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DIGITAL ACCESS AND PROFICIENCY FOR INNOVATIVE CAPACITY TRAINING FOR TEACHERS TO ENHANCE HIGHER THINKING WITH INCLUSION AND EQUITY: A BASELINE DATA ANALYSIS

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Abstract: *Globally, economic and technological changes shape the occupational outlook of today's students, these changes have in turn impacted the educational system across the world. Therefore, schools have begun to double their efforts on the need to instill Higher-Order Thinking (HOT) skills to prepare the 21st-century workforce. This can only be achieved when the teacher is professionally trained and equipped to engage students appropriately and create the needed classroom environment that will foster HOT. Hence this study focused on CL4STEM as an innovative capacity training for science and mathematics teachers to enhance HOTs with Inclusion and Equity (HOTIE): A Baseline Data Analysis. A quantitative research approach was adopted specifically a descriptive survey. The population of the study is made up of science and mathematics teachers in three states in the northwest and North-central states of Nigeria. Three states were purposefully selected for this study because there is a minimal level of insecurity in these states. Twenty-five (25) schools were randomly selected from the three states. Four teachers (Mathematics, Physics, Chemistry, and Biology) were elected from each school. The sample size comprised of: the control group had 20 teachers, the intervention others had 60, and the intervention focus group had 20. The instrument for data collection was adopted structured questionnaire containing items on teacher profiles which includes, respondents' demographic data and facilitating conditions such as infrastructures that support users' engagement with the module and CoPs for professional capacity training. The structured questionnaire was validated for face and content validity and the reliability of the instrument was found satisfactory. Baseline data was collected and analysed and the findings indicate that the participating teachers are intermediate or averagely proficient in the use of ICT devices and there is inadequate internet provision in this population. It was recommended among others that data subscriptions be provided for the teachers to enhance their effective engagement with the CL4STEM project.*
Keywords: *Innovative Capacity Training, Mathematics and Science Teachers, Higher-Orde Thinking and Equity and Inclusiveness*

Introduction

The changing global economy of the 21st century has necessitated a shift in education worldwide. The emphasis on higher-order thinking skills and the need to provide equal opportunity for all categories of learners places a critical demand on teachers to be pedagogically proficient in assisting students to acquire these skills and creating an equitable and inclusive learning environment for all students. However, schools in Africa, especially Nigeria is suffering from poor funding for Continuous Professional Capacity Training, this has created the need for teachers to seek alternative ways to improve their classroom practices, especially with the advent of the new set of skills called 21st-century skills. Therefore, school administrators, teachers, and policymakers have to adopt initiatives through the use of platforms such as WhatsApp, Twitter, and Telegram, among others as a replacement for formal learning opportunities through content curation. This could be achieved through conversations, sharing ideas, and resources. One such initiative is the Connected Learning Initiative CLIx developed by Tata Institute for Social Sciences (TISS), India. The project focused on professional capacity building of science and mathematics teachers in four selected states in India and was found effective and positively impacted teacher instructional practices (CLix, 2018). The CLIx project is now being scaled through a process of knowledge diffusion and adaptation as CL4STEM to a new country context based on a South-South collaboration among higher education institutions involving Nigeria, Bhutan, and Tanzania.

The CL4STEM project being piloted in selected Nigeria secondary schools involving newly qualified teachers (NQTs) who have been given orientation training for piloting curated OER modules and to develop new pedagogical practice and in the method of using ICT in implementing curated subject-specific OERs. CL4STEM is aimed at bringing about educational changes that improve teacher subject content and pedagogical knowledge. The project also aims to offer the Newly Qualified Teachers (NQTs) the knowledge to integrate technology and engage students in active learning of science and mathematics. The online Community of Practice is one of the critical features of the CL4STEM project. It adapts or adopts technology devices and online platforms to give academic support for professional capacity training. In the context of the CL4STEM project, the COP will include expert teacher educators who will provide academic and technical support for Newly Qualify Teachers (NQTs) to engage in the sharing and exchange of ideas with regard to design thinking and Universal Design Learning Principles (UDL) principles with the view to enhance higher order thinking skills and equity and inclusiveness into STEM classrooms.

Communities of practice are dynamic learning environments where members' identities are shaped by their interactions with those both inside and outside the community, by the agreement and negotiation of their opinions and skill sets, and by their creativity (Wenger, 1998).The deployment of novel instructional practices or concept knowledge by teachers may be influenced by their membership in diverse communities of practice. Weisberger and Butler (2012) highlighted some stages for being an effective educational curator including; finding and selecting content that should be based on quality and relevance, and an editorial role which will involve contextualizing, summarising, and adding your view. Others include; arranging your thoughts, creating, sharing, engaging with others, and tracking that engagement. The content that teachers curate should be restricted to content knowledge, pedagogical knowledge, and other relevant knowledge. Mutual involvement, cooperative enterprise, and a shared repertory are the three characteristics that Wenger (1998) identified as being present in communities of practice. Wenger contends that mutual interaction entails a variety of individuals collaborating to negotiate meaning. Rosell-Aguilar, (2018). Examined Twitter as a tool for professional development among teachers and found that most of the participants in Cop adopted the suggestions and ideas posted on the platform and their participation in the Twitter CoP positively enhanced their classroom instruction. It is important to highlight that one of the core elements of the advancement of 21st-century education is the implementation of higher-order thinking Skills (HOTS) which incorporates logical, critical, reflective, metacognitive, and creative thinking (Gopalan & Hashim, 2021). Students' active involvement in the learning process may be necessary to close this achievement gap among students (Sailin & Mahmor, 2018). One of such innovative learning approach or framework embedded in CL4STEM is the Universal Design-based Learning (UDL) which may increase teachers-students' interaction, and active participation and reduce the achievement gaps between various academic-ability groups (Arkan, 2018).

ICT accessibility and usage are important factors in knowledge acquisition, curriculum management practices, and research. Blackwell (2013) stated that there is little proof that teachers shared their lessons via technology even though these ICT resources are essential to teaching and learning in the twenty-first century. In any educational system, the level of accessibility, availability, and usage restricts the degree to which any innovation like CL4STEM can be introduced or adopted for teachers' professional capacity training.

Furthermore, integrating the use of these resources into teachers' capacity training must be seen as a top priority and as a crucial component of the national strategy for teaching and learning in an online environment. In addition, many stakeholders are now considering developing a robust educational system with e-learning in light of the COVID-19 pandemic. All students irrespective of gender and academic abilities will be able to engage in meaningful learning and will be better able to attain curriculum outcomes if ICT materials are used as instruments for capacity training and classroom instruction.

Statement of the Problem

Raising science achievement for all pupils irrespective of their ability, background, and gender, among others, is necessary for them to compete favourably in the global market. Therefore, more research on equity and inclusiveness focused on the teachers' ability to engage every learner in meaningful learning is required. The adoption and adaptation of a cutting-edge instructional strategy that will cater to each student's unique learning needs such as Universal Design-based (UDL) are being advocated. Nevertheless, achieving equity and inclusiveness among learners is a persistent and enduring challenge (Thalib, Corebima, & Ghofur 2017). Hence there is advocacy for the adoption of innovative technological initiatives to assist teachers with relevant pedagogical skills for equity and inclusiveness. One such initiative is the Connect Learning Initiative (CLx) developed based on the principles of UDL by the Tata Institute India and is effective in enhancing teachers' pedagogical knowledge towards enhancing higher-order thinking with inclusion and equity (HOTIE). This initiative is being adopted in Nigeria as "The Connected Learning for Science, Technology, Engineering, and Mathematics (CL4STEM). The target of the project is to pilot the innovation initiative and its effectiveness in building instructional capacities of secondary school teachers in Science and Mathematics for fostering higher-order thinking with inclusion and equity (HOTIE) in their classrooms. The CL4STEM pilot engages STEM teachers in curated OERs-based modules in Science and Mathematics and partaking in online Communities of Practice (CoP).

The teacher is a critical element in the implementation of this initiative. In support of this, Mustapha *et al.* (2022) observed that the integration of technology integration into classroom instruction is to a great extent influenced by the teacher. Consequently, teachers' readiness and competence, among others could positively or negatively influence technology adoption and usage for capacity training. It is important, therefore, to comprehend what could influence STEM teachers' use of technology for professional training. This could help us understand the return on investment that could be expected from technology-enhanced capacity training in science and mathematics teaching to enhance HOTIE. The prospect of ICT to improve the professional quality of science and mathematics teachers is trending and discussed in several educational policies in many countries. This study focused on teachers' profiles or characteristics such as ICT access, and proficiency among others.

Therefore, teachers' profile analysis could provide important insight into the success of this initiative in Nigeria. Hence this study focuses on Innovative Capacity Training for Science and Mathematics Teachers to Enhance HOTIE in Nigeria: A Profile Analysis. Specifically, the study seek to achieve the following objectives;

1. Examine teachers' ICT access to engage in technology-based capacity training
2. Determine the teachers' level of ICT proficiency to engage in technology-based capacity training
3. Determine the ICT devices and communicating media frequently used for teaching

Research Questions

The following research questions were stated to guide the studies;

1. What are teachers' ICT access to engage in CL4STEM capacity training?
2. What is the teachers' level of ICT proficiency to engage in CL4STEM capacity training?
3. What are the ICT devices and communicating media frequently used for teaching?

Literature Review

With the expansion and accessibility of the internet, it is thought that online learning communities might enhance instructors' professional development, eradicating time limits and distance (Sijia, *et al*, 2019; Voskoglou, 2019; Qi & Wang, 2018).Hermital, *et al*. (2021) investigated the importance of the Community of Practice (CoP) in improving primary school teachers' performance in Riau province, the study adopted a descriptive study, and the finding indicated that COP based on active learning enhanced teachers' performance in the instructional process in the classroom. It

was concluded that CoPs improve the quality of education. Juandi, and Jupri, (2013) reported that CoP enhances the teachers teaching competence and improves the students' learning outcomes and the quality of education. It provides the opportunity for group members to share ideas and experiences, and assist each other in adopting more professional innovative strategies and approaches.

Voskoglou, (2019) Conducted a study to highlight the importance of Communities of Practice for teaching and learning mathematics, the findings of the study indicated that CoP enhances teachers' mathematics thinking and representation. The study found that mathematics teacher profile and socio-cultural play an important role in teaching and learning. Sijia, et al, (2019) investigated building an online community of practice through WeChat for teacher professional learning. The finding shows positive perceptions about COP using WeChat were identified among participants on joining the teacher group. Moreover, their teaching practices were positively transformed. It also reported in the literature that Online CoPs allow greater flexibility than traditional, face-to-face mentoring, it also enhances members' professional growth through interactions with professional colleagues. Rosell-Aguilar, (2018). Examined Twitter as a tool for professional development among teachers. The data were collected using structured questionnaires and interviews, the findings showed that most of the participants in Cop adopted the suggestions and ideas posted on the platform and their participation in the Twitter CoP positively enhanced their classroom instruction.

Conceptual Framework

Etienne Wenger and Jean Lave created the concept of Communities of Practice in 2009 when studying apprenticeship as a learning model and described it as a 'Community that acts as a living curriculum" for practitioners to learn from one another irrespective of their position within the organization. Further, Wenger (2013) defined CoP as groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly. The actual intention of communities of practice is to provide a forum or opportunity where teachers could go to get support, to get or share new ideas and connect to their practice, and to connect to their colleagues for professional development.

Other dimensions to the definition in the literature give meanings to the community of practice as a group of individuals with similar roles and responsibilities coming together to;

- and Share ideas, knowledge, insight and visions, and best practices, providing or getting feedback effective communication amongst the group.
- spend time discussing important topics, asking questions, and sharing answers,
- discuss problems of practice and see if anyone in the community can offer solutions, and
- interact with experts to share best practices.

Communities of practice could be based on face-to-face contact or could be facilitated online to communicate, connect, and conduct professional activities. In the present-day realities of globalization, CoP is best facilitated online through social media platforms; Zoom, Skype, WhatsApp, Email, Facebook, Groupme, and Telegram, among others. The choice depends on members' social media interests, skills, and what technology mobile devices members are more comfortable with or have easy access to.

Methodology

A quantitative research approach was adopted. This study adopted a quantitative approach to gathering data (Creswell, 2014). The population of the study is made up of science and mathematics teachers in three states in the north; 2 in the northwest and 1 in the North-central state of Nigeria. Twenty-five (25) schools were randomly selected from the three states. Four teachers (Mathematics, Physics, Chemistry, and Biology) were elected from each school. The sample size was made up of 100 teachers: the control group had 20 teachers, the intervention other had 60, and the intervention focus group had 20.

The instrument for data collection was adopted structured questionnaire containing items on teacher profiles which include, respondents' demographic data and facilitating conditions such as infrastructures that support users' use of new technology or CoPs for professional capacity training. The structured questionnaire was validated for face and content validity and the reliability of the instrument was found satisfactory.

Firstly, ethical approval was obtained from the respondents to ensure adherence to ethical principles, confidentiality, and privacy. The data collected were analysed using frequency counts and percentages to answer the research questions. It is hoped that the findings of this study could have implications for STEM teacher capacity training and further scaling of this initiative.

Results

The findings of the study are presented based on the stated research question;

Teachers' ICT access to engage in CL4STEM capacity training

The study examined teachers' readiness to meaningfully engage in the CL4STEM project by surveying their level of ICT accessibility with regards to ICT devices possessed and reliable internet access before the intervention. This data was obtained during the launch of the project and the result is as presented below

Devices Owned

Figure 1 shows the findings of teachers who possessed devices that could enhance their participation in the CL4STEM project.

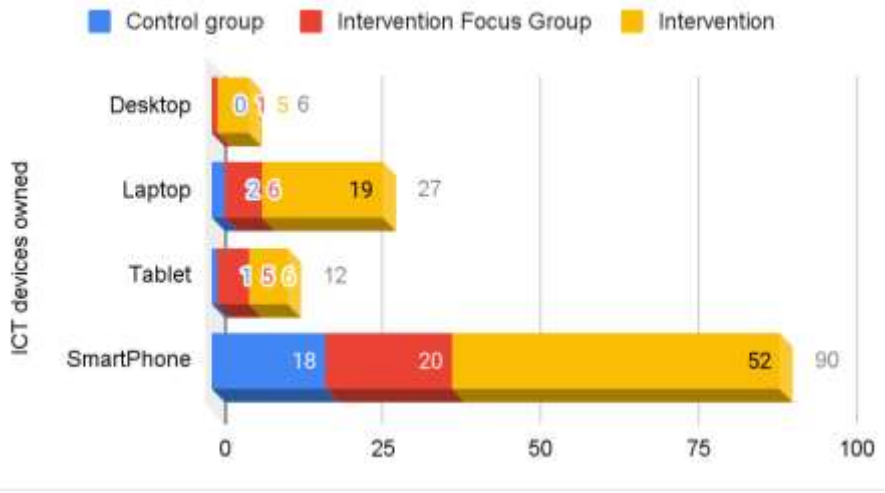

Figure 1: ICT Devices Owned by Teachers

The results in Figure 1 show that only 6 (6%) teachers which include; 1 (5%) intervention focus compared with 5 representing 8.33% of the intervention group owned desktops. 2, 6, and 19 teachers from the control group, intervention focus, and intervention group, representing 1%, 30%, and 32% respectively, owned laptops. Only 12% of teachers have a Tablet device. The total number of those who own smartphones is 90 (90%) of the participating teachers altogether representing 18% in the control group compare with 20% and 52% intervention focus and intervention group respectively.

The findings from the baseline data with regards to ICT owned indicate that all the participants in CL4STEM project owned ICT devices that will enable them participate in the COP and module implementation if the participants are proficient in the use of these devices and internet access is available.

Reliable Internet Access

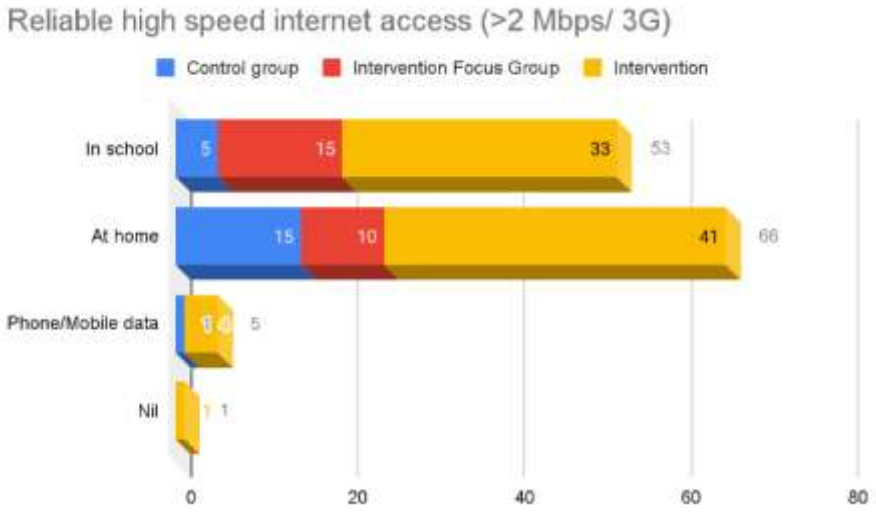

Figure 2: Reliable Internet Access

In terms of reliable internet access, 53%this include 5 (25%) teachers in the control group compare with 15 (75%) in the intervention focus group and 33 (55%) of the teachers in the intervention others indicates that there is high speed internet access in their schools. Similarly, 66% this include15 (75%) control compared with 10 (50%) intervention focus and 41 (68%) intervention group) of the participating teachers indicated that they have high speed internet in their homes. Only 5% as indicated in the figure have mobile data in their phones. These findings indicate that there is no adequate internet access both at school and at home for teachers' meaningful engagement in the project and teachers in this population do not seem to have finance to purchase mobile data. This finding at the baseline suggest that the project should explore ways to provide internet access or mobile data for the participants for effective engagement.

Teachers' ICT Proficiency

Results from baseline data analysis on Teachers' ICT Proficiency to engage in CL4STEM capacity training to enhance HOTIE is presented in figure 3

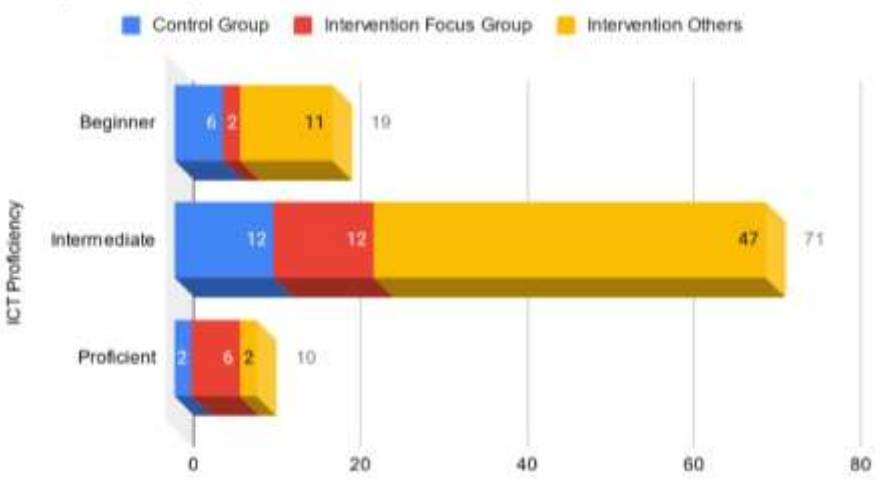

Figure 3: Teachers' ICT Proficiency

In terms of ICT level of proficiency, 6 (30%) of the control group are beginners compare with 2 representing 10% are beginners in the intervention focus group compared with 11 representing 18% are beginners in the intervention others. In the intermediate category 60%, are in the control compare to 60% and 78% intervention focus and intervention others group, respectively. Teachers that are proficient in ICT in this sample are 1 representing 10% of teachers in the control group

compare with 6 representing 30% of the intervention focus group are proficient compared with 2 representing 3% of teachers are proficient in the intervention focus group. Thus a greater number of the teachers 71% of the sample size are in the intermediate category.

The results indicated that the intervention others have the highest in the beginners and Intermediate categories while the intervention focus group had more in the proficient group (6) and 2 each in the control and the intervention others. The results suggest that teachers in the intermediate and proficient levels will be able to participate effectively in the CoP and module implementation. The COP could provide the opportunity for beginners to improve their ICT skills.

ICT devices and communication media frequently used for teaching

Data were collected at the baseline to examine the ICT devices or communication media used by the participants for teaching science and mathematics, and the results are presented in Table 1

Table 1: ICT devices and communicating media frequently used for teaching

ICT devices used for teaching	Control group	Intervention Focus Group	Intervention (Inservice)	Total
Desktop	1	2	5	8
Laptop	1	5	12	18
Tablet	1	3	7	11
Smart Phone	12	17	44	73
Smart Board	3	2	4	9
Smart TV	0	0	0	0
Projector	1	4	6	11
None	1	0	1	2

Table 1 shows the ICT devices and communicating media frequently used for teaching science and mathematics at secondary schools. The results show that only 8 representing 8% of the respondents use desktop computers for teaching while 18% and 11% of the respondents use laptops and tablets in their teaching. The results also indicated that 73 % of the respondents use the smartphone for science and mathematics instruction compared with only 9% of teachers using the Smart Board for teaching. In the sampled schools no teachers use the Smart TV for teaching. The baseline results suggest that the teachers in this population are familiar with the use of ICT devices for science and mathematics instruction. This implies that most of them will be able to engage in COP and module implementation with adequate motivation.

Conclusion

The study examined CL4STEM as an innovative capacity training for science and mathematics teachers to enhance HOTs with Inclusion and Equity (HOTIE): A baseline data analysis. Given the finding of the baseline data on ICT proficiency, ICT accessibility regarding ICT devices possessed and reliable internet access before the intervention. It is concluded that the integration of technology into capacity training and classroom instruction would be successful because of the facilitating conditions that indicate the availability of internet connectivity, possession of mobile devices, and teacher ICT proficiency among others. The findings of this study would have implications for policy and practice.

Recommendations

Given the findings of the study, the following recommendations are made;

1. Government and educational stakeholders should provide access to ICT devices and platforms for Science and Mathematics teachers to engage in educational training at their own pace
2. The government should also provide basic digital or computer proficiency training to equip the teachers with the skills to integrate digital devices into teaching and learning

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