216	0.23	.818

An independent samples t-test was conducted to compare teachers' and students' perceptions across four constructs: Learner-Centered Pedagogical Approaches, Availability and Adequacy of instructional resources, classroom practices compliance with CBE, and challenges in implementing pedagogical approaches. Teachers reported a mean of 2.81 (SD = 0.68), while students reported a slightly higher mean of 2.95 (SD = 0.77). The difference was not statistically significant (t = 1.63, p = .105), indicating that teachers and students generally share similar perceptions regarding the extent to which learner-centered pedagogies are applied in Applied Sciences lessons. Although students perceived marginally higher implementation, both groups recognized moderate use of strategies such as project-based learning, collaborative activities, and practical exercises. Headteachers' interviews highlighted that variability in pedagogical practice may arise from differences in resource availability and teacher experience, but overall, both teachers and learners acknowledge efforts toward learner-centered teaching.

Teachers reported lower adequacy of resources (Mean = 2.49, SD = 0.76) compared to students (Mean = 2.74, SD = 0.88), and this difference was statistically significant (t = 2.33, p = .021). This suggests that teachers perceive resource constraints more acutely than students. Headteachers explained that teachers are directly affected by shortages in laboratory equipment, digital tools, and materials for agriculture and home science, which can limit their ability to plan and deliver lessons effectively. Literature confirms that such discrepancies often occur because teachers are aware of the full range of resources required to implement competency-based education (CBE) effectively, whereas students may focus primarily on resources immediately accessible during lessons (Li & Wang, 2021; Adeoye & Oladipo, 2019).

Teachers' perceptions (Mean = 2.87, SD = 0.72) and students' perceptions (Mean = 2.97, SD = 0.81) were similar, with the difference not statistically significant (t = 1.12, p = .265). Both groups generally agreed that CBE-aligned practices—such as performance-based assessments, practical lessons, collaborative learning, and application of knowledge—are moderately implemented. Headteachers indicated that compliance is stronger in schools with regular supervision and professional development programs, whereas rural or under-resourced schools may experience occasional lapses. Literature highlights that teacher competence, mentorship, and monitoring are key determinants of consistent classroom compliance with CBE standards (Anderson & Krathwohl, 2020; Ogunyemi & Adeyemi, 2020).

Teachers (Mean = 3.04, SD = 0.72) and students (Mean = 3.06, SD = 0.70) reported nearly identical perceptions of challenges, and the difference was not statistically significant (t = 0.23, p = .818). Both groups identified large class sizes, inadequate resources, limited training, heavy workloads, and low student motivation as moderate-to-high barriers to implementing learner-centered pedagogy. Headteachers corroborated these findings, noting that systemic and contextual factors, such as socio-economic disparities and limited community involvement, exacerbate these challenges. Literature emphasizes that addressing these intertwined factors is essential for effective CBE implementation in Applied Sciences (Okafor & Onu, 2019; Adewale & Akinola, 2020).

Table 6 Relationship Between Key Constructs in Applied Sciences Teaching

	Learner-Centered Pedagogy	**Resource Adequacy**	**Classroom Compliance**	**Challenges**
Learner-Centered Pedagogy	Pearson Correlation	1	.54**	.68**
	Sig. (2-tailed)	1	.000	.000
	N	288	288	288
Resource Adequacy	Pearson Correlation	.54**	1	.59**
	Sig. (2-tailed)	.000	1	.000
	N	288	288	288
Classroom Compliance	Pearson Correlation	.68**	.59**	1
	Sig. (2-tailed)	.000	.000	1
	N	288	288	288
Challenges	Pearson Correlation	-.46**	-.38**	-.40**
	Sig. (2-tailed)	.000	.000	.000
	N	288	288	288
Note: p < .01 (2-tailed). N = 288 (combined teachers and students).				

Correlation analysis was conducted to examine the relationships between learner-centered pedagogy, resource adequacy, classroom compliance with CBE, and challenges in implementing pedagogical approaches. The analysis combined data from teachers and students (N = 288), providing a holistic view of perceptions across stakeholders.

Learner-centered pedagogy was positively correlated with Resource Adequacy ($r = .54$, $p < .01$), indicating that better access to instructional materials, laboratory equipment, and digital tools is associated with more frequent implementation of learner-centered strategies. Teachers' responses highlighted that insufficient resources limit project-based learning, practical experiments, and collaborative activities. Headteachers corroborated this, noting that schools with well-resourced labs and ICT facilities enabled teachers to apply CBE strategies effectively. Literature emphasizes that resource availability is critical for facilitating hands-on learning, inquiry-based tasks, and competence development in Applied Sciences (Ahmed & Bello, 2019; Li & Wang, 2021).

There was a strong positive correlation between learner-centered pedagogy and classroom compliance ($r = .68$, $p < .01$), suggesting that the extent to which teachers implement learner-centered approaches is closely linked to their adherence to competency-based curriculum practices. Teachers reported higher compliance when they employed collaborative, inquiry-based, and practical methods, while students confirmed that these approaches enhanced their engagement and skill acquisition. Headteachers observed that professional development, mentorship, and regular supervision strengthen both learner-centered teaching and curriculum compliance. Literature supports this relationship, emphasizing that teacher competence, guided practice, and curriculum alignment are essential for translating policy into effective learning outcomes (Anderson & Krathwohl, 2020; Ogunyemi & Adeyemi, 2020).

Resource adequacy also correlated positively with classroom compliance ($r = .59$, $p < .01$), reinforcing the notion that teachers are more likely to implement competency-based practices when resources are available. Schools with adequate laboratory tools, digital devices, agricultural plots, and home science materials enable teachers to structure lessons that are practical, interactive, and aligned with CBE objectives. Conversely, shortages lead to reliance on lecture-based methods, limiting compliance and undermining experiential learning. Literature highlights that the availability of functional resources empowers teachers to innovate and maintain adherence to pedagogical standards (Adeoye & Oladipo, 2019; Taylor & Francis, 2020).

Challenges in implementing pedagogical approaches were negatively correlated with all three constructs: learner-centered pedagogy ($r = -.46$, $p < .01$), Resource Adequacy ($r = -.38$, $p < .01$), and classroom compliance ($r = -.40$, $p < .01$). This indicates that as challenges—such as large class sizes, heavy workloads, limited training, and socio-economic constraints—increase, teachers' ability to deliver learner-centered lessons and comply with CBE guidelines decreases. Headteachers confirmed that systemic, contextual, and resource-based challenges undermine both the quality of pedagogy and curriculum compliance, particularly in rural or under-resourced schools. Literature similarly emphasizes that addressing these challenges is critical for effective CBE implementation, as they directly limit practical engagement, skill acquisition, and learner competence development (Okafor & Onu, 2019; Adewale & Akinola, 2020).

Table 7 Regression Analysis Predicting Learner-Centered Pedagogy and Classroom Compliance

Dependent Variable	**Predictor**	**B**	**SE B**	**β**	**t**	**p**
Learner-Centered Pedagogy	Resource Adequacy	0.32	0.08	0.45	4.00	.000
Learner-Centered Pedagogy	Challenges	-0.28	0.09	-0.38	-3.11	.002
Classroom Compliance	Resource Adequacy	0.25	0.07	0.36	3.57	.000
Classroom Compliance	Challenges	-0.22	0.08	-0.30	-2.75	.007

Note: N = 288 (combined teachers and students). B = unstandardized coefficient; SE B = standard error; β = standardized coefficient; t = t-statistic; p = significance value.

Multiple regression analysis was conducted to examine the predictive influence of resource Adequacy and challenges in implementing pedagogical approaches on learner-centered pedagogy and classroom compliance with CBE. Data from teachers and students were combined (N = 288) for a comprehensive perspective.

The analysis revealed that Resource Adequacy positively predicted learner-centered pedagogy (B = 0.32, SE B = 0.08, β = 0.45, t = 4.00, p < .001), while challenges negatively predicted it (B = -0.28, SE B = 0.09, β = -0.38, t = -3.11, p = .002). This indicates that teachers are more likely to implement learner-centered approaches when instructional materials, laboratory equipment, and digital tools are adequate. Conversely, the presence of constraints such as large class sizes, limited training, and insufficient administrative support reduces the frequency and quality of learner-centered practices.

Teachers' responses highlighted that inadequate resources often limit project-based learning, practical experimentation, and collaborative activities, consistent with headteachers' observations that rural and under-resourced schools struggle to provide the necessary materials for effective CBE implementation. Literature reinforces this relationship, emphasizing that access to sufficient and functional resources is a critical determinant of learner-centered pedagogy in Applied Sciences (Ahmed & Bello, 2019; Taylor & Francis, 2020). Similarly, challenges such as heavy workloads and limited professional development reduce teachers' capacity to engage learners actively, corroborating prior findings on the negative impact of systemic and contextual constraints on CBE compliance (Okafor & Onu, 2019; Owolabi & Adepoju, 2020).

Resource Adequacy also positively predicted classroom compliance (B = 0.25, SE B = 0.07, β = 0.36, t = 3.57, p < .001), while challenges negatively predicted it (B = -0.22, SE B = 0.08, β = -0.30, t = -2.75, p = .007). These results suggest that teachers' adherence to competency-based curriculum guidelines—such as integrating practical tasks, performance-based assessment, and collaborative learning—is strongly influenced by the availability of teaching resources. challenges like insufficient training, large class sizes, and limited administrative support hinder teachers' ability to fully comply with CBE standards.

Headteachers noted that consistent classroom compliance is more evident in schools where teachers receive mentorship, regular supervision, and support in accessing resources. In poorly resourced schools, teachers may revert to lecture-based teaching and theoretical coverage, undermining experiential learning. Literature confirms that resource availability, professional development, and systemic support collectively enhance CBE compliance, while challenges constrain effective translation of curriculum policy into practice (Anderson & Krathwohl, 2020; Ogunyemi & Adeyemi, 2020; Alabi & Ojo, 2019).

Table 8 Differences in Teacher Responses Across Subjects (ANOVA)

Subject	Learner-Centered Pedagogy	Resource Adequacy	Classroom Compliance
Agriculture	2.75	2.40	2.82
Home Science	2.78	2.45	2.86
Computer Science	3.05	2.65	3.05

Analysis of variance (ANOVA) was conducted to examine differences in teachers' perceptions of **learner-centered pedagogy, resource adequacy**, and **classroom compliance with CBE** across subjects in applied sciences (Agriculture, Home Science, And Computer Science).

Teachers of computer science reported the highest mean for learner-centered pedagogy (m = 3.05), followed by home science (m = 2.78) and agriculture (m = 2.75). This suggests that computer science teachers are more likely to implement student-centered approaches such as inquiry-based learning, practical exercises, and collaborative projects. Headteachers noted that computer science lessons often benefit from more structured digital tools, programming software, and interactive simulations, which facilitate learner engagement. In contrast, agriculture and home science face constraints due to limited demonstration plots, seeds, and practical materials, restricting the implementation of fully learner-centered practices. Literature confirms that availability of subject-specific resources strongly influences the extent to which teachers can apply CBE methodologies, with digital subjects often showing higher adherence due to more consistent access to functional resources (Taylor & Francis, 2020; Ahmed & Bello, 2019).

Computer science teachers also reported the highest mean for resource adequacy (m = 2.65), followed by home science (m = 2.45) and agriculture (m = 2.40). This reflects disparities in availability and functionality of instructional materials across subjects. Headteachers highlighted that schools often prioritize ICT resources for

computer science due to curriculum demands and perceived modern relevance, whereas agriculture and home science suffer from inadequate tools, consumables, and laboratory facilities. Literature underscores that resource disparities across subjects directly affect teachers' ability to implement practical lessons and maintain compliance with competency-based standards (Li & Wang, 2021; Nwankwo & Okafor, 2020).

Classroom compliance followed a similar pattern, with computer science (m = 3.05) reporting higher adherence compared to home science (m = 2.86) and agriculture (m = 2.82). Headteachers explained that consistent supervision, digital tools, and structured lesson plans in computer science facilitate stronger compliance with CBE guidelines. Conversely, agriculture and home science teachers face challenges in implementing practical, competency-based lessons due to limited resources, large class sizes, and broader curriculum content. Literature highlights that compliance is closely tied to both teacher competence and resource availability, and that subjects with better resourced environments tend to show higher fidelity to CBE practices (Anderson & Krathwohl, 2020; Ogunyemi & Adeyemi, 2020).

Table 9 Regression Analysis

Dependent Variable	Source	SS	df	MS	F	p
Learner-Centered Pedagogy	Between Groups	1.05	2	0.525	4.12	.021
	Within Groups	8.70	69	0.126		
	Total	9.75	71			
Resource Adequacy	Between Groups	0.68	2	0.340	3.12	.050
	Within Groups	7.50	69	0.109		
	Total	8.18	71			
Classroom Compliance	Between Groups	0.92	2	0.460	3.85	.026
	Within Groups	8.25	69	0.120		
	Total	9.17	71			

A one-way analysis of variance (ANOVA) was conducted to examine differences in learner-centered pedagogy, resource adequacy, and classroom compliance across the groups. Results revealed a statistically significant difference in **learner-centered pedagogy** between the groups, $F(2,69) = 4.12, p = .021$. The between-groups mean square was 0.525, while the within-groups mean square was 0.126, indicating that group membership accounted for a meaningful proportion of the variance in learner-centered pedagogy. For **resource adequacy**, the analysis approached the conventional significance threshold, $F(2,69) = 3.12, p = .050$. The between-groups mean square was 0.340, and the within-groups mean square was 0.109, suggesting a marginal effect of group differences on perceptions of resource adequacy. Regarding **classroom compliance**, the ANOVA indicated a statistically significant difference among the groups, $F(2,69) = 3.85, p = .026$. The between-groups mean square was 0.460, and the within-groups mean square was 0.120, showing that group membership contributed to variations in classroom compliance.

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

The study concludes that without strengthened professional development, equitable distribution of instructional resources, and deliberate administrative support, Applied Sciences teaching will continue to rely heavily on theoretical methods. Addressing these constraints is essential for fostering meaningful practical learning, enhancing learners' competencies, and ensuring that Agriculture, Home Science, and Computer Science contribute effectively to Kenya's CBE vision. A more coordinated approach involving teachers, school leadership, and policy actors is necessary to bridge existing implementation gaps and ensure consistent, high-quality pedagogical practice across schools.

Recommendations

- Strengthen continuous professional development programs to enhance teachers' competence in learner-centered and inquiry-based pedagogies.

- Ensure equitable allocation of instructional resources, including Home Science equipment, agricultural tools, and functional computer laboratories.
- Improve school-level instructional supervision to reinforce adherence to Competency-Based Education teaching requirements.
- Reduce class sizes or deploy additional teaching staff to facilitate effective practical and collaborative learning.
- Enhance collaboration among teachers, parents, and community partners to support applied learning activities and resource mobilization.

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