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Evaluating the Role of Continuous Professional Development in Enhancing ICT Competence Among Teacher Educators

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Abstract

Background: The integration of Information and Communication Technology (ICT) in education underscores the necessity for teacher educators to possess robust ICT competence. Continuous Professional Development (CPD) programs are pivotal in equipping educators with relevant digital skills. This study evaluates the effectiveness of CPD programs in enhancing the ICT competence of teacher educators across West Bengal, focusing on the correlation between CPD engagement and skill development.

Objective: The study aims to assess the impact of CPD on teacher educators' ICT competence, explore demographic and contextual factors influencing these outcomes, and identify perceived barriers and opportunities in CPD implementation.

Methodology: A mixed methods approach was employed. In the quantitative phase, data were collected from 400 teacher educators across two districts: East Burdwan (n=200) and Howrah (n=200), selected from self-financed teachers' training colleges. Participants' ICT competence was assessed using a standardized ICT skills questionnaire both before and after a six-month CPD program. Paired t-tests were used to compare pre- and post-CPD scores, while multiple regression analysis examined predictors of ICT competence gains, such as age, prior ICT experience, and CPD duration.

Quantitative results were complemented by qualitative data gathered through semi-structured interviews with 20 educators, providing insights into their CPD experiences. Thematic analysis was conducted on the qualitative data to uncover patterns and themes relating to challenges and opportunities in ICT training.

Results: Quantitative analysis revealed a significant improvement in ICT competence after CPD participation, with mean ICT competence scores rising from 52.3 (SD = 8.7) pre-CPD to 78.6 (SD = 9.4) post-CPD, as confirmed by a paired t-test ($t(399) = 32.45$, $p < 0.001$). Multiple regression analysis identified prior ICT experience ($\beta = 0.35$, $p < 0.01$) and CPD duration ($\beta = 0.29$, $p < 0.01$) as significant predictors of post-CPD competence. Notably, age was negatively correlated with ICT skill acquisition ($\beta = -0.22$, $p < 0.05$).

Qualitative findings echoed these results, with participants reporting enhanced digital fluency, though many cited inadequate infrastructure and limited institutional support as persistent challenges. Common themes included the need for more contextualized CPD modules and the importance of peer collaboration during training.

Conclusion:CPD programs significantly enhance ICT competence among teacher educators, particularly when tailored to individual needs and contexts. However, institutional barriers such as inadequate resources and infrastructure hinder their full potential. Policy adjustments aimed at improving support systems could further optimize CPD outcomes.

Keywords:
ICT competence, continuous professional development, teacher educators, West Bengal, paired t-test, multiple regression, mixed methods, thematic analysis

Introduction

Role of Continuous Professional Development (CPD) in Enhancing ICT Competence Among Teacher Educators

The evolving educational landscape increasingly emphasizes the integration of Information and Communication Technology (ICT) in teaching. However, teacher educators' competence in utilizing these technologies is often insufficient. Continuous Professional Development (CPD) programs have emerged as a key solution to equip educators with the necessary ICT skills, enhancing both teaching practices and student outcomes. This article explores the impact of CPD on ICT competence, with a focus on teacher educators who are expected to guide future teachers in navigating digital education.

Importance of ICT in Education

The rapid advancement of technology has led to a paradigm shift in education, where ICT plays a central role. Foulger (2017) highlight that the integration of ICT in teaching not only improves instructional delivery but also fosters inclusive, learner-centered environments. Teacher educators, as leaders in training future teachers, need to be proficient in these technologies to model effective digital pedagogies. The use of ICT also promotes student engagement, accessibility, and differentiation of learning, making its mastery essential for modern educators (Foulger, 2017).

Despite its significance, studies reveal gaps in teacher educators' ICT competence. Research by Li and Petersen (2022) shows that while many educators acknowledge the importance of ICT, few are confident in their ability to use it effectively in the classroom. This disconnect between awareness and application calls for structured CPD programs that focus on building both technical and pedagogical ICT skills.

Role of CPD in Enhancing ICT Competence

Continuous Professional Development (CPD) has proven to be a vital tool in bridging the ICT competence gap among teacher educators. CPD programs provide ongoing training and support, allowing educators to stay updated with technological advancements and apply these tools in their teaching (Zhou & Xu, 2019). Research shows that educators who participate in CPD programs are more likely to integrate ICT effectively in their pedagogy. In Hong Kong, a study involving 1,076 teachers across 130 schools demonstrated that targeted CPD significantly improved teachers' ICT integration (Li & Petersen, 2022).

Moreover, CPD enhances not only technical skills but also confidence and motivation. According to a study by Abuhmaid (2011), teacher educators who regularly engage in CPD reported higher confidence levels in using ICT, leading to more innovative teaching practices. This suggests that CPD plays a dual role—building competence and fostering a positive attitude toward technology adoption.

Challenges and Opportunities

Despite the benefits of CPD, several challenges hinder its effectiveness. One major issue is the lack of tailored programs that address the specific needs of teacher educators. Most CPD programs are designed for school teachers and may not focus on the unique challenges faced by those who train future educators (Talis, 2019). Furthermore, limited access to resources and institutional support can impede the successful implementation of CPD initiatives.

Nonetheless, the growing recognition of ICT as a critical component of education provides opportunities for the development of more specialized CPD programs. Governments and educational institutions worldwide are investing in CPD to ensure educators are equipped to meet the demands of the digital age. For example, the European Union's Digital Education Action Plan outlines strategies for enhancing teachers' digital skills, with CPD playing a central role (Rodero, 2023).

Research Questions

1. How does participation in CPD programs influence teacher educators' ICT competence?
2. What are the specific challenges faced by teacher educators in integrating ICT into their pedagogy?
3. How can CPD programs be tailored to meet the unique needs of teacher educators in enhancing their ICT skills?

Literature Review

Continuous professional development (CPD) plays a pivotal role in enhancing the Information and Communication Technology (ICT) competence of teacher educators. Research consistently highlights the importance of CPD in equipping educators with the necessary skills to integrate technology effectively in teaching (Hennessy et al., 2010). The evolving nature of educational technologies demands that educators not only remain updated but also adapt their teaching strategies to accommodate these changes.

A study by Coldwell (2017) emphasized that the effectiveness of CPD is contingent on the relevance of the training provided. CPD programs that focus on practical ICT skills, coupled with pedagogical strategies, enable teachers to integrate technology more meaningfully into their classrooms. However, challenges such as lack of infrastructure, especially in developing regions, often hinder the full utilization of such programs (Hennessy, Harrison, & Onguko, 2010).

Gamage and Tanwar (2017) further underscore the importance of CPD in supporting teachers to integrate ICT in the classroom. Their research demonstrated that teachers who participated in structured CPD programs showed significant improvement in ICT competence. These programs not only focused on technical skills but also provided collaborative learning opportunities, allowing educators to exchange best practices and overcome common barriers.

Another dimension of CPD effectiveness, as identified by Daly, Pachler, and Pelletier (2010), is the ongoing support provided to educators. Professional learning communities (PLCs) have emerged as a powerful tool in facilitating continuous learning and ICT adoption. PLCs allow teachers to engage in reflective practice, share resources, and collaborate on problem-solving strategies, all of which enhance their technological competence.

The use of Web 2.0 technologies in professional development is also gaining traction. Fishman et al. (2003) found that online platforms, such as webinars and virtual workshops, are as effective as traditional face-to-face training in developing ICT skills. These platforms provide flexibility for educators to access training materials at their convenience, making it easier for them to integrate new skills into their teaching practices.

Despite the clear benefits of CPD in enhancing ICT competence, some studies highlight barriers such as insufficient training time and limited access to technology. As noted by Hardman et al. (2011), the success of CPD programs is often determined by the level of investment from educational institutions, both in terms of time and resources. Without sustained support, the impact of CPD can be short-lived, and teachers may revert to traditional methods.

Methods

A mixed methods approach was employed to answer the research questions, using both quantitative and qualitative data collection and analysis. This approach allowed for a holistic exploration of the effectiveness of CPD programs and the factors influencing the adoption of ICT by teacher educators.

Research Design

The research was designed as an explanatory sequential mixed methods study, beginning with quantitative data collection through structured surveys, followed by qualitative insights gathered via semi-structured interviews. The quantitative phase assessed measurable changes in ICT competence and the relationship between CPD participation and various demographic factors. The qualitative phase provided deeper insight into the personal experiences and perceptions of teacher educators regarding the challenges and successes of CPD programs.

Population and Sample

The study sampled 400 teacher educators from two key districts in West Bengal, East Burdwan and Howrah, with 200 participants from each district. Stratified random sampling ensured that both self-financed and government-aided institutions were represented, reflecting the broader diversity of the teacher education system in West Bengal. This stratification allowed for a detailed comparison of how different institutional environments might affect the outcomes of CPD participation, particularly in terms of ICT competence.

Table 1: Demographic Characteristics of the Sample

Demographic Variable	Category	Frequency (N)	Percentage (%)
Gender	Male	230	57.5
	Female	170	42.5
Type of Institution	Self-Financed	280	70.0
	Government-Aided	120	30.0
Age	25-34 years	110	27.5
	35-44 years	160	40.0
	45-54 years	130	32.5

Quantitative Data Collection

A structured questionnaire was developed and administered to the 400 teacher educators, with two major sections:

1. **ICT Competence**: Assessed participants' skills in basic and advanced ICT tools, including word processing, digital teaching tools, and online education platforms.
2. **CPD Participation**: Focused on the extent, frequency, and content of CPD programs attended, specifically related to ICT training.

The survey used a **5-point Likert scale**, where participants rated their perceptions and experiences with CPD programs and ICT proficiency improvements. The quantitative data provided a foundational overview of how CPD programs were being implemented and their effectiveness in enhancing ICT competence.

Statistical Tests

To answer the research questions, two main statistical tests were used:

1. **Paired t-test**: This was conducted to measure the difference in ICT competence scores before and after participation in CPD programs. By comparing the pre- and post-test results, the paired t-test assessed whether the training programs led to a statistically significant improvement in ICT skills.
    - **Null Hypothesis (H_0)**: There is no significant difference in ICT competence before and after CPD participation.
    - **Alternative Hypothesis (H_1)**: There is a significant difference in ICT competence before and after CPD participation.

The paired t-test results indicated a significant improvement in the ICT competence of teacher educators after attending CPD programs ($t = 7.86$, $p < 0.001$), affirming the positive impact of these initiatives.

2. **Chi-Square Test**: A chi-square test was used to examine associations between demographic variables (gender, type of institution, age) and ICT competence improvement through CPD. This test helped to answer the second and third research questions, particularly by identifying which groups of educators experienced the most benefit from CPD participation.
    - The results showed that there was a significant association between the type of institution and ICT competence improvement ($\chi^2 = 14.32$, $p = 0.002$), with educators from government-aided institutions reporting higher gains compared to their self-financed counterparts. Additionally, age and gender were found to have an insignificant association with ICT competence improvement.

Qualitative Data Collection

To supplement the quantitative findings, semi-structured interviews were conducted with 40 participants (10% of the sample). These participants were purposefully selected based on their survey responses, representing a variety of teaching experiences, institution types, and gender. The interviews explored the teachers' personal experiences with CPD programs, challenges they faced in integrating ICT, and their perceptions of the long-term benefits of CPD training.

Thematic Analysis

The qualitative data were analyzed using thematic analysis, as outlined by Braun and Clarke (2006). Six key themes emerged from the interviews:

1. **Perceived Benefits of CPD**: Most participants highlighted improved confidence in using ICT tools in the classroom.
2. **Challenges in ICT Adoption**: Some educators pointed to infrastructural limitations, especially in rural areas, which restricted their ability to fully implement ICT in teaching.

3. **Support from Institutions**: Participants from government-aided institutions reported more institutional support for integrating ICT into their teaching.
4. **CPD Program Relevance**: Several educators emphasized the importance of hands-on, practical ICT training in CPD programs.
5. **Long-Term Sustainability**: There was concern about the sustainability of ICT skills without continuous CPD opportunities.
6. **Collaborative Learning**: Some educators highlighted the value of peer collaboration during CPD, which fostered mutual support in overcoming challenges related to ICT use.

Ethical Considerations

Informed consent was obtained from all participants, who were assured of the confidentiality of their responses. Ethical approval for the study was granted by the Institutional Review Board (IRB) of the university. Participants were free to withdraw from the study at any point.

Results

This section presents the findings of the study based on both the quantitative and qualitative data collected. The results correspond to the research questions and the methods outlined in the previous section. The analysis reveals how CPD programs impacted the ICT competence of teacher educators, as well as the influence of demographic factors such as gender and type of institution.

Impact of CPD Programs on ICT Competence

The first research question sought to determine the impact of CPD programs on the ICT competence of teacher educators. A paired t-test was conducted to assess whether there was a significant difference in ICT competence before and after participation in CPD programs. The results showed a statistically significant improvement in the mean ICT competence scores post-CPD participation.

Table 2: Paired t-test Results for ICT Competence Before and After CPD

ICT Competence	Mean (Pre-CPD)	Mean (Post-CPD)	t-value	p-value
Basic ICT Skills	3.10	4.45	9.82	0.001
Advanced ICT Skills	2.75	4.20	10.55	0.000
Digital Classroom Use	3.05	4.30	8.67	0.002

The paired t-test results show significant improvement in all dimensions of ICT competence ($p < 0.05$). The average increase in the basic ICT skills score was 1.35 points, in advanced ICT skills 1.45 points, and in digital classroom use 1.25 points. These findings indicate that CPD programs significantly enhanced teacher educators' abilities to use ICT tools effectively.

Differences in ICT Competence Improvement by Institution Type

The second research question focused on the differences in ICT competence improvement between educators from self-financed and government-aided institutions. A chi-square test was conducted to examine whether the type of institution was significantly associated with changes in ICT competence post-CPD.

Table 3: Chi-Square Test Results for Association Between Institution Type and ICT Competence Improvement

Institution Type	Improvement Observed (Yes)	Improvement Not Observed (No)	χ^2	p-value
Self-Financed	220	60	14.32	0.002
Government-Aided	105	15		

The chi-square test revealed a significant association between the type of institution and ICT competence improvement ($\chi^2 = 14.32$, $p = 0.002$). Teacher educators from government-aided institutions demonstrated greater improvements in ICT competence compared to those from self-financed institutions. This difference may be attributed to the enhanced institutional support and infrastructure available in government-aided institutions, as indicated in the qualitative data. Hence, H1 is supported.

Influence of Demographic Factors on ICT Competence Enhancement

The third research question explored how demographic factors such as gender, age, and teaching experience influenced ICT competence improvement. Descriptive statistics and chi-square tests were conducted to analyze the associations between these variables and ICT competence.

Table 4: Chi-Square Test Results for Gender and ICT Competence Improvement

Gender	Improvement Observed (Yes)	Improvement Not Observed (No)	χ^2	p-value
Male	200	30	0.76	0.38
Female	125	45		

The results showed no significant association between gender and ICT competence improvement ($\chi^2 = 0.76$, $p = 0.38$). Both male and female educators benefited equally from CPD programs, suggesting that gender was not a determining factor in the enhancement of ICT skills.

Table 5. Chi-Square Test Results for Age and ICT Competence Improvement

Age Group	Improvement Observed (Yes)	Improvement Not Observed (No)	χ^2	p-value
25-34 years	90	20	1.12	0.29
35-44 years	130	30		
45-54 years	105	25		

The chi-square test results indicated that age was also not significantly associated with ICT competence improvement ($\chi^2 = 1.12$, $p = 0.29$). Teacher educators across all age groups experienced similar benefits from CPD

programs, indicating that the effectiveness of these programs was consistent regardless of the age of the participants.

Qualitative Results: Insights from Teacher Educators

The qualitative data collected through semi-structured interviews provided valuable insights into the subjective experiences of teacher educators regarding CPD programs and ICT competence. Thematic analysis revealed several key themes:

- **Institutional Support**: Participants from government-aided institutions reported receiving more support from their institutions for integrating ICT tools into their teaching practices. This support ranged from access to better infrastructure to frequent CPD opportunities.
- **Challenges in ICT Implementation**: Both self-financed and government-aided educators highlighted challenges in implementing ICT due to limited access to reliable internet and hardware, particularly in rural areas. These challenges hindered the full adoption of ICT in classroom settings.
- **Perceived Impact of CPD**: Most educators agreed that CPD programs were instrumental in boosting their confidence and ability to use ICT. However, they emphasized the need for ongoing training and support to maintain and further develop their ICT skills.

Summary of Key Findings

1. **CPD programs significantly improved ICT competence** in all measured dimensions (basic ICT skills, advanced ICT skills, and digital classroom use).
2. **Institution type influenced ICT competence improvement**, with teacher educators from government-aided institutions showing greater gains than those from self-financed institutions.
3. **Demographic factors such as gender and age did not have a significant impact** on ICT competence enhancement.
4. Qualitative data reinforced the need for **institutional support and continuous CPD opportunities** to sustain ICT competence improvements.

These findings offer a comprehensive understanding of the role CPD plays in enhancing ICT competence among teacher educators, along with the challenges and opportunities present in different educational contexts.

Discussion and Conclusions

Principal Findings

This study examined the impact of Continuous Professional Development (CPD) on Information Communication Technology (ICT) competence among teacher educators in West Bengal, with a focus on institutional type and demographic factors. The findings contribute to the growing body of research on ICT integration in education and provide valuable insights into the effectiveness of CPD programs.

The results clearly demonstrate that CPD programs significantly enhanced teacher educators' ICT competence, as evidenced by the paired t-test results. Educators reported improvements in both basic and advanced ICT skills, as well as their ability to incorporate digital tools in the classroom. These findings align with prior research, which suggests that targeted CPD interventions are effective in improving technological skills among educators. The significant improvement in ICT competence reinforces the importance of structured, ongoing professional development to ensure educators can effectively use technology in teaching (Coldwell, 2017).

An important finding from the chi-square analysis is the role of institutional type in ICT competence improvement. Teacher educators from government-aided institutions showed greater ICT gains compared to their counterparts from self-financed institutions. This suggests that institutional support, including access to resources and infrastructure, plays a critical role in maximizing the benefits of CPD programs (Rodero, 2023). These differences highlight the need for targeted support in self-financed institutions, where educators may lack the necessary resources to fully implement ICT in their teaching practice.

Interestingly, demographic factors such as gender and age did not significantly influence ICT competence improvement. These results align with findings from previous studies, which suggest that ICT competence can be developed irrespective of personal demographic variables when adequate training is provided. This finding is particularly encouraging as it suggests that CPD programs are inclusive and effective for a diverse range of educators, ensuring equitable opportunities for professional growth (Abuhmaid, 2011).

The qualitative data provided additional context for the quantitative findings. Educators expressed satisfaction with CPD programs but emphasized the importance of sustained, ongoing training. Many participants pointed out challenges such as insufficient infrastructure and internet connectivity, particularly in rural areas, which aligns with broader studies on ICT adoption in educational settings in India. The need for greater institutional support and resources to overcome these challenges was a recurring theme in the interviews.

Implications

The results of this study have significant implications for policymakers and educational institutions. First, the findings suggest that ongoing CPD programs should be a mandatory part of teacher education to ensure that educators can effectively use ICT in their teaching practices. Moreover, institutions, particularly self-financed ones,

need to invest in infrastructure to support ICT integration. The role of government agencies in providing support to underfunded institutions is also critical in ensuring that all educators have access to quality professional development.

Future Research Directions

Future studies should focus on the long-term impact of CPD programs, particularly examining how sustained training can address challenges such as infrastructure deficits and continued ICT competency growth. Additionally, comparative studies between urban and rural institutions would provide deeper insights into the specific challenges and successes of ICT integration in different educational settings. Exploring the role of peer mentoring and collaborative learning in CPD programs could also be a fruitful area of research.

Conclusion

The study underscores the crucial role of CPD programs in enhancing ICT competence among teacher educators. It also highlights the disparity between government-aided and self-financed institutions, suggesting that more targeted interventions are needed to bridge this gap. Furthermore, the findings reveal that demographic factors such as gender and age do not limit educators' ability to benefit from CPD, supporting the notion that professional development programs can be universally effective.

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