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Assessing the Impact of CL4TEM Innovation on Teaching Practices of Kaduna State University Science Education Department Lecturers Using the Individual Innovativeness Scale

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ABSTRACT

This study assesses the impact of CL4STEM (Connected Learning for STEM) innovation on the teaching practices of lecturers in the Science Education Department at Kaduna State University (KASU) using the Individual Innovativeness Scale (IIS). The CL4STEM framework, stems from Connected Learning for STEM (CL4STEM), an innovative project aimed at teacher capacity building in sciences and mathematics involving communities of practice as its component to developing teachers' ability to adopt an innovative approach to science instruction and to implement a novel curriculum.

A mixed-methods research design was employed, combining quantitative surveys with the IIS to categorize lecturers based on their innovativeness levels (Innovators, Early Adopters, Early Majority, Late Majority, and Laggards) and qualitative focus group discussions (FGDs) to explore their perceptions, challenges, and institutional support needs. Descriptive statistics, correlation analysis, and thematic analysis were used to examine the relationship between lecturers' innovativeness levels and their adoption of CL4STEM methodologies.

Findings reveal that there is a positive correlation between Teacher Educators' (lecturers who have taken part in the CL4STEM project) exposure to CL4STEM teaching practices and their level of innovativeness. These Teacher Educators (TE) were found out to be within the Innovators and Early Adopters categories. Key benefits of the CL4STEM innovative practices reported included enhanced student engagement, which impact conceptual understanding, critical thinking and problem-solving skills of students. However, challenges such as resistance to change, inadequate infrastructure, lack of training, and assessment difficulties hinder full implementation. Institutional support in the form of training, incentives, and technology integration was identified as a critical enabler for CL4STEM adoption. The study recommends strategic interventions to enhance faculty readiness, address barriers, and create an enabling environment for sustainable innovation in STEM teaching.

Keywords: CL4STEM, Faculty Adoption, Individual Innovativeness Scale, STEM Education, Teaching Innovation,

INTRODUCTION

Background of the Study

The rapid advancement of technology and innovative pedagogies in education has significantly influenced teaching and learning methodologies. In higher education, particularly in science education, there is a growing need to incorporate innovative instructional strategies that enhance engagement, critical thinking, and problem-solving skills among students (OECD, 2018). One such initiative is the CL4STEM (Connected Learning for STEM), an educational innovation aimed at improving science, technology, engineering, and mathematics (STEM), instruction through collaborative learning and modern digital tools (Johnson, Adams Becker, Estrada,

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& Freeman 2015). According to Obaje, Adamu, Garba, Daniyan, Kawu, Musa, Majiya & Ibrahim, (2022), many teachers teach STEM subjects (in this case: Biology, Chemistry, Physics, and Mathematics) with low capacity and poor instructional materials. Furthermore, in many of these schools, the female students are less likely to take STEM subjects in their courses of choice.

Kaduna university (KASU) is one of the institutions striving to enhance the quality of STEM education through innovative teaching practices. However, the adoption of such innovations depends on various factors, including the willingness and capability of lecturers to integrate these practices into their teaching methodologies. The individual innovativeness scale (IIS), developed by Hurt, Joseph, and Cook (1977) is a widely used instrument for assessing individuals' propensity to adopt innovations. By employing this scale, this study seeks to evaluate how CL4STEM has influenced the teaching practices of science education lecturers at KASU.

Using newly qualified teachers (NQTs) who have received orientation training to pilot curated OER modules, develop new pedagogical practices, and learn how to use ICT to implement curated subject specific OERs, the CL4STEM project was piloted in a few secondary schools in three states in Nigeria: Niger, Kaduna and Kano States, with the aim of using innovative educational resources and strategies to enhance the capacity of secondary schools teachers, making the teaching of STEM subjects more inclusive and thus achieving better learning outcomes. it is thus expected that this will in turn promote the knowledge and interest of secondary schools in STEM subjects, thus enhancing national technological development (Obaje *et al.,* 2024) The project used online communities of practice (CoP) and ICT to provide academic support while expert teacher educators offer NQTs academic and technical support as they pilot the topic modules in STEM classrooms using active pedagogy and Universal Design for Learning (UDL) principles within the framework of the CL4STEM project CoP (Mustapha *et al*., 2022).

Statement of the Problem

Despite the recognized benefits of CL4STEM, its effectiveness depends largely on lecturers' readiness to embrace and implement innovative teaching strategies. In Low and Medium Income Countries, some lecturers may readily adopt new methods, while others may resist change due to various barriers. In the Nigerian context, the Global Partnership for Education's Knowledge and Innovation Exchange (KIX) thematic group (Obaje *et al*, 2003) has identified three key challenges in improving teaching and learning processes in the context of developing countries.

1. The poor quality of support to teacher development, including weak initial teacher education and subsequent professional development programmes,
2. Inadequate teaching methods and learning materials, particularly in local languages and accessible to learners,
3. Lack of robust systems for recruiting, managing and engaging' teachers, in terms of attracting and retaining the most qualified individuals to the teaching profession, teacher deployment to underserved and difficult to reach areas of the country, reducing unauthorized teacher absences and maximizing instructional time, and engaging teachers in policy dialogue and reform.

At Kaduna State University, there has been limited empirical research assessing the extent to which CL4STEM has impacted teaching practices. Moreover, little is known about the levels of individual innovativeness among science education lecturers and how this affects their adoption of new instructional strategies. Thus, this study aims to bridge this gap by utilizing the Individual Innovativeness Scale to evaluate the correlation between lecturers' innovativeness and their adoption of CL4STEM innovative practices.

Research Objectives

This study aims to:

1. Assess the level of individual innovativeness among science education lecturers at Kaduna State University.
2. Determine the extent to which CL4STEM has influenced teaching methods in science education.

3. Analyze the relationship between lecturers' innovativeness and their adoption of CL4STEM instructional approaches.

4. Identify the key barriers and facilitators to the adoption of CL4STEM.

Research Questions

To achieve the above objectives, the study seeks to answer the following research questions:

1. What is the level of individual innovativeness among Science Education lecturers at KASU?

2. How has CL4STEM influenced teaching practices in the Science Education Department?

3. Is there a correlation between lecturers' innovativeness levels and their adoption of CL4STEM?

4. What are the major challenges and opportunities in integrating CL4STEM into science education at KASU?

LITERATURE REVIEW

Introduction

The integration of innovative teaching methodologies in higher education is crucial for improving instructional effectiveness and student engagement. The CL4STEM Innovation (Connected Learning for STEM) aims to enhance STEM education through innovative pedagogical strategies. The individual Innovativeness Scale (IIS), developed by Hurt, Joseph, and Cook (1977), is a tool widely used to assess educators' willingness to adopt new instructional Innovations. This Literature review explores the impact of CL4TEM innovations on teaching practices, particularly in the Science Education department of Kaduna State University (KASU), through the lens of the IIS.

Concept of CL4STEM Innovation in Higher Education

The CL4STEM model is a research-driven initiative designed to improve Science, Technology, Engineering, and Mathematics (STEM) education by integrating collaborative and student-centered learning approaches (Mishra *et al.*, 2021). Research suggests that such innovations enhance students' critical thinking, problem-solving abilities, and active learning participation (Lombardi, 2019). In Nigerian universities, the implementation of CL4STEM faces challenges such as resistance to change, inadequate professional training, and infrastructural constraints (Ezegwu & Yusuf, 2022). However, studies indicate that when properly adopted, CL4STEM fosters pedagogical transformation, making STEM education more interactive and research-oriented (Okebukola & Ajewole, 2020).

Individual Innovativeness in Educational Contexts

The Individual Innovativeness Scale (ITS) is a psychometric tool developed by Hurt, Joseph, and Cook in 1977 to assess an individual's propensity to adopt new ideas and technologies. Comprising 20 items, the IIS evaluates various aspects of innovativeness, including willingness to try new things, tendency to seek novel solutions, adaptability to new conditions, and resistance to change. Respondents rate each item on a Likert-type scale, and the cumulative score categorizes them into adopter categories as follows: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards. (Hurt *et al.*,1977).

The IIS has been widely utilized across diverse fields to measure individual innovativeness. For instance, a study among nurses employed the IIS to explore the relationship between individual innovativeness and attitudes toward evidence-based practice. The research found that nurses with higher innovativeness scores exhibited more positive attitudes toward implementing evidence-based practices (Gosdemir & Celik 2021).

Innovation in education is primarily a task of teachers, it might be argued that individual innovativeness of teachers is very important both in education and within the society at large (Akdeniz, 2020). Innovative teachers make innovative education possible. Because contemporary education intends to raise qualified individuals who are open to innovations, teachers must also be open to innovations as they play a critical role in educational development (Gökçearslan, Yildiz-Durak, & Atman-Uslu, 2022). Indeed teachers are expected to set example for students and the society at large in terms of innovativeness by being open to innovation and also improving themselves continually (Geç ikli, 2022).

In educational settings, the IIS has been adapted and applied to assess the innovativeness levels of education administrators and teacher candidates. Research indicate that a significant portion of these groups fall into the "questioning" category, suggesting a moderate level of openness to innovation. These findings highlight the importance of fostering a culture that encourages innovation within educational institution (Yavuz, Yanpar, & Sancar, 2018).

Despite its extensive application, some researchers have critiqued the IIS for potential limitations. Concerns have been raised regarding its ability to capture the multifactual natural of innovativeness, suggesting that individual innovativeness is a complex construct that may not be fully encapsulated by the IIS alone (Ramazan, 2023; West & Farr, 1990).

Overall, the Individual Innovativeness Scale remains a valuable instrument for assessing an individual's readiness to embrace new idea and technologies, with applications spanning healthcare, education and organizational research. Within the educational sphere, the 5 levels of innovativeness can be described as follows: -

1. **Innovators -** proactively seek out and experiment with new teaching methods and technologies.

2. **Early Adopters -** willing to adopt innovations but require some evidence of effectiveness before doing so.

3. **Early Majority -** accept change once it has been widely recognized as beneficial.

4. **Late Majority -** skeptical about change, adopting it only when absolutely necessary.

5. **Laggards -** Highly resistant to change, preferring traditional methods.

In higher education settings, the IIS has been used to study faculty members' attitudes toward pedagogical innovations (Sahin, 2006). Studies indicate that faculty members scoring high on the IIS are more likely to integrate technology-enhanced learning (TEL), active learning strategies, and student-centered teaching techniques (Rogers, 2003). In contrast, those in the Late Majority or Laggard categories often require institutional support and targeted professional development (Yilmaz & Bayraktar, 2014).

Impact of CL4STEM on Teaching Practices in STEM Education.

Several studies emphasize that innovative STEM teaching approaches significantly improve learning outcomes. A study by Mishra *et al*. (2021) highlighted that STEM faculty members who engage in active learning techniques report increased student participation and better retention rates. Similarly, a survey of Nigerian universities found that CL4TEM-driven instructional strategies led to a 30% improvement in students' problem-solving skills and knowledge retention (Okebukola, 2020).

In the context of Kaduna State University, faculty readiness to integrate CL4TEM depends on individual innovativeness. Studies show that lecturers who score high on the IIS are more likely to embrace technology-enhanced teaching (Ogunleye & Adelakum, 2021). However, low-scoring lecturers require additional training and administrative support to successfully integrate CL4STEM practices into their teaching (Ezegwu & Yusuf, 2022).

STEM educators, in particular, exhibit varying degrees of innovativeness in adopting new teaching approaches. According to Mishra *et al* (2021), educators with high innovativeness are more likely to implement digital tools such as virtual labs, online simulations, and flipped classrooms. However, those classified as Late Majority or Laggards often resist such changes due to lack of training, fear of failure, or institutional barriers (Yilmaz & Bayraktar, 2014).

A study by Ogunleye and Adelakun (2021) in Nigerian universities found that only 35% of STEM lecturers fell into the "Innovators" and "Early Adopters" categories, with the majority falling into the Early and Late Majority groups. This suggests that while many educators acknowledge the importance of innovation, institutional and individual barriers slow down adoption rates.

Research suggests that IIS scores can predict a lecturer's likelihood of adopting CL4STEM teaching innovations (Rogers, 2003). Those with higher innovativeness scores are more likely to: use latest E-learning tools like learning management systems and blended learning strategies (Kabir, 2025); incorporate project-based learning (PBL) and hands-on experimentation in STEM courses (West & Farr, 1990); or adopt learning analytics to track student progress and adjust teaching methods accordingly (Ogunleye & Adelakun, 2021). In contrast, faculty members with low innovativeness scores require institutional intervention, incentives, and structured training programs to integrate CL4STEM into their teaching.

The CL4STEM model (Connected Learning for STEM), which is an innovative approach designed to transform traditional STEM teaching methods by emphasizing student engagement, connected problem-solving, and active learning (Mishra *et al.,* 2021), encourages a shift from lecturer-based instruction to interactive and technology-driven learning environment.

Several studies have examined the impact of CL4STEM on teaching practices: Mishra *et al.* (2021) found that STEM faculty members who incorporated connected learning strategies observed increased student engagement and knowledge retention. The study showed that students exposed to CL4STEM-based courses performed 20% better in critical thinking assessments compared to those in traditional lecture-based courses. Lombardi (2019) conducted a meta-analysis of active learning strategies in STEM fields and found that connected learning techniques improved problem-solving skills by 30% and student participation rates by 40%. Okebukola and Ajewole (2020) reported that CL4STEM adoption in Nigerian universities led to improved classroom dynamics, with students showing greater interest in science subjects.

The Role of IIS in CL4STEM Adoption Among Kaduna State University (KASU) Science Lecturers

The adoption of CL4STEM at Kaduna State University (KASU) is expected to significantly transform the teaching approaches of science lecturers, provided that faculty members' individual innovativeness aligns with the model's requirements (Ezegwu & Yusuf, 2022). The benefits of CL4STEM for KASU Science Lecturers, will among many others, be:-

1. Enhanced Student Engagement — Interactive learning techniques reduce passive learning and increase active participation (Ogunleye & Adelakun, 2021).

2. Increased Knowledge Retention — Studies suggest that students retain more information when learning through connected activities rather than traditional lectures (Ogunleye & Adelakun, 2021).

3. Encouragement of Research-Oriented Teaching-- CL4STEM encourages faculty members to incorporate real-world problem-solving into the curriculum (Okebukola, 2020).

The Individual Innovativeness Scale (IIS) plays a crucial role in determining the speed and extent of CL4STEM adoption at KASU. Previous researches (Kabir, 2025; Mishra *et al.,* 2021; Okebukola 2020) have shown that, faculty members categorized as Innovators and Early Adopters are more likely to lead the transition towards interactive STEM teaching, while those in the Late Majority and Laggards groups require tailored interventions such as: workshops and professional development programs to enhance faculty readiness for CL4STEM; institutional incentives for faculty members who actively integrate connected learning and improved access to digital tools and resources to facilitate technology-driven teaching.

Challenges and Barriers to Implementation

Despite its immense benefits in STEM education, research has shown that a number of factors hinder the adoption of CL4STEM in higher education:

1. Resistance to Change – faculty members with low innovativeness scores often resist adopting new teaching methods (Sahin, 2006).
2. Lack of Institutional Support – universities in Nigeria face challenges such as inadequate funding and lack of access to modern teaching technologies (Ogunleye, & Adelakun, 2021).
3. Limited Profession Development – many lecturers require continuous training and mentorship programs to fully integrate innovative STEM pedagogies into their classrooms (Mishra, *et al.*, 2021).
4. Infrastructure Constraints – the effectiveness of CL4STEM depends on access to reliable internet, laboratory facilities, and digital tools, which are often limited in Nigerian institutions (Okebukola, 2020).

METHODOLOGY

Research Design

This study adopts a mixed-methods approach, incorporating both quantitative and qualitative research methods. A quantitative survey was used to measure lecturers' individual innovativeness scores, while qualitative interviews or focus group discussions provide deeper insights into their perceptions and experiences regarding CL4STEM innovation adoption. The rationale for using a mixed-methods design is that quantitative data helps to establish trends and correlations, whereas qualitative data explores underlying motivations, challenges, and facilitators of CL4STEM adoption. This triangulation of methods enhances the study's reliability and validity (Creswell & Plano Clark, 2018). The target population for this study consisted of all 42 lecturers in the Science Education Department at Kaduna State University (KASU). These educators are responsible for teaching and training students in STEM disciplines and are directly affected by the integration of CL4STEM innovations into the curriculum. Due to the small size of the population, a sample size of N/2 was used (Qian, 2020), which amounts to 21 science education lecturers used in this study.

Data Collection Methods

A survey was carried out using a structured questionnaire on Google forms, to collect quantitative data on lecturers' innovativeness levels using the Individual Innovativeness Scale (IIS) developed by Hurt, Joseph, and Cook (1977). The IIS consists of 20 items measuring respondents' openness to adopting new ideas and classifies them into five categories: Innovators, Early Adopters, Early Majority, Late Majority and Laggards. Each item was rated on a 5-point Likert scale, where 1 = Strongly Disagree and 5 = Strongly Agree. The level of innovativeness for individuals is determined by means of IIS and individuals are thus categorized based on their levels of innovativeness (Hurt *et al.,* 1977).

Interviews and Focus Group Discussions

To complement the quantitative data, focus group discussions (FGDs) were conducted with purposively selected respondents: seven lecturers who participated in the CL$STEM project as Teacher Educators (TEs), and five lecturers who did not participate, in two separate batches. This was to encourage discussion and exchange of ideas. Interviews were audio-recorded and transcribed for further analysis.

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Data Analysis Techniques

Quantitative Data Analysis

Quantitative data from the Individual Innovativeness Scale (IIS) surveys were analyzed using a simple computer code to add values assigned to responses of the participants, generated from the IIS instrument. For each question there were 5 options on a Likert scale of 1 to 5 (from Strongly Agree to Strongly Disagree). These values were summed up as described in the following steps:-

Step 1: Add the scores for items 4, 6, 7, 10, 13, 15, 17, and 20.

Step 2: Add the scores for items 1, 2, 3, 5, 8, 9, 11, 12, 14, 16, 18, and 19.

Step 3: Complete the following formula: Individual Innovativeness (II) = 42 + total score for Step 2 - total score for Step 1. (Hurt, Joseph, and Cook, 1977)

The formula of "42+ (total score of positive items) — (total score of negative items)" is used to calculate the scores of innovativeness (Kilicer & Odabasi, 2010). After calculating the IIS scores for each respondent, those who scored above 80 points are called “Innovators”; those who scored between 69 and 80 are “Early Adopters”; those who scored between 57 and 68 points are labelled “Early Majority”; respondents who scored between 46 and 56 are termed “Late Majority while those with a point below 46 are called “Laggards” or “Traditionalists” (Kilicer & Odabasi, 2010). For this study, the IIS scores for each respondent were summed up according to the formula described above and thus faculty members were categorized into the five adopter classes to determine their predisposition to adopting CL4STEM innovations.

Qualitative Data Analysis:

Qualitative data from FGDs was analyzed using Thematic Analysis (Braun & Clarke, 2006) which comprised of the following steps: -

1. Coding: Key phrases and concepts related to faculty perceptions, challenges, and institutional support were coded.

2. Theme Identification: Common themes such as resistance to change, perceived benefits of CL4STEM, and institutional barriers were identified.

3. Interpretation: Findings were cross-referenced with quantitative results to provide a holistic understanding of CL4STEM adoption trends at KASU. Generative Al (chat GPT) was used in this process to assist with coding, theme identification and Interpretation.

Ethical Considerations

Ethical principles were strictly adhered to throughout the study, ensuring the rights, privacy, and dignity of all participants.

Informed Consent: Participants were provided a detailed consent form explaining the study's objectives, methodology, and expected outcomes. They were offered the right to withdraw at any stage without consequences, clearly stated on the consent form.

Data Confidentiality and Protection: All survey responses and interview recordings were anonymized to protect participants' identities while pseudo-names were used in the FGDs. Findings were reported in aggregate form to prevent individual identification.

Institutional Approval: Approval was sought from the Ethics Committee of Kaduna State University before data collection. Also, requisite permissions were obtained from the Science Education Department to access faculty members for participation.

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DISCUSSION OF FINDINGS

Quantitative Data Analysis:

Results obtained from the analysis of the IIS showed that there were six (6) Innovators from the respondents, two (2) were Early Adopters, four (4) were Early Majority, seven (7) from the Late Majority category and two (2) were Laggards. The distribution is as shown in the table below:-

Table 1: Distribution of Respondents According to Innovativeness:

Innovativeness Category	Number (frequency)	Percentages
Innovators	6	28.57%
Early Adapters	2	9.52%
Early Majority	4	19.05%
Late Majority	7	33.33%
Laggards	2	9.52%
Total (N)	**21**	**100%**

Qualitative Data Analysis:

The qualitative data collection used focus group discussions to provide deeper insights into respondents perceptions and experiences regarding CL4STEM innovation adoption. In addition, this is to explore underlying motivations, challenges, and enablers of CL4STEM adoption by these respondents. The data was triangulated into themes. Below is the thematic Analysis of responses from the participants.

Theme 1: Perceived Benefits of CL4STEM in Enhancing STEM Education

- **Student-Centered and Active Learning:** All respondents who were TEs of the CL4STEM project (Dr. A, Dr. B, Dr. C, Dr. D, Ms. E, Mr. F, and Prof K) emphasized the student-centered nature of CL4STEM, highlighting how it promotes active learning, collaboration, and problem- solving. CL4STEM's focus on engaging students through inquiry-based learning, group discussions, and peer-to-peer interactions was commonly mentioned as a key benefit. Respondents also viewed CL4STEM as a way to move beyond traditional, teacher-centered methods, enabling students to take ownership of their learning.

- **Real-World Applications:** Several respondents, including Dr A, Dr B, Dr C, and Prof K, noted that CL4STEM helps bridge the gap between theoretical knowledge and practical application. By integrating real-world problems, project-based learning, and hands-on activities, CL4STEM makes STEM education more relevant and applicable to students' everyday lives.

- **Critical Thinking and Problem-Solving:** All respondents who were TEs of the CL4STEM project, agreed that CL4STEM enhances critical thinking and problem-solving skills. They emphasized that collaborative learning and inquiry-based tasks encourage students to think deeply, develop innovative solutions, and apply their knowledge in real-world contexts.

- **Technology Integration:** There was strong consensus among respondents, particularly Dr A, Dr B and Prof. K, on the positive impact of technology integration within CL4STEM. They highlighted the role of virtual labs, simulations, and digital tools in enhancing engagement, making learning more interactive, and reinforcing theoretical concepts. However Prof L, Mr. G and Ms. H (who did not participate in the CL4STEM project) cited the challenges of integrating technology in teaching and learning.

Theme 2: Challenges and Barriers to Adopting Innovative Teaching Methodologies

- **Resistance to Change:** Several respondents (Dr. B, Dr. C, Dr D, Mr. G and prof K) identified faculty resistance to change as a significant barrier to the widespread adoption of innovative teaching methods like CL4STEM. They attributed this to factors such as unfamiliarity with new methods, perceived increase in workload, and skepticism regarding the effectiveness of student-centered approaches.
- **Infrastructural Limitations:** Limited access to digital tools, unreliable internet, and inadequate laboratory facilities were cited as key obstacles by many respondents, particularly Dr. C, Dr. I, Dr. J and Prof L. These infrastructural challenges hindered the seamless integration of technology and interactive learning approaches.
- **Student Readiness and Engagement:** Many respondents (Dr. B, Dr. D, Dr. I, Dr. J, Ms. H and Prof L) noted challenges related to student attitudes and readiness. Some students prefer traditional, passive learning methods and show reluctance to actively participate in group activities or inquiry-based learning. Additionally, issues such as lack of resources (e.g., smartphones, internet access) among students were identified as barriers to effective implementation.
- **Time and Curriculum Constraints:** Heavy teaching loads, rigid curriculum structures, and limited class time were common challenges mentioned by respondents (Dr B, Dr. E, Mr. G, Ms. H and Prof L). These constraints made it difficult to fully implement CL4STEM strategies as there was often not enough time to incorporate interactive, hands-on, and project-based learning into the curriculum.

Theme 3: Institutional Support and Training Needs for Effective CL4STEM Implementation

- **Need for Training and Professional Development:** All respondents agreed that additional training is essential for effectively adopting CL4STEM methodologies. While some respondents (e.g., Prof K, Dr A, Dr C and Dr D) felt they had some exposure, they stressed the need for more focused training, especially in areas like integrating digital tools, designing collaborative learning experiences, and assessing student-centered activities.
- **Institutional Support:** While some respondents (e.g., Prof K, Dr A and Dr C) mentioned that the university administration has in the past provided some support through training workshops, they noted that more structured initiatives, funding, and policies are necessary to encourage the adoption of innovative teaching methods.
- **Incentives for Faculty:** Most respondents, particularly Prof L, Dr B and Dr. I, Dr J and Mr. G stressed the importance of offering research grants, professional development opportunities, workload reductions, and recognition awards as motivators for faculty adoption of CL4STEM practices. Such incentives could encourage faculty members to invest more time and effort in adopting innovative teaching strategies.
- **Peer Collaboration and Mentorship:** Many respondents, including Dr A, Dr C, Dr. D, Ms. E, and prof K, emphasized the importance of peer collaboration and mentorship in overcoming barriers to CL4STEM adoption. By working together, faculty can share best practices, offer support, and reduce resistance to new teaching methods.

Theme 4: Recommendations for Enhancing CL4STEM Adoption

1. **Continuous Training:** A major recommendation from all respondents was the need for continuous training, including hands-on workshops, to equip faculty with the necessary skills and knowledge to effectively implement CL4STEM methodologies.
2. **Improved Infrastructure:** Improving digital and laboratory infrastructure was widely recommended, with respondents stressing the need for reliable internet connectivity, access to digital tools, and well-equipped laboratories to facilitate the adoption of CL4STEM.

3. **Flexible Assessment Methods:** Several respondents, mostly TEs on the CL4STEM project, suggested integrating more flexible and assessment methods that align with active learning strategies. This would help better assess the outcomes of collaborative learning and student-centered activities.

4. **Institutional Incentives:** Providing incentives such as funding, research grants, workload reductions, and recognition for innovative teaching was also frequently mentioned as a way to motivate faculty to adopt CL4STEM strategies.

5. **Collaboration and Mentorship:** Encouraging collaboration among faculty members and fostering mentorship opportunities were seen as important for supporting the widespread adoption of CL4STEM. By sharing successful strategies and experiences, faculty can build confidence in using these innovative methods.

6. **Policy Recommendations:** Most respondents also called for clear institutional policies that support the integration of innovative teaching methods. These include investment in digital infrastructure, regular training sessions, and the creation of a policy framework that incentivizes innovative teaching practices.

CONCLUSION AND RECOMMENDATIONS

Comparison between IIS Adopter Groups and CL4stem Teacher Educators (TEs)

The responses from the twelve interviewees (seven TEs and five lecturers who did not take part in the CL4STEM project) revealed a strong appreciation for the potential benefits of CL4STEM, particularly its ability to engage students, enhance critical thinking, and connect theoretical knowledge to real-world applications by the TEs in the CL4STEM project. Thus this study highlighted the relationship between adoption of CL4STEM innovative practices and level of lecturers Innovativeness. Lecturers that turned out to be Innovators, Early Adopters or Early Majority categories, who were quick to adopt the CL4STEM innovative practices, were all Teacher Educators on the CL4STEM project. While 50% of those in the Late Majority and 100% of those in the Laggard categories i.e. those who are not prone to adoption of innovative practices, were discovered not to have taken part in the CL4STEM project.

The responses of the FGD also reported along the same line. Dr. A, Dr. B, Dr. C, Dr. D, Ms. E, and Prof. K who were TEs in the CL4STEM project were very positive about their innovativeness and adoption of CL4STEM innovative teaching practices. This is in line with the findings of Ogunleye & Adelakun (2021) where faculty members who had been competent in using digital technologies were found to be the Innovators and Early Adopters.

In this study, it was found out that there was a high level of correlation between exposure to the CL4STEM innovative practices and Innovativeness level (in alignment with findings in Obaje *et al.,* 2024). In this study, the IIS scores of most of the lecturers who did not participate in the CL4STEM project classified them as Late majority and Laggards and in addition their responses to the FGD showed that they did not appreciate the innovative classroom practices and were more worried about the challenges of adopting innovative teaching practices. This is in line with findings of Ezegwu & Yusuf (2022) which reported negative perception by Nigerian higher education lecturers to technology integration in their classes. They were more persistent on challenges of such innovations.

Conclusion

Many studies have reported relation between use of technology and innovativeness.
In a research by (Gecikli, 2022) on pre-service science teachers' innovativeness level at a state university in Turkey, it was observed that majority of science teachers who participated in the study (62 %) were individually innovative at medium level and that they could be placed in the category of "questioning" which is equivalent to Late Majority category on the IIS scale.
In another research, Coklar (2012) revealed that educational administrators were generally in the group of Early Adopters in terms of individual innovativeness, and that the variables of professional seniority and age were influential on their technology use. The findings in Mustapha *et al.*, 2022, with regards to teachers' instructional

practices indicate a shift from traditional classroom practices to innovative instructional practices embedded in the CL4STEM modules. The teachers' knowledge attitudes and perception towards engaging their students in classroom practices was enhanced.

In Kaduna State University, the CL4STEM model has the potential to revolutionize teaching practices at Kaduna State University by fostering an interactive, research-driven learning environment. Similarly, Gecikli (2022) had reported that individual innovativeness levels among pre-service science teachers were believed to have a positive correlation to their professional performance in practice. Indeed, the individual innovativeness of lecturers plays a critical role in determining the extent of adoption. While highly innovative lecturers readily integrate CL4STEM practices, those with lower innovativeness scores require institutional support, training, and incentives. Addressing these challenges can enhance STEM education and improve student learning outcomes in Nigeria.

Recommendations

Recommendations that stem from this study include:-

1. Enhance continuous professional development programmes for the faculty.
2. Provide improved ICT Infrastructure by ensuring reliable access to digital tools, platforms, and internet connectivity to support CL4STEM implementation.
3. Incorporate CL4STEM into institutional policy by formalizing formalize the use of CL4STEM strategies in the Science Education curriculum, ensuring its adoption is institutionally supported and sustained.
4. Provide individualized support based on Innovativeness Levels of faculty while providing general technical support for all.
5. Promote a culture of innovation by encouraging peer mentoring and knowledge sharing among lecturers to promote collective growth in innovativeness.
6. Encourage collaboration and mentorship between the Science Education department and other departments actively using CL4STEM to cross-pollinate innovative practices.
7. Provide institutional incentives such as funding, research grants, workload reductions, and recognition for innovative teaching to encourage adoption of innovative practices.

In conclusion, improved institutional policies, and a culture of innovation are essential for maximizing the impact of CL4STEM in STEM education at KASU. In addition, this study recommends strategic interventions to enhance faculty readiness, address barriers, and create an enabling environment for sustainable innovation in STEM teaching. Peer collaboration and mentorship have been identified as key strategies to facilitate the adoption of CL4STEM, ensuring that STEM education becomes more interactive, relevant, and impactful.

This study however is delimited by a small sample size because the study focused on science education lecturers of the Kaduna State university, a population of about fifty (50). Hence the findings cannot be generalized. A similar study with wider scope needs to be carried out. In addition, the effects of some other variables, such as gender, were not examined in this study.

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