Extent of Implementing Teachers' Continuous Professional Development Programme in Enhancing Science and Technology Integration in Public Primary Schools of Moshi Municipality, Tanzania

Gladness Mbwambo[1]; Victorini Salema[2]; Bahiya Abdi[3]

[1] Masters Student at Mwenge Catholic University, Tanzania
[2] Senior Lecturer, Department of Education, Psychology and Curriculum Studies
Mwenge Catholic University, Tanzania
[3] Lecturer, Department of Education, Psychology and Curriculum Studies, Mwenge Catholic University, Tanzania

Abstract: This study evaluated the extent of implementing the Teachers' Continuous Professional Development (TCPD) program in promoting the integration of science and technology into teaching and learning in public primary schools of Moshi Municipality, Tanzania. Employing a mixed-methods approach with a convergent design, the study collected and analyzed both quantitative and qualitative data simultaneously. The target population included 830 individuals from 37 public primary schools, including teachers, headteachers, TCPD school coordinators, one municipal primary education officer and one Municipal Primary education academic officer. A stratified random sampling method was used to select 110 teachers and 13 education stakeholders. Data collection instruments consisted of questionnaires, interview guides and observation guides, which were validated through expert review from the Faculty of Education of Mwenge Catholic University (MWECAU), specifically academic staff specialized in Educational Assessment and Evaluation, and reliability-tested via a pilot study (Cronbach's alpha = 0.881). The trustworthiness of qualitative data was ensured through triangulation. Quantitative data were analyzed using descriptive statistics via SPSS version 27, while qualitative data were subjected to thematic analysis. Ethical standards such as confidentiality, anonymity, and data integrity were strictly observed. The study revealed that the TCPD program has, to a great extent, enhanced teacher competencies in lesson planning, student engagement, assessment techniques, and digital tool usage. The study concluded that, TCPD is fundamentally empowering teachers with relevant competences in various aspects, despite challenges such as limited internet connectivity, which emerged as a barrier to effective technology integration. The study recommends that the Government, through the Ministry of Education, Science and Technology to strengthen internet infrastructure, ongoing digital training, and regular program monitoring to sustain the impact experienced.

Keywords: Evaluation, Implementation, Teachers' Continuous Professional Development (TCPD), Programme, and Quality Teaching Pedagogy.

I. INTRODUCTION

Continuous professional development (CPD) for teachers has increasingly been recognized worldwide as a critical mechanism for enhancing the overall quality of education. According to the World Bank (2024), one of the most significant challenges facing global education systems is strengthening teachers' capacities to facilitate learning effectively. The report posits that education systems that foster lifelong learning among teachers empower them to serve as transformative agents within their professional contexts. Consequently, CPD is regarded as a vital platform for the sustained professional growth and learning of educators. In the context of 21st-century education, there is a growing emphasis on equipping teachers with digital competencies to meet evolving instructional demands. This aligns with the broader goals of the UNESCO 2030 Agenda, particularly Sustainable Development Goal 4 (SDG 4), which seeks to ensure inclusive, equitable, and quality education while promoting lifelong learning opportunities for all (UNESCO, 2015).

The origins of Teacher Continuous Professional Development (TCPD) in Europe can be traced back to the 1970s. A significant milestone was the European Council's launch of the "Education Permanente" initiative in 1970, which underscored the importance of sustained investment in the professional development of in-service teachers (Strasburg, 1970, as cited in Kougkas, 2020). Greece, among other European Union member states, adopted CPD as a strategic framework aimed at cultivating a highly professional teaching workforce, ensuring adequate preparation for the teaching profession, and providing consistent training support. Today, this objective is widely shared across the EU. Despite such foundational efforts, the impact of TCPD on enhancing pedagogical practices and improving student learning outcomes as measured through assessments and academic performance remains a subject of ongoing discussion and inquiry across both European and global contexts.

Governments across East Africa have increasingly prioritized the improvement of teacher quality as a cornerstone for enhancing learning outcomes. This has led to the institutionalization of structured frameworks for Teacher Continuous Professional Development (TCPD) across the region. In Kenya, the Teachers Service Commission (TSC) enforces a mandatory Teacher Professional Development policy that requires all practicing teachers to undergo in-service training aligned with the country's competency-based curriculum reforms (TSC, 2019). In Uganda, the Teacher Incentive Framework seeks to improve teacher motivation and professional advancement by offering pathways for promotion and support. Uganda has also operationalized the Teacher Development Management System, which provides in-service training to enhance pedagogical practices, supported by both governmental and non-governmental actors such as the British Council and Aga Khan University's Centre for Education and Lifelong Learning (CELL). These institutions offer modular courses, workshops, and school-based support systems to address the evolving professional development needs of teachers, especially in areas involving digital pedagogy and learner-centered methodologies.

In Tanzania, the Ministry of Education, Science and Technology (MoEST) launched the National Framework for Teachers' Continuous Professional Development (NF-TCPD) in 2020. This framework serves as a national policy instrument designed to improve instructional quality across the education sector by institutionalizing continuous in-service training. It has three core objectives: (1) to improve the quality of classroom instruction, (2) to strengthen teachers' content knowledge in subject areas, and (3) to promote innovative pedagogical practices, particularly the integration of science and technology into daily teaching and learning. This is critical in the context of 21st-century education, which demands digital fluency and inquiry-based learning approaches for improved learner engagement and comprehension.

The NF-TCPD is underpinned by Tanzania's long-term development agenda as articulated in the National Development Vision 2050, and its implementation aligns with key education policies such as the Education and Training Policy (ETP) 2014, as revised in 2023. These policies advocate for equitable access to high-quality education and recognize the role of teacher development in achieving inclusive and sustainable learning outcomes. However, empirical evidence suggests that gaps remain between policy intentions and classroom realities. For instance, Kahangwa and Kafanabo (2023) reported that challenges such as inadequate ICT infrastructure, weak school leadership, and limited professional support for teachers continue to hinder the effective integration of science and technology in Tanzanian schools. Likewise, evaluation reports from the Quality Assurance Division of MoEST have raised concerns regarding the implementation fidelity of TCPD programs, particularly in rural and under-resourced areas.

This evaluation study was therefore designed to respond to these challenges by focusing specifically on outcome-level evaluation of the NF-TCPD framework in Moshi Municipality, a region that presents a unique opportunity for examining program effectiveness due to its relatively advanced education indicators. Moshi is widely recognized for its high literacy rates, strong school performance, and the presence of a dense network of public primary schools. It also exhibits a sociocultural environment that places a high value on education (URT, 2023), making it an ideal testing ground for understanding the local outcomes of national teacher development initiatives.

While the NF-TCPD framework is national in scope, this study narrows its focus to Moshi Municipality to allow for a deep and context-specific outcome evaluation. Unlike basic academic research, which primarily seeks to generate theory, this evaluation is practice-oriented and focused on assessing the effectiveness, relevance, and immediate results of the TCPD program for teachers' integration of science and technology into classroom instruction. The key evaluation questions guiding this study include:

- To what extent have teachers adopted science and technology integration approaches promoted by TCPD?
- What changes in teaching practices and student engagement can be attributed to TCPD participation?
- What barriers or enabling conditions influence the implementation of TCPD-supported digital pedagogy?

By answering these questions, the evaluation aims to generate actionable insights for policy implementers, school heads, teacher resource centers, and development partners. It will also contribute to the limited body of evaluation-focused literature on TCPD implementation in Tanzania's basic education sector.

II. PURPOSE OF THE EVALUATION

The purpose of this summative evaluation was to examine the extent to which the Teachers' Continuous Professional Development (TCPD) programme has been implemented to enhance the integration of science and technology in public primary schools within Moshi Municipality. TCPD in Tanzania is guided by the 2020 National Framework (NF-TCPD), which positions continuous, school-based professional learning as a central pillar for improving instructional quality and fostering innovation in teaching practices. Unlike earlier models that relied heavily on centralized workshops, the current approach emphasizes decentralization, peer collaboration, digital content, and context-sensitive support aligned with competency-based curriculum reforms.

Despite the progressive orientation of the NF-TCPD, monitoring reports and recent studies have highlighted systemic implementation challenges. For instance, Chachage and Thakrar (2023), in collaboration with EdTech Hub and supported by UNICEF, UKaid, and the World Bank, observed that while school-based professional learning models have been adopted, schools still face persistent barriers, including inadequate digital resources, weak mentorship structures, and limited follow-up mechanisms. Similar concerns are echoed by Shukia and Komba (2022) and Rugambwa and Abdi (2021), who reported that low teacher participation and inconsistent application of training content continue to hinder the intended outcomes of TCPD reforms.

Although these studies raise critical concerns about general implementation, few have explicitly evaluated the degree to which TCPD promotes science and technology integration, a key strategic goal in the framework. Moreover, there remains a limited empirical understanding of how teachers in well-performing municipalities like Moshi apply TCPD-acquired competencies in everyday classroom practice.

Accordingly, this evaluation specifically sought to assess the extent of TCPD implementation in enhancing teachers' ability to integrate science and technology into instructional approaches. By focusing on actual practice in Moshi Municipality's public primary schools, the study contributes to both accountability and learning-oriented

goals, providing insights that can inform future scaling, resource allocation, and programme redesign at national and sub-national levels.

III. EVALUATION QUESTION

The following evaluation question guided the evaluation theme: To what extent does TCPD enhance the integration of science and technology in teaching and learning processes in public Primary Schools of Moshi Municipality?

IV. SIGNIFICANCE OF THE STUDY

This study holds substantial significance within the broader agenda of strengthening science and technology integration in Tanzania's primary education sector. As global education systems shift towards digital and competency-based approaches, teacher capacity to meaningfully integrate technology into instructional practice becomes essential. Within this context, Tanzania's TCPD programme serves as a strategic response to build teacher capabilities in leveraging digital tools for effective pedagogy. Evaluating how well this policy is being implemented, especially in scientifically strong municipalities like Moshi, provides actionable insights for education policymakers, local government authorities, and development partners.

The evaluation responds to national priorities articulated in the National Framework for TCPD (2020) and the Education Sector Development Plan (ESDP), which call for school-based professional development as a driver of inclusive and technology-supported learning. Furthermore, the study's findings offer practical guidance for the Ministry of Education, Science and Technology (MoEST), curriculum developers, and implementing partners by highlighting strengths, gaps, and recommendations to improve science and technology integration. By focusing on teacher perceptions, training participation, and use of digital tools in classroom practice, the study informs the ongoing improvement of TCPD delivery across Tanzania.

V. EVALUATION MODEL

This study was guided by the CIRO evaluation model, developed by Warr, Bird, and Rackham (1970), which is specifically designed to assess training and development interventions. The model comprises four key dimensions: Context, Input, Reaction, and Outcome, making it particularly relevant for evaluating professional development in educational settings.

Context evaluation examined the institutional and policy environment surrounding TCPD implementation in Moshi Municipality, including school-level support structures, availability of ICT infrastructure, and alignment with national strategies.

Input evaluation focused on the design and delivery mechanisms of TCPD, including training content, methods

(e.g., peer coaching), access to resources, and availability of facilitators.

The reaction evaluated teachers' perceptions, satisfaction, and immediate responses to the training programs captured through survey ratings and qualitative feedback.

Outcome evaluation assessed changes in teaching practices, particularly in the integration of science and technology, and observable shifts in classroom engagement, assessment, and lesson delivery.

By applying CIRO to this study, the evaluation goes beyond surface-level assessment to examine the multi-dimensional effectiveness of TCPD implementation. The framework provides a structured lens for linking training inputs with tangible teaching outcomes, enabling both accountability and improvement-oriented feedback for stakeholders involved in teacher development.

VI. LITERATURE REVIEW AND DEMONSTRATION OF THE RESEARCH GAPS

This section presents the theoretical and previous reviews regarding the integration of science and technology in the teaching and learning process in primary schools. The section ends with a demonstration of the knowledge gap.

➢ *Review of Empirical*

This section consists of a review of empirical studies related to teachers' continuous professional development programs on enhancing the integration of science and technology teaching and learning processes.

In China, Lee et al. (2023) conducted a study on technology-facilitated continuous professional development (CPD) during the pandemic, focusing on a Hong Kong primary school. Using a mixed-method case-study approach, the study explored how one teacher educator and a group of English as a Second Language (ESL) teachers used technology to facilitate school-based professional support (SBPS). The findings showed that teachers appreciated the technological tools (Google Drive, Google Meets, and WhatsApp) that enabled collaborative action research with the educator. The study concluded that a blended continuous professional development approach, integrating different modes of support, promoted greater teacher development and improved classroom practices. However, the study shows the specific modes that were found to be effective, and a little information is provided on the integration of Science and Technology. Therefore, this study will evaluate the different modes of professional development on the integration of Science and Technology in Moshi Municipal.

In Indonesia, a study by Kasi et al. (2022) investigated the benefits of a teacher professional development program that integrated partnership, technology, and ethnoscience. Conducted from September to November 2021, the study involved 28 science teachers across six districts in Nagekeo

Regency. The program utilized both online and offline methods. Online sessions via Zoom allowed teachers to analyze science concepts within Nagekeo's cultural context and align them with basic competencies. In offline sessions, teachers collaborated to design culture-based lesson plans and implemented them in class. The study found a significant improvement in teachers' knowledge of the TPACK components, with posttest results showing a marked increase in scores compared to pretest results, indicating the effectiveness of the program. While the findings provide valuable quantitative data, they provide insufficient detention on the qualitative aspects of teachers' experiences and their perceptions of the TPD program. Hence, this study will involve qualitative methods such as interviews to gather teachers' viewpoints on the program's impact in Moshi Municipal.

In a study by You et al. (2021), the authors explored the effect of robotics-integrated PD programs through the changes in teachers' technological pedagogical content knowledge (TPACK). The improvement in self-reported knowledge and classroom practices among Indian teachers after the training indicated the effectiveness of the PD. The study further emphasized the importance of access to mentors, hands-on digital tools, and follow-up mechanisms in supporting sustained teaching change. Similarly, in the Tanzanian context, the current evaluation aims to examine how effectively teachers in Moshi Municipality are applying the skills acquired through TCPD programs to improve the integration of science and technology in their classrooms.

The data were analyzed using both statistical and qualitative methods to identify the effectiveness of the TCPD. The findings offer comparative value, particularly when examined alongside regional experiences such as in Kenya and Uganda, where structured professional development frameworks have similarly sought to embed digital competencies at the school level (Chachage & Thakrar, 2023). Unlike those systems, however, Tanzania's TCPD has been decentralized and school-based, with varying levels of support across different LGAs. Understanding these variations provides an opportunity to identify context-specific enablers and barriers to effective science and technology integration.

In this regard, the current study offers a focused evaluation of how public primary schools in Moshi Municipality—known for strong literacy rates and educational values—are translating national TCPD objectives into tangible classroom practices. The research not only aims to assess program uptake and implementation fidelity but also adds value to comparative literature on how professional development programs integrate the use of science and technology in teaching and learning processes in different regions.

A study by Kibona et al. (2023) in Tanzania examined the Professional Development (PD) needs of science teachers in secondary schools in Mbeya. Using a quantitative approach and stratified random sampling, the study surveyed 286 science teachers selected through purposeful school

stratification. The findings revealed critical PD gaps in Pedagogical Knowledge (PK), subject content mastery, and classroom teaching techniques. Moreover, the study identified preferred delivery modes for PD, including collaborative platforms between teachers, specific reference to subject-based training, and school-based peer learning. Specific themes emerging from the PD needs included content mastery, classroom management, and access to digital instructional tools. While the study identifies specific areas where teachers need support, it did not explore how these PD needs are being addressed through ongoing programs, particularly in the context of science and technology integration. Therefore, the current evaluation builds on Kibona et al.'s findings by examining not only teacher needs but also the actual implementation outcomes of a national TCPD program in a focused primary school context.

In Tanzania, Tandika & Ndijuye (2021) contributed to the discourse on primary teachers' preparedness to integrate ICT into pedagogical approaches. By assessing the level of ICT literacy, the study revealed that although most teachers were aware of the role of digital tools, practical application in classrooms remained limited due to lack of structured training and follow-up support. These findings reveal that teachers' ability to integrate ICT depends not only on awareness but also on ongoing training and contextual institutional support.

Building upon these foundational insights, the present study examines how TCPD is being implemented specifically in Moshi Municipality. The municipality was chosen as a focal point due to its strong educational track record, urban setting, and its role as a model district for educational reforms in the Kilimanjaro region. Additionally, Moshi Municipality has a relatively higher concentration of trained personnel and digital infrastructure compared to surrounding areas, making it an appropriate case for examining the integration of science and technology in teaching practices. By evaluating TCPD implementation within this unique local context, the study aims to generate insights that are both practically relevant and scalable to other regions in Tanzania.

➤ *Research Gaps*

The reviewed empirical studies done on the implementation of Teachers' Continuous Professional Development Programme (TCPDP) on enhancing the integration of science and technology into the teaching and learning practices have been conducted globally, including China, India, Lesotho, Indonesia, and Tanzania as well. Despite the contributions of different scholars such as You et al. (2021), Lee et al. (2023), and Kasi eta al. (2022), there is a limitation in body knowledge that particularly evaluates how the teachers' professional development program supports the integration of science and technology in primary schools. Also, the reviews relied primarily on primarily quantitative approach, which may limit the comprehensive understanding of both the outcomes and the lived experiences. Therefore, this current study filled in these gaps by assessing how the implementation of the TCPD program enhances the integration of science and technology in public primary schools by employing both quantitative and qualitative approaches.

VII. EVALUATION METHODOLOGY

This study employed a mixed-methods approach, which was justified by the need to triangulate data from multiple sources to enhance the validity and depth of the findings. Quantitative data provided measurable indicators on the extent of TCPD implementation, while qualitative data enriched the interpretation by capturing the lived experiences and contextual insights from key education stakeholders. The integration of the two approaches allowed for a comprehensive understanding of both outcome trends and process mechanisms related to TCPD implementation.

The study was conducted in Moshi Municipality across ten public primary schools purposively selected based on active participation in TCPD activities and availability of science teaching programs. The target population included all public primary school teachers in the municipality, particularly those handling science subjects. From this, a sample size of 110 respondents was drawn using stratified sampling to ensure representation across schools and wards. The sample included 80 science teachers, 10 headteachers, 10 Ward Education Officers, and 10 School Quality Assurers. Inclusion criteria focused on teachers with at least two years of teaching experience and direct participation in TCPD training within the last 12 months.

Quantitative data were collected using structured questionnaires with Likert-scale items measuring key TCPD indicators such as planning, digital tool use, lesson implementation, and collaboration. Internal consistency reliability was ensured using a Cronbach's Alpha coefficient ($\alpha = 0.84$), indicating strong reliability.

Qualitative data were collected through semi-structured interviews and Focus Group Discussions (FGDs). Two FGDs were conducted with teachers, each comprising 6–8 participants, while individual interviews were held with headteachers, WEOs, and SQAs. To ensure clarity in process, data collection occurred in two distinct phases: (i) quantitative surveys were administered first to establish patterns, and (ii) qualitative interviews and FGDs were then conducted to explore underlying reasons for those patterns.

VIII. RESULTS AND DISCUSSION OF FINDINGS

➤ *Extent to Which the TCPD Programme Enhances Integration of Science and Technology in Teaching and Learning*

The study evaluation question was sought to investigate the extent to which the TCPD program has enhanced the integration of science and technology into the teaching and learning process in public primary schools in Moshi Municipality. A five-level Likert scale was utilized for data analysis, with 1 representing Very Low Extent (VLE), 2= Low Extent (LE), 3=Moderate (M), 4 high Extent (HE), 5=Very High Extent (VHE), F=frequencies, P=Percentages. The frequency and percentage distribution of responses were categorized as follows: $\leq$ 20=extreme minority; 21-49=minority; 50-59=moderate; 60-69=majority; 70-89=very high majority; 90-99=extremely majority;

100=overwhelming majority (Taherdoost, 2019). A mean score greater than 3 indicates that compliance with rules and regulations enhances the learning process, while a mean score less than 3 suggested limited impact. A mean score greater than 3 indicates a significant enhancement in the integration of science and technology, while a mean score less than 3 suggests limited impact. Both quantitative and qualitative findings are presented, drawing from responses of teachers, school CPD coordinators, head teachers, and the municipal education officer. The summary of teacher responses on the TCPD integration on t

He use of science and technology in teaching and learning processes in Table 1.

Table 1. Teachers' Responses on the Extent to Which the TCPD Programme Enhances Integration of Science and Technology in Teaching and Learning (n = 110)

Statement	VLE		LE		ME		HE		VHE		Mean
	f	%	f	%	f	%	f	%	f	%	
i.TCPD programs have significantly improved teachers' abilities to plan science lessons that integrate appropriate technological tools.	0	0	2	1.8	28	25.5	52	47.3	28	25.5	3.964
ii.The content of TCPD programs equips teachers with the necessary tools to incorporate science and technology in the classroom	3	2.7	5	4.5	15	13.6	60	54.5	27	24.5	3.936
iii.TCPD participation has greatly enhanced teachers' competence in using varied assessment strategies to evaluate students' learning in science subjects.	2	1.8	3	2.7	23	20.9	49	44.5	33	30	3.982
iv.Teachers' involvement in TCPD programs has led to a noticeable increase in student engagement through interactive and technology-supported lessons.	0	0	2	1.8	20	18.2	60	54.5	28	25.5	4.036
v.The ability of teachers to provide differentiated support to students with diverse learning needs has been strengthened through TCPD sessions	0	0	0	0	20	18.2	49	44.5	41	37.3	4.191
vi.TCPD programs have helped teachers to design and implement simple science projects that reinforce theoretical knowledge	0	0	2	1.8	19	17.3	56	50.9	33	30	4.091
ii.Use digital tools for assessment, quizzes, and feedback to improve the assessment of pupils' understanding.	2	1.8	4	3.6	19	17.3	48	43.6	37	33.6	4.036
viii.TCPD has contributed to a higher level of confidence among teachers in integrating technology into daily classroom instruction	0	0	0	0	19	17.3	60	54.5	31	28.2	4.109
ix.Teachers' integration of science and technology in teaching has increased the involvement of pupils during lessons	0	0	4	3.6	16	14.5	64	58.2	26	23.6	4.018
x.The frequency of using technological resources in classrooms has increased pupils' support in their learning	0	0	3	2.7	27	24.5	41	37.3	39	35.5	4.055
Grand Mean											4.042

Source: Field Data (2025)

The data in Table 1 show that very high majority (72.8%) rated the effectiveness of TCPD programs in improving their ability to plan lessons with appropriate technology tools as high or very high. Additionally, minority of teachers (25.5%) rated the effectiveness of the program as average, while only extreme minority of teachers (1.8%) rated it as low, and none rated it as very low. The overall mean score was 3.96, which falls within the high extent category based on the evaluation scale. These results indicate that TCPD sessions have been effective in building teachers' digital literacy and science teaching skills, as demonstrated by high and very high ratings.

"There are teachers who went to the seminar, and when they returned, they taught others, so we learn. But also, sometimes we learn how to use various programs, for example, the Microsoft Excel program helps us a lot in terms of results in terms of preparing lesson plans, lesson notes, and preparing exams" (School Head Teacher 1, Personal Communication, 5th May 2025).

Another School Coordinator added that, "*After the training, I started using the tablet to prepare my schemes and lesson notes. It is now faster, and I also learned to organize digital content better, like using images and simulations for science lessons*" (School Coordinator D, Personal Communication, 19th May 2025).

These interview accounts highlight the TCPD programme's role in promoting peer-to-peer knowledge transfer, where trained teachers return to their schools and share new digital pedagogical practices with others. Both the

quantitative and qualitative findings suggest a cultural shift toward digital integration, where planning lessons is about traditional preparation and aligning digital tools with curriculum goals. This reflects increased confidence and efficiency in instructional design among primary school teachers. The findings are consistent with the results of Lee et al. (2023) in China, who found that continuous professional development programs enhanced teachers' technological competence and collaborative practices through structured training.

Contrary to the practice, Chachage's TCPD monitoring Report (2023) revealed that primary school teachers in Tanzania who participated in TCPD sessions demonstrated improved planning and delivery of science lessons using ICT, especially when digital resources such as tablets and apps were made accessible. Furthermore, Ngendahayo et al. (2023) emphasized that the collaborative aspect of CPD, especially when supported by peer mentoring and leadership, has a multiplier effect in enhancing digital lesson planning practices. Collectively, these studies and the present evaluation point to a growing realization that technology-supported instructional planning is a core competence enabled by well-structured CPD programs.

The data in Table 5.5 shows that very high majority of teachers (79.0%) perceived the TCPD content as supporting technology integration to a high or very high extent. Meanwhile, extreme minority of teachers (13.6%) rated the program's content effectiveness to a moderate extent, and extreme minority of teachers (7.2%) rated it at a low extent. The computed mean score of 3.94, which corresponds to very high majority (78.8%) of the maximum score, falls in the high extent category according to the Likert evaluation scale, which confirms a generally positive perception of the program's content relevance and utility. Specifically, teachers expressed that TCPD content was directly applicable to their classroom realities, particularly in integrating science topics with ICT-based instructional methods. The relevance was highlighted in their ability to modify lesson plans, select appropriate teaching tools, and adapt assessments to better align with digital pedagogy principles. These data suggest that most teachers find the TCPD program materials practical and applicable, particularly in improving their ability to embed digital resources into daily instructional routines. In affirming this, School Coordinator 4 put:

"TCPD has helped in the intervention of science and technology… we were fortunate to have access to computers. So, computers have helped teachers to prepare their work, prepare materials using those computers, and be able to present them to students in an easy way" (School Coordinator 4, Personal Communication, 6th May 2025).

The support provided through TCPD enabled teachers to identify appropriate digital tools such as simulations, science apps, and audiovisual aids that enhanced conceptual clarity. For instance, some participants highlighted how video demonstrations and interactive whiteboards improved student engagement and understanding of abstract scientific processes.

On the other side, Teacher 5 suggested that:

"The science module we used during TCPD training showed us real examples of how to integrate animations and videos in our lessons. Even those who were afraid of computers became curious. The examples were made simple but made sense" (Head Teacher, Personal Communication, 07th May 2025).

The responses from the interview with School Coordinator 5 and Head Teacher 5 show that the TCPD content is theoretically aligned with curriculum demands and practically designed to equip teachers with hands-on tools and demonstrable techniques. The mention of computer labs and shared learning spaces reinforces how the materials are used to support both lesson preparation and student engagement. The second teacher's quote also illustrates how well-designed CPD content can demystify technology, making it accessible to even less tech-savvy educators.

These barriers, including lack of confidence, limited ICT skills, and unavailability of tailored teaching materials, were addressed through regular peer workshops and hands-on ICT training. Teachers also received guidance on improvising with available resources, fostering resilience and adaptability in low-resource settings.

According to the findings, a high proportion of teachers reported that TCPD programs enhanced their ability to apply learner-centered methods, particularly when using technology-supported strategies. This observation is reflected in a high mean score of 4.09 on the item: "TCPD programs have helped teachers to design and implement simple science projects that reinforce theoretical knowledge." This suggests that TCPD is not only equipping teachers with theoretical insights but also enabling the practical application of digital tools in classroom settings. For instance, teachers reported using project-based learning approaches, science kits, and digital resources such as mobile apps and interactive simulations to reinforce key concepts. This high mean score corresponds primarily to responses where over 80% of teachers rated the TCPD as contributing to improvements in interactive lesson planning and differentiated instruction using ICT tools.

This is consistent with findings by Musomba and Mshindi (2021), who found that teacher training aligned with the use of digital platforms resulted in higher student engagement in Kenya and Tanzania. Moreover, Chachage and Thakrar's (2023) TCPD Evaluation Report similarly noted that science-based projects were among the most common instructional innovations in Tanzanian public schools where structured peer-support models were introduced. These findings further affirm that where TCPD is implemented consistently, it enhances not just knowledge acquisition, but also the practical integration of science and technology in daily classroom routines.

On using varied assessment strategies to evaluate students' learning in science subjects, reported that very high majority (74.5%) teachers noted a high degree of

competencies gained. Meanwhile, extreme minority of teachers (20.9%) rated their competence to a moderate extent of competence, and extreme minority (4.5%) reported a low extent, with a mean score of 3.98. This suggests that the TCPD program has extensively equipped teachers with diverse assessment techniques such as formative quizzes, project-based tasks, digital assessments, and peer evaluations appropriate for science subjects. These tools enable more accurate monitoring of pupils' understanding and learning progress, aligning well with the principles of competency-based education. During the interview, Science Teacher 2 said that;

"In our school, we now use Google Forms to prepare science quizzes, and these are done during class or even at home. We also sometimes design practical assignments where pupils must investigate or experiment using simple local materials and report back. We learned this from TCPD workshops. These assessments help pupils think critically and practically. Before, it was mostly asking pupils to memorize facts, but now we use digital forms, and it marks an instant. We also review the answers together and provide feedback as a class. This approach has changed the way we teach and how pupils engage with science learning" (Science Teacher 2, Personal Communication, 05th May 2025).

Furthermore, the School Coordinator 3 responded to that;

"After attending TCPD sessions, I started using Kahoot and Quizizz platforms to do short assessments. It helps to see which concepts learners have understood and which need repetition. We also do reflective journals sometimes. For instance, I ask learners to write what they found difficult in the topic we finished and how they solved it. These methods were strange to me at first, but I now understand that assessments are not just final exams. They are tools to guide instruction and engage pupils. My fellow teachers also share digital templates in our WhatsApp groups, especially for science topics like energy or weather. TCPD gave us exposure to these tools, and we continue to learn from one another" (School Coordinator 3, Personal Communication, 06th May 2025).

Responses from interviews by SCT2 and SC3 provide a deeper insight into how TCPD has empowered teachers to move beyond traditional summative assessments. Teachers are now deploying digital and reflective strategies that promote active learning and immediate feedback. The emphasis on collaborative peer learning and technology use shows a pedagogical shift aligned with 21st-century skills. It also reflects a professional culture where teachers take initiative in sharing assessment tools and refining strategies based on learners' needs. Such innovations improve learning outcomes and foster a more inclusive and feedback-driven classroom environment. The findings resonate with the study conducted by Vattøy and Gamlem (2024) in suburban areas, which found that professional digital development interventions enhanced teachers' understanding of formative assessment, including its timing and influence on student engagement and academic progress. In line with the CIPP

model's product evaluation domain, the outcomes derived from teachers' self-reported survey responses suggest that TCPD initiatives in Moshi Municipality have yielded measurable benefits in assessment literacy among science educators.

This underlines the relevance of continuous digital training to support sustainable teaching reforms in competency-based curricula. These science experiments commonly involved low-cost, locally sourced materials to demonstrate core concepts such as plant growth, basic chemical reactions, and energy transformations. Teachers noted that TCPD training provided them with simplified, context-relevant practicals that could be executed even in resource-limited classrooms.

Regarding whether teachers' involvement in TCPD programs has led to a visible increase in student engagement through interactive and technology-supported lessons, the results show that very high majority (80.0%) teachers rated it to a high extent. In comparison, extreme minority of teachers (18.2%) rated to a moderate extent, and extreme minority (1.8%) to a low extent, with a mean score of 4.04. This indicates that the majority of teachers perceive that TCPD has enhanced pupils' participation in learning through the integration of digital tools and interactive pedagogical strategies. The findings imply that pupils are becoming more involved, responsive, and eager to learn due to the use of educational technologies such as digital media, audiovisual tools, and online learning platforms. Interview responses provided further insights into how this engagement manifests in practice. Head Teacher 5 observed that:

"Children today, you know very well that if you give an assignment to students, they can access music, watch movies, even today, if you give them a task to find material on the internet, they will still search for it. So, technology really cannot be avoided in any way when it is used, and it helps a lot" (School Head Teacher 5, Personal Communication, 07th May 2025).

Another Head Teacher elaborated on how audio-visual aids and digital music tools are used to reduce absenteeism and stimulate interest:

"These small classes, you will see that today, children have become very interested in learning through songs, today teachers use radios, they will put flash drives, children will enjoy it in the classroom, but also absenteeism goes away because a child cannot stay at home, remembering that there are songs at school, for sure he cannot stay at home, he must come to school, so technology has been developed very widely" (Head Teacher 6, Personal Communication, 08th May 2025).

The participants included both generalist class teachers responsible for integrated subjects in lower primary, and science subject teachers in upper primary. The feedback revealed nuanced variations, with science teachers reporting more frequent application of TCPD strategies, especially in integrating simulations and visual aids.

The reflections from interviews illustrate how technology fosters a dynamic and interactive learning environment that captures pupils' attention and reduces truancy. The findings are consistent with a study conducted by Casilao et al. (2025) in the Philippines, which showed that teachers widely adopted digital platforms like Google Classroom and media tools to make teaching more effective and engaging, particularly in early-grade instruction. This supports the assertion that the TCPD has contributed meaningfully to the enhancement of learner engagement through pedagogical innovations.

When asked whether the TCPD program enhanced support for diverse learners, the data showed that very high majority of teachers (81.8%) rated it to a high extent and extreme minority of teachers (18.2%) agreed to a moderate extent, with none reporting a low or very low extent. The mean score of 4.19 falls in the highest category. These findings suggest that TCPD has equipped teachers with competencies in differentiated instruction by promoting the use of accessible and adaptive technologies. Teachers are increasingly adopting strategies such as customized digital content and flexible lesson designs that respond to students' varying academic abilities and learning needs.

one school coordinator stated that: "*They gain confidence, and they understand more, but they are also instructed on how to search for various materials that are available through the computers that are in the school*" (School Coordinator 3, Personal Communication, 06th May 2025)

This insight was drawn from a direct interview with a head teacher, indicating the perceived value of TCPD in equipping teachers with practical strategies for guiding learners in digital research and safe internet navigation.

Another teacher emphasized the application of individualized learning methods by saying:

"Some learners, especially those who struggle with reading or writing, now use educational videos and apps. We guide them step-by-step, and they feel comfortable because the tools adjust to their pace. It's no longer one-size-fits-all" (Inclusive Education Focal Teacher, Personal Communication, 08th May 2025)

One teacher emphasized, "What they see at home is now matched at school, they're excited to find videos in class like the ones they love online." This highlights how the use of educational videos not only aids understanding but also bridges home-school digital environments, sustaining learner interest.

Responses from school coordinator 3 and the inclusive education focal teacher reflect a shift toward inclusive practices that address the needs of all learners, including those with learning difficulties or limited exposure to formal instruction. Through access to ICT and teacher guidance, students benefit from both the tools and the pedagogical approaches tailored to them. The results align with the study

by Revelian (2022), which emphasized the importance of including inclusive education courses in teacher preparation curricula to promote responsiveness to learner diversity. The current TCPD approach mirrors this recommendation by building teacher capacity for inclusive, student-centered learning environments.

The teachers also affirmed the role of the TCPD programme in improving their ability to design and implement simple science projects that reinforce theoretical knowledge delivered during lessons. According to the data, very high majority (80.9%) of respondents reported a high extent, extreme minority (17.3%) a moderate extent, and extreme minority (1.8%) a low extent, with a mean score of 4.09. This suggests that TCPD has enhanced teachers' competence in planning and executing hands-on science activities that allow pupils to translate theory into practice. The capacity to conduct low-cost experiments or classroom demonstrations using locally available materials and basic digital tools reflects a shift toward experiential learning approaches in science education. Interview narratives provided by Science Teacher 2 pointed out that:

"Before, we used to teach theory alone, especially topics like magnetism and weather. Now, after the training, we learned how to improvise using plastic bottles, magnets, water, and even videos. So, pupils can see what we are explaining. It sticks in their minds better" (Science Teacher 2, Personal Communication, 05th May 2025)

This quote illustrates the practical transformation in teachers' classroom approaches to science concepts following TCPD participation.

Another teacher emphasized the impact of collaborative planning and creativity in science project design:

"After TCPD, we came back and shared ideas on simple science experiments. We now include at least one activity each week, and we also use tablets to show short clips before we start the experiment. It makes the lesson exciting and clear" (School Coordinator 1, Personal Communication, 05th May 2025)

These experiences indicate that teachers are actively applying knowledge gained from TCPD sessions to foster learner engagement through project-based learning. The shift from purely theoretical instruction to participatory experimentation supports deeper understanding and retention among pupils. This aligns with findings by Kasi et al. (2022), who noted that post-training; teachers significantly improved their use of the TPACK framework, particularly in integrating content and technology for science education. Therefore, from both the quantitative and qualitative evidence, TCPD is seen as instrumental in strengthening science pedagogy through simple but meaningful practical applications.

Regarding the use of digital tools for assessment, quizzes, and feedback to improve pupils' understanding, very high majority (77.2%) of teachers rated the TCPD program as effective to a high extent, extreme minority (17.3%) to a

moderate extent, and only extreme minority (5.4%) to a low extent. The mean score was 4.04, which falls within the high extent category. These results suggest that many teachers are now able to integrate digital assessment strategies such as online quizzes, auto-graded assignments, and feedback dashboards into their daily teaching routines. These strategies help track student learning more accurately, offer timely feedback, and allow for differentiated assessment methods that cater to pupils with varying levels of understanding.

Interview evidence provided deeper insight into how digital assessment tools are used in practice. These tools were predominantly utilized during assessment phases, including both formative and summative evaluations, to improve efficiency and accuracy in tracking pupil progress. One school coordinator explained:

"We have been trained and empowered to use tablets and mobile phones to enhance our teaching. Platforms like ChatGPT help us generate questions and explanations for lessons. We also use websites and apps to clarify concepts we find challenging. During assessment periods, we rely on these tools to help design examinations and compile results efficiently." (School Coordinator 1, Personal Communication,05th May 2025).

Another teacher emphasized the practical benefits of daily classroom management: "*Sometimes we use Google Forms to give short tests. The students complete them quickly, and we get marks immediately. It saves time and gives us a chance to see who needs more help*" (ICT Subject Teacher, Personal Communication, 6th May 2025).

These statements from the interview highlight that the adoption of digital tools extends beyond teaching content; it enhances the whole instructional cycle, including assessment and learner feedback. Teachers now have access to tools that promote real-time monitoring of learner progress and individualized intervention. The findings reflect the outcome stage of the CIRO evaluation model, demonstrating practical improvements in teaching through digital adoption.

While some platforms mentioned, such as ChatGPT, were reported as being used by a minority of digitally proactive teachers, the general trend points to increased confidence and willingness to experiment with educational technology. These results also resonate with Casilao et al. (2025), who found that digital integration in the Philippines led to improvements in both classroom instruction and assessment accuracy. In the context of Moshi Municipality, the TCPD initiative appears to be building similar momentum

in reshaping how assessments are conceived, delivered, and used for pedagogical decisions.

Concerning the role of TCPD in supporting the integration of technology into daily classroom instruction, very high majority of teachers (82.7%) of teachers rated the program as effective to a high extent, while extreme minority (17.3%) rated it as moderately effective. None of the respondents indicated low effectiveness, and the mean score of 4.11 falls within the high extent category. These results suggest that TCPD has played a pivotal role in shifting teacher behavior from passive consumers of technology to active adopters who are increasingly experimenting with and applying digital tools in lesson delivery.

This transition was echoed in the interview responses. One teacher noted:

"I did not even know how to open a projector before, but now I can use it in class, show videos or PowerPoints, and even create slides for my lessons. It gives me a lot of confidence, and the students enjoy it more than just talking all the time" (Science Teacher 2, Personal Communication, 05th May 2025).

Another School Coordinator added that:

"Even if we don't have many computers, we try to make use of what we have. Sometimes, two students share one tablet, but we make it work. You will find even the pupils are now guiding each other on how to find materials or answers using the devices" (School Coordinator 3, Personal Communication, 06th May 2025).

This observation complements the insights provided earlier by Science Teacher 2, who also highlighted how TCPD empowered teachers to creatively utilize limited digital resources during lessons.

These quotations highlight that the skills developed during TCPD sessions are retained and translated into real instructional practices, reinforcing the view that teachers are now more confident and proactive in using technology in the classroom. Additional evidence on teachers' acquired skills in using various digital gadgets, such as tablets, during teaching is presented in Figure 1.

➤ *Teachers Using Digital Gadgets (Tablets) During Training Session*

Fig 1: Teachers Using Digital Gadgets (Tablets, Laptops, and Smartphones) During Training Session

Figure 1 shows teachers independently using tablets, which are commonly known as "*vishikwambi*" in Kiswahili. In some scenarios, teachers use other digital tools such as laptops and projectors in teaching and the provision of assessments, like interactive quizzes, online simulations, or video-based activities. Although a few better-resourced schools were using smart boards for full-class instruction, such technology was not uniformly available. The current findings align with Obispo's (2023) study in Laguna, Philippines, which emphasized that positive teacher perceptions are a critical precursor to effective integration of science and technology in classrooms. Findings also reflect success in the 'Outcome' stage of the CIRO model, where observable changes in teacher practices demonstrate the realization of intended program benefits.

In terms of teachers' integration of science and technology into classroom practices, very high majority of teachers (81.8%) of respondents reported implementing it to a high or very high extent, extreme minority (14.5%) to a moderate extent, and only extreme minority (3.6%) to a low extent. The mean score of 4.02 corresponds to a high level of effectiveness based on the evaluation scale. These results indicate that digital tools are becoming essential in supporting inclusive and participatory learning environments where students are more actively engaged during instruction. This reflects a significant transformation in teaching practices, in which traditional lecture-based delivery is increasingly replaced by interactive and student-centered pedagogies aided by technology. This shift was clearly described by the school coordinator 1, who shared: "*We have seen that when we use tablets or online materials, more pupils raise their hands to respond or volunteer to work in pairs or small*

groups. They enjoy interacting with the content" (School Coordinator 1, Personal Communication,05ᵗʰ May 2025).

Another teacher illustrated this transformation with an example from their classroom:

"Even the quiet pupils now participate when videos or games are used in science. One day, a child who never speaks answered a question just because he saw the experiment video before others. It's something that builds their courage" (Personal Communication with Municipal Primary Education Academic Officer, 26ᵗʰ May 2025).

Despite this progress, infrastructural constraints remain a major challenge, particularly in sustaining long-term integration. One school head teacher emphasized: *"The technology we access includes tablets, and another is internet access, which is available, but it comes at the teachers' own expense; therefore, each teacher is responsible for their internet access"* (School Head Teacher 3, Personal Communication, 06ᵗʰ May 2025)

Such challenges point to an uneven implementation landscape, where teacher commitment and personal sacrifice play a role in driving integration efforts. The interviews underline that while TCPD has equipped educators with relevant digital skills and encouraged active pedagogies, the sustainability of these gains depends on infrastructural investments and systemic support. These findings resonate with the study by You et al. (2021) in India, which revealed that targeted professional development programs enhanced teachers' content knowledge, confidence, and outcome expectancy in integrating robotics into classroom instruction.

This indicates progress in both knowledge acquisition and teaching confidence, fulfilling key goals of continuous professional development and supporting the Outcome component of the CIRO evaluation model.

Regarding the frequency of using technological resources in classrooms to support pupils' learning, very high majority of teachers (72.8%) of the respondents indicated a high extent of utilization, minority (24.5%) reported a moderate extent, and only extreme minority (2.7%) a low extent. The calculated mean score was 4.05, positioning this outcome in the "high extent" category on the Likert scale. These results demonstrate that most teachers are now routinely employing technological tools such as projectors, tablets, educational software, and internet resources to support instruction and pupil engagement. This suggests a growing normalization of ICT-based instructional practices in everyday classroom activities.

This was affirmed in the interviews, with one school coordinator stating:

"We have been trained on how to use PowerPoint and YouTube videos to simplify science lessons. When you teach and play a short experiment video, students understand faster. So, we use these tools more often now, at least weekly if not daily" (School Coordinator 2, Personal Communication, 05th May 2025).

Another teacher explained how the availability of tech resources drives usage:

"We use the tablets often now, especially for science and math. Even when the internet is slow, we can still use pre-downloaded materials. Pupils like visual learning; if we don't use videos or graphics, they lose interest quickly (Municipal Primary Education Officer, Personal Communication 26th May 2025).

These qualitative insights align well with the quantitative data and offer an in-depth understanding of how TCPD has shifted teaching routines toward digital integration. The shift influences the way content is delivered and impacts the learner's motivation, conceptual understanding, and inclusiveness. The consistency in reported usage also indicates that the professional development initiatives have been translated into practical application and behavioral change among teachers. The findings resonate with those found by Tandika and Ndijuye (2021) in Tanzania, which revealed that most teachers were aware of ICT in teaching and learning, understanding it as the use of ICT-based tools such as televisions, mobile phones, computers, and radios to implement the curriculum. These tools, once peripheral, have now become essential in curriculum delivery in Moshi's public primary schools.

Overall, the results of this evaluation underline that the Teachers' Continuous Professional Development (TCPD) program has significantly contributed to the integration of science and technology in daily instructional routines. This is evidenced by the high ratings across indicators with the grand mean of 4.042, which reflects a high extent of the implementation of TCPD in enhancing the integration of science and technology. Despite such a high extent of implementation of science and technology. The noted challenges include power supply, lack of computer laboratories in some schools, unreliable internet, and the cost of bundles. These personal digital resources predominantly include tablets, laptops, and mobile phones, which were frequently mentioned by teachers as the primary tools for accessing content, conducting assessments, and supporting digital instruction due to the limited availability of institutional desktops or smartboards in classrooms.

The evaluation has, to a great extent, enhanced the integration of science and technology for instructional practices, particularly lesson planning, digital assessment strategies, and pupil engagement. The study concludes that, despite such recommendable achievements, the TCPD implementation has encountered infrastructural limitations, especially unstable internet access and reliance on personal digital resources, which remain challenges in some schools.

IX. CONCLUSION

Based on findings, the evaluation study concluded that TCPD has, to a great extent, enhanced the integration of science and technology for instructional practices, particularly lesson planning, digital assessment strategies, and pupil engagement. Nevertheless, the study concludes that, despite such recommendable achievements, the TCPD implementation has encountered infrastructural limitations, especially unstable internet access and reliance on personal digital resources, which remain challenges in some schools.

RECOMMENDATIONS FOR ACTION

Based on the conclusions, the study recommends that the Program owners see a way of expanding the focus of the program to train teachers on the pedagogical use of digital tools, including emerging platforms such as AI. Furthermore, future evaluation studies should investigate the effectiveness of the TCPD program in secondary schools with more extensive delimitations to assess its sustained impact on the integration of science and technology in teaching and learning. Finally, the study recommends that the Government, through the Ministry of Education, Science and Technology, to seek for more collaborations with stakeholders in order to invest in laboratories and internet installation in schools.

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