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Bridging the Digital Divide: ICT Competency of Chemistry Teachers in Public and Private Secondary Education

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Abstract This research examines the ICT (Information and Communication Technology) competency of Chemistry teachers at the secondary level in both government and private schools in the West Tripura district of Tripura state. The objective is to assess and compare the levels of ICT competency among teachers from both sectors to understand the current status and identify areas for improvement in technology integration in science teaching. A multi-stage sampling technique was used for data collection. One educational district out of eight in Tripura—West Tripura—was selected purposively for the study. In this district, four blocks were randomly selected, and from each block, four schools were picked, including two public and two private institutions. Three Chemistry teachers from each school participated, resulting in a total sample of 48 teachers. Data were collected through a structured questionnaire designed to measure ICT competency across various dimensions, related to word processing, Presentation Competency, Spreadsheets Competency, E-mail, Internet and Networking, Communication, Professional and Digital Tools in classroom teaching. A t-test was conducted to interpret the data using SPSS (Statistical Package for the Social Sciences). The results show a significant difference in ICT competency between government and private school teachers. In government schools, only 8.33% of teachers demonstrated high ICT competency, 29.16% showed moderate competency, and a majority of 62.50% exhibited low competency. In contrast, 79.16% of private school teachers were found to possess high ICT competency, 20.83% demonstrated moderate levels, and none were in the low competency category. These results highlight a critical gap in ICT preparedness between government and private sector teachers, with private school teachers showing a significantly higher level of competency. The findings suggest the need for targeted ICT training programs, especially for government school teachers.

Keywords: *ICT Competency, Digital Chemistry Education*

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1. Introduction

In the 21st century, the incorporation of Information and Communication Technology (ICT) in Chemistry education has become a transformative force, reshaping the teaching-learning process across the globe. ICT has become an important component in modern pedagogy. It offers the quality of education, promotes student engagement, and supports teachers in delivering more interactive and effective lessons. The swift advancement of ICT resources like computers, projectors, online applications, virtual laboratories, and multimedia educational tools has greatly influenced the instruction of science disciplines, especially Chemistry. Chemistry, as a field that frequently includes intricate ideas and theoretical abstractions, greatly benefits from the incorporation of technology. Visual simulations, animations, virtual experiments, and educational software can enhance learning by making it more tangible and enjoyable for students. Consequently, ICT competency among Chemistry teachers is crucial for improving students' comprehension and enthusiasm for the subject.

In India, there has been a growing focus in national education policies and programs on incorporating ICT into education. The National Policy on ICT in School Education (2012) and the newer National Education Policy (NEP) 2020 emphasize the significance of digital literacy and ICT incorporation in secondary-level education. These policies aim to bridge the digital divide and ensure equitable access to quality education across the country.

Nonetheless, the development of ICT in schools continues to be inconsistent across various states. In numerous areas, especially in the North-Eastern part of India, difficulties like insufficient infrastructure, absence

of skilled staff, and restricted access to digital tools impede the efficient implementation of ICT in classrooms.

West Tripura, one of the eight districts in Tripura. The district includes a mix of urban and rural schools, consisting of both government-operated and privately-run institutions. This variety makes West Tripura a perfect location for comparative research on the ICT competency of secondary-level teachers. Understanding the ICT competency of Chemistry teachers in this region provides valuable insights into the strengths and challenges of implementing digital teaching practices in similar educational contexts.

This research specifically examines the ICT competency of Chemistry teachers employed in both government and private secondary schools located in the West Tripura district. Chemistry, being a fundamental science subject, is instructed at the secondary level in various schools and plays a crucial role in equipping students for advanced education and competitive tests. Chemistry teachers should have not only knowledge of the subject but also the technological abilities to teach content effectively using modern tools. In this context, ICT competency encompasses the capability to use digital devices, employ subject-related software and applications, incorporate multimedia into lesson plans, carry out online evaluations, and adjust to changing technological trends in education. Chemistry secondary-level teachers must gradually adopt Artificial Intelligence (AI) in their teaching-learning methods.

The results of this study seek to offer a comparative evaluation of ICT competency levels among Chemistry teachers in public and private secondary schools. Through analysing the distribution of high, moderate, and low ICT competency levels in both sectors, the researcher aims to uncover patterns and derive conclusions regarding the elements impacting ICT adoption in Chemistry education.

2. Objective of the Study

I. To study the ICT Competency of Chemistry Secondary Level Government Teachers.

II. To study the ICT Competency of Chemistry Secondary Level Private Teachers.

III. To study the comparison of the ICT competency of Chemistry Secondary Level School Teachers (Government Vs Private).

3. Hypotheses of the Study

I. **H_{01}:** There is no significant difference in ICT competency of Government and Private chemistry secondary level school teachers.

4. Review of Related Literature

Hamza et al. [1] Investigated a study on “Utilization of ICT Resources in Teaching Chemistry in Senior Secondary Schools in Kwara State, Nigeria”. It explores the application of ICT tools by chemistry teachers and examines how aspects such as gender, qualifications, and experience affect their usage. The research indicates that while certain ICT tools like computers and smartphones are accessible, numerous others, such as multimedia projectors and e-learning software, are deficient, leading to generally low usage. Findings indicate that male teachers are utilizing more ICT tools in Chemistry teaching-learning methods than their female counterparts. Statistical analysis reveals a significant difference in ICT usage related to gender, qualifications, and teaching experience.

Gupta [2] Conducted a study on “ICT Tools for Teaching and Research in Chemistry”. It highlights the vital role of Information and Communication Technology (ICT) in modern chemical education and research. It emphasizes the role of ICT tools like ChemDraw, ChemSketch, Avogadro, and Jmol in creating chemical structures, visualizing molecules in both 2D and 3D, and performing simulations and molecular modelling. The research outlines various software applications that assist in chemistry education and improve comprehension of intricate ideas via digital visualization. Moreover, it highlights how IT-driven tools such as spectrophotometers, NMR (Nuclear Magnetic Resonance), and scanning electron microscopes enhance chemical research. The study concludes that incorporating ICT is vital for creative teaching and advanced research in chemistry.

Boris and Olojo [4] Investigated a study on “The Role of Information and Communication Technologies (ICT) in the Teaching and Learning of Science in the 21st Century”. It examines how ICT improves science education by boosting student involvement, enthusiasm, and comprehension of concepts. It highlights that ICT has the potential to revolutionize conventional teaching techniques by utilizing multimedia tools, internet resources, and interactive technologies, promoting critical thinking and immediate collaboration. The authors highlight major obstacles limiting ICT utilization in Nigeria, such as insufficient infrastructure, lack of training, inadequate funding, and teacher resistance. They emphasize that ICT facilitates personalized learning, instant feedback, and availability of worldwide scientific information, which is particularly crucial for bridging the educational divide between rural and urban areas. The research finds that ICT is essential for education in the 21st century and suggests policies, funding, teacher development, and infrastructure to thoroughly incorporate ICT into science programs.

Dewi et al. [5] Investigated a study on “The Need for ICT-Driven Chemistry Learning Resources in the Disruptive Era”.The research investigates the difficulties and requirements for incorporating Information and Communication Technology (ICT) into chemistry education. The study highlights poor student performance and comprehension in redox topics caused by abstract concepts, insufficient learning resources, and a lack of student enthusiasm. Teachers, although skilled in fundamental ICT concepts, struggle to create innovative media such as e-learning platforms. The school has modern technology, and both students and teachers show an eagerness to utilize digital learning resources. ICT-based media, such as e-learning, can boost student motivation and comprehension, making chemistry education more effective in the era of disruption.

Rusek et al. [3] Conducted a study on "Adoption of ICT Innovations by Secondary School Teachers and Pre-service Teachers within Chemistry Education". It investigates the perspectives and acceptance of Information and Communication Technology (ICT) among chemistry teachers in the Czech Republic. Applying Rogers' theory of diffusion of innovations, 432 in-service and pre-service teachers were classified into categories such as innovators, early adopters, and laggards. The majority of participants exhibited practical and optimistic views on ICT, favouring proven tools and gradual implementation, with merely 3% displaying resistance (laggards). Unexpectedly, pre-service teachers exhibited greater skepticism than in-service teachers, indicating a necessity for enhanced ICT integration in teacher education. Gender differences were minor, although men displayed a bit more confidence and initiative in using ICT.

5. Methodology

5.1. Research Design

The current investigation was conducted through a survey method approach to gather quantitative data on the ICT competency of chemistry secondary-level school teachers. The researcher has physically visited the different secondary schools of the West Tripura district, which is located North-East part of India.

5.2. Tool

The researcher has used the following tool for the entire research work.

ICT Competency Scale developed by Juran Joy Reang and Dr. Ramakanta Mohalik. This tool was developed in the year 2023. In this tool, there are 52 items. These items are based on eight components of ICT, such as word processing, presentation, spreadsheets, e-mail, internet and networking, communication, professional, and digital tools. The Likert-type scale of three options, such as high competency (HC) 3-point, moderate competency (MC) 2-point, and low competency (LC) 1-point used as a scale.

5.3. Population and Sample

The population of this present study contains public secondary-level chemistry school teachers as well as private secondary-level chemistry school teachers of Tripura. A multi-stage sampling technique was employed in the present study. Out of 8 districts, one educational district has been selected for this study. The selected district has 9 blocks, out of which 4 blocks were selected. These blocks are Dukli, Old Agartala, Jirania, and Mohanpur. Then,4 schools were selected from each block. Three teachers from each school were selected. A questionnaire consisting of 52 items was assigned to collect the respondents' information on ICT competency. The distribution of the sample is shown below.

5.4. Data Collection and Techniques of Analysis

The investigator personally visited all secondary schools in the West Tripura district of Tripura state. After getting permission, the investigator explained the purpose of the study and detailed information about the tools to the teachers, and then the investigator provided them with a copy of the tool for filling up. In this way, data were collected from all the secondary school teachers. After the data collection, data were systematically put into the SPSS software for analyzing the data. Both descriptive and inferential statistics such as mean, standard deviation, and t-test, were done using SPSS software accordingly interpretation was made.

6. Data Analysis and Interpretation

Table 1. ICT Competency of Chemistry Secondary Level Government Teachers

SL No	Score Range	Number & Percent of Teachers	Level of ICT Competency
1	118 above	2 (8.33%)	High Competency
2	100 to 118	7 (29.16%)	Moderate Competency
3	Below 100	15 (62.50%)	Low Competency
	Total	24	

Interpretation: Table 1 shows the ICT competency level of Government secondary-level chemistry teachers. It also shows the percentage of high, moderate, and low competency of teachers.

Table 2. ICT Competency of Chemistry Secondary Level Private Teachers

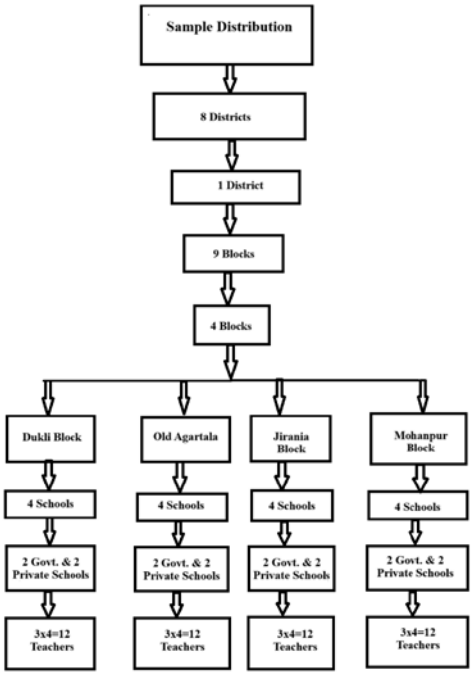
SL No	Score Range	Number & Percent of Teachers	Level of ICT Competency
1	118 above	19 (79.16%)	High Competency
2	100 to 118	5 (20.83%)	Moderate Competency
3	Below 100	0	Low Competency
	Total	24	

Interpretation: Table 2 shows the ICT competency level of Private secondary-level chemistry teachers. It also shows the percentage of high, moderate, and low competency of teachers.

Table 3. Comparison of the ICT Competency of Chemistry Secondary Level School Teachers (Government Vs Private)

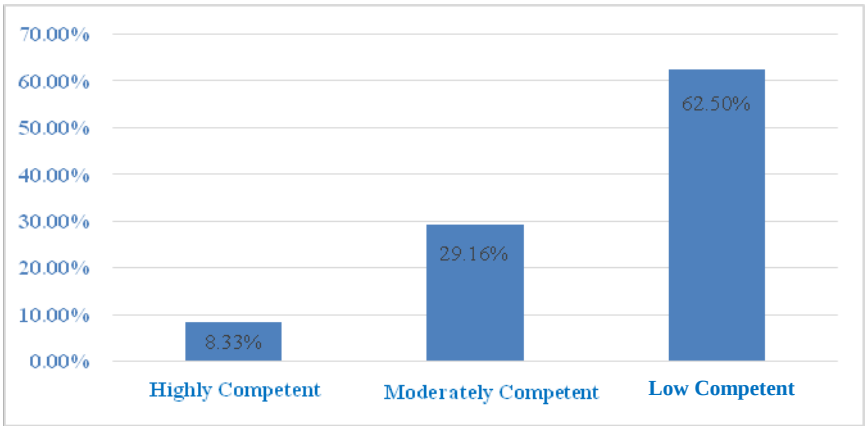
Sl. No	Gender	N	Mean	SD	df	't' Value	Level of Significance
1	Government (Chemistry Teachers)	24	90.04	23.568	46	-7.657	0.000
2	Private (Chemistry Teachers)	24	135.04	16.541			

Interpretation: An independent sample t-test was conducted to compare the ICT competency of Government secondary-level chemistry teachers and Private secondary-level chemistry teachers. Levene's test was checked and found that, "P" value is less than 0.05. So, the alternative hypothesis is accepted. There is a significant difference between Government chemistry teachers and Private chemistry teachers.



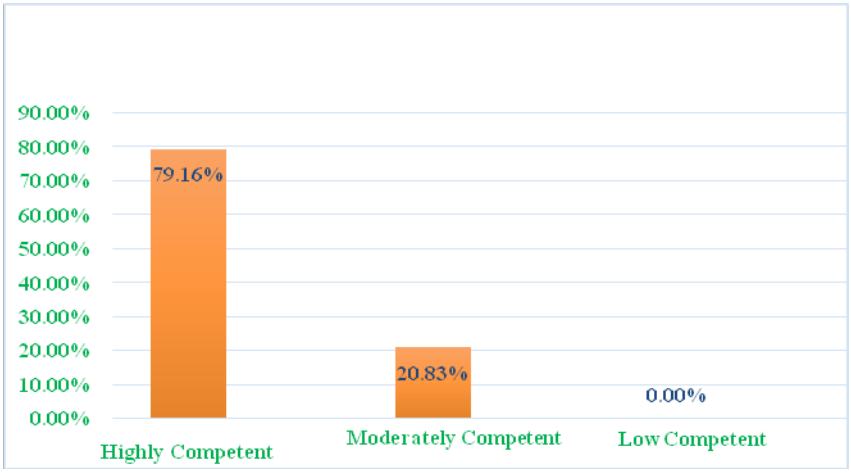
Interpretation: Figure 1 indicates the distribution of sample collection. Data was collected through a multi-stage sampling technique.

Figure 1. Flow Chart of the Sample



Interpretation: Table 1 data is graphically represented by Figure 2.

Figure 2. ICT competency levels of Chemistry Secondary Level School Teachers (Government)



Interpretation: Table 2 data is graphically represented by Figure 3.

Figure 3. ICT competency levels of Chemistry Secondary Level School Teachers (Private)

6. Major Findings

6.1. Government Secondary Level Chemistry Teachers

- Merely 8.33% of secondary chemistry teachers in government schools demonstrated advanced ICT skills.
- 29.16% of secondary chemistry teachers in government schools exhibited moderate ICT skills.
- A significant majority, 62.50% of government secondary-level chemistry teachers, displayed low ICT proficiency.

6.2. Private Secondary Level Chemistry Teachers

- A large majority, 79.16% of private secondary chemistry teachers, demonstrated strong ICT skills.
- 20.83% of private secondary chemistry teachers showed a moderate level of ICT proficiency.
- None of the private secondary chemistry teachers exhibited low ICT competency, indicating no teacher with poor ICT skills.

6.3. Comparative Observation

- Private secondary chemistry teachers exhibited significantly greater ICT competency levels than their government secondary counterparts.
- Limited ICT proficiency was noted solely among government school teachers, while it was entirely lacking in private school teachers.
- The gap between government and private school teachers in terms of high ICT competency is very wide (around 70.83%), showing a serious disparity.

7. Discussion of Results

The study's results show a notable difference in ICT competency between chemistry teachers at the secondary level in government and private schools. Although merely 8.33% of government school teachers showed strong ICT competency, a significant 62.50% were categorized as having low competency, underscoring a significant deficiency in digital readiness. In comparison, teachers at private schools demonstrated a significantly elevated level of ICT proficiency, with 79.16% exhibiting high competency and none falling within the low competency range. This comparison indicates that private organizations might be offering superior access to ICT resources, training options, and assistance for technological incorporation in education. The findings highlight the critical necessity for specialized professional development and capacity-building initiatives for chemistry teachers in government schools to improve their ICT skills and close the digital divide in secondary education.

8. Educational Implications

The results of this research hold significant educational implications, especially for policymakers, school administrators, and teacher training institutions. The significant difference in ICT skills between government and private secondary chemistry teachers highlights an urgent requirement to enhance ICT infrastructure, training, and support in government schools. To enhance teaching standards and foster digital integration in science education, specific in-service training programs, consistent workshops, and practical ICT sessions must be provided for government teachers. Moreover, integrating ICT competency training into pre-service teacher education can prepare future teachers more effectively for modern classrooms.

9. Conclusion

The research findings indicate a notable difference in ICT skills between chemistry teachers in government and private secondary schools. Though most private school teachers have advanced ICT skills, allowing for successful technology integration in the teaching-learning process, a significant number of government school teachers show low ICT competency, reflecting limited preparedness for digital education. This disparity underscores the unequal availability of ICT training, resources, and institutional backing between the two sectors. To guarantee quality and fair science education, such as an extensive ICT training initiative, infrastructure improvement, and continuous professional assistance, especially for teachers in government schools.

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