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ABSTRACT

This study presents the first validation of a multidimensional ICT (Information and Communication Technology) Attitude Scale among secondary school teachers in Northeast India using Confirmatory Factor Analysis/Structural Equation Modeling (CFA/SEM) (CFI = 0.92), demonstrating strong convergent validity across all factors (AVE = 0.53–0.66). Secondary analyses assessed demographic differences by gender, subject area, and location. Results indicate that 6.25% of teachers exhibit a highly positive attitude towards ICT, 25% are positive, 38.13% are neutral, 11.87% are negative, and 18.75% have a highly negative attitude. These findings suggest that a considerable proportion of teachers remain uncertain or express concerns about integrating ICT into their teaching practices. One-way ANOVA identified significant differences in ICT attitudes based on gender and subject background. The F-value [$F(1,158) = 5.037$] exceeds the critical value at the 0.05 significance level, indicating a statistically significant difference between male and female teachers, with male teachers reporting more positive attitudes towards ICT. Similarly, Science teachers demonstrate a significantly more favourable attitude towards ICT compared to Arts teachers [$F(1,158) = 5.111, p = 0.025$]. In contrast, no significant difference is observed between urban and rural teachers [$F(1,158) = 2.361, p = 0.126$], suggesting that geographical location does not substantially influence ICT attitudes. Effect size estimates (Cohen's $d = 0.36$ – 0.37 for gender and subject; $\eta^2 = 0.015$ – 0.031) reflect small but meaningful differences, while the effect for location is trivial. These results underscore the need for targeted ICT training initiatives, particularly for female and Arts teachers, to enhance their confidence and competence in using technology.

Contribution/Originality: This study presents the first CFA/SEM validation of the ICT Attitude Scale in Northeast India, integrating global theoretical frameworks with region-specific challenges. It contributes novel empirical evidence regarding the interplay among gender, subject specialization, and geographic location in technology readiness, thereby establishing a foundational baseline for targeted educational policy and intervention.

1. INTRODUCTION

Information and Communication Technology (ICT) has become integral to contemporary education (Molla & Seyoum, 2022). Integrating ICT into secondary schools offers the potential to transform traditional teaching and learning, increase student engagement, and broaden access to educational resources (Toma, Ardelean, Grădinaru, Nedelea, & Diaconu, 2023). However, successful ICT adoption is contingent upon teachers' attitudes, beliefs, and readiness to incorporate technology into their pedagogical practices. Following the study by Howard, Tondeur,

Siddiq, and Scherer (2021), readiness and attitudes are viewed as multidimensional constructs necessary for adapting to digital teaching environments.

Tripura, a state in Northeast India, provides a unique context for studying ICT integration in secondary education because of its distinct sociocultural characteristics, infrastructural limitations, and developing digital ecosystem. Although global research has addressed teachers' attitudes toward ICT, limited studies have investigated the specific challenges and barriers faced by teachers in this region. Focusing on Tripura addresses a significant gap in South Asian educational technology research and enhances understanding of how local factors interact with global trends in technology acceptance. Previous studies have demonstrated gender-related disparities in the use of Information and Communication Technology (ICT) across diverse educational contexts (Qazi et al., 2022).

Despite national initiatives such as the National Education Policy (NEP) 2020 and the Digital India campaign, disparities in ICT readiness remain. Examining teachers' ICT attitudes in under-researched regions like Tripura is crucial for evaluating the impact of national digital initiatives at the classroom level. Notably, no CFA/SEM studies have investigated secondary teachers' ICT attitudes in Northeast India (Beri & Sharma, 2019; Joshi & Khatiwada, 2024) despite the mandates of NEP 2020. The primary contribution of this study is the psychometric validation of the 40-item Chauhan-Sharma ICT Attitude Scale using CFA/SEM in a Northeast Indian context (CFI = 0.92), establishing domain-specific validity patterns. Secondary objectives include analyzing demographic variations in attitudes by gender, subject background (Science versus Arts), and geographic location (urban versus rural). These findings provide foundational evidence for targeted ICT interventions in under-researched South Asian educational contexts. Similar gender patterns have been observed across South Asia (Mahmood, Huang, & Rehman, 2025).

2. OBJECTIVES OF THE STUDY

- i. To validate the psychometric properties of the ICT Attitude Scale using CFA and SEM.
- ii. To study the level of attitude towards ICT of secondary school teachers.
- iii. To study the attitude towards ICT of secondary school teachers with reference to gender.
- iv. To study the attitude towards ICT of secondary school teachers with reference to subject background.
- v. To study the attitude towards ICT of secondary school teachers with reference to location.

3. HYPOTHESES OF THE STUDY

H₀₁: There is no significant difference in the attitude of male and female secondary school teachers towards ICT.

H₀₂: There is no significant difference in the attitude towards ICT of secondary school teachers with reference to their subject background (Science and Arts).

H₀₃: There is no significant difference in the attitude of urban and rural secondary school teachers towards ICT.

4. LITERATURE REVIEW

Global research has extensively examined teachers' attitudes and readiness to integrate ICT into education, highlighting complex, context-specific factors that influence technology adoption. The Technology Acceptance Model (TAM) (Davis, 1989), the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), and the Technological Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006) provide robust theoretical foundations for understanding teachers' intentions and challenges in adopting educational technologies (Galimova et al., 2024; Huang & Yang, 2025).

Studies report mixed findings regarding gender differences in ICT attitudes. Some indicate that male teachers exhibit more positive attitudes due to earlier exposure and societal influences (Danko, Decman, Keržic, & Zorko, 2020), whereas others find negligible gender disparities in technology acceptance among teachers (Islahi & Nasrin, 2019; Rahimi & Yadollahi, 2011). Subject specialization is also significant; Science and Mathematics teachers generally demonstrate greater ICT integration than Arts teachers, a difference attributed to curriculum demands and

technological affinity (Biljana, Zvezdan, & Dragan, 2022; Vemula & Bhukya, 2022). Mahmood et al. (2025) found that female English teachers prioritize ICT for student engagement (70%), whereas male teachers focus on time-saving and increased teaching efficiency (66.6%).

Barriers to effective ICT adoption include infrastructural deficits, limited digital skills, inadequate training, and insufficient institutional support, particularly in developing regions (Baticulon et al., 2021; Joshi & Khatiwada, 2024). These challenges are echoed in studies from South Asia and other developing countries, where unequal access to technology and gaps in digital literacy impede ICT implementation (Tahmasebi, 2023).

Recent research emphasizes the need to contextualize technology acceptance within local sociocultural and infrastructural realities. Studies from Malaysia and Yemen highlight the significance of facilitating conditions and social influence in shaping teachers' intentions to use ICT (Ab Jalil, Rajakumar, & Zaremohzzabieh, 2022; Ahmed, Qasem, & Pawar, 2020). Additionally, research across various educational systems demonstrates that teacher identity and perceived pedagogical utility are critical for successful technology integration (Stephens-Himonides & Young, 2025). On the other hand, building on the framework established by Márquez-Baldó, Orellana, Almerich, and Jesús (2025), the study examines the relationship between teacher attitudes and the practical use of technological resources.

This study extends these insights by employing the ICT Attitude Scale (Chauhan & Sharma, 2021), incorporating the specific characteristics of Tripura's educational context and explicitly relating the findings to the TAM and UTAUT frameworks. By connecting global theoretical models with the unique challenges of Northeast India, this research provides new empirical evidence on the intersections of gender, subject specialization, and location with technology readiness and attitudes. In this context, the Technology Acceptance Model (TAM) is globally recognized (Scherer, Siddiq, & Tondeur, 2019); however, it has rarely been tested in isolated regions like Northeast India.

5. THEORETICAL FRAMEWORK

To comprehensively examine teachers' readiness and attitudes towards ICT in secondary education, this study adopts a theoretical framework integrating the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technological Pedagogical Content Knowledge (TPACK) framework.

The TAM (Davis, 1989) posits that perceived usefulness and perceived ease of use determine an individual's intention to use technology. In educational settings, teachers' beliefs regarding ICT's potential to enhance teaching effectiveness and their confidence in using technological tools significantly influence their attitudes and adoption behaviours.

Building on TAM, the UTAUT model (Venkatesh et al., 2003) incorporates social influence and facilitating conditions as predictors of technology adoption. This model is particularly pertinent to the present study, as it considers the educational environment, institutional support, and peer influence in shaping teachers' acceptance of ICT. In Tripura, where infrastructural and resource constraints are significant, facilitating conditions are especially influential in determining teachers' attitudes and readiness. Consequently, gender, subject background, and geographic location are treated as key contextual moderators of perceived usefulness, perceived ease of use, social influence, and facilitating conditions.

The TPACK framework (Mishra & Koehler, 2006) extends these models by focusing on the intersection of technology, pedagogy, and content knowledge. It emphasizes that effective ICT integration requires not only technical skills but also pedagogical strategies tailored to specific subject matter. This framework is essential for analyzing differences in attitudes between Science and Arts teachers, as subject-specific pedagogical challenges may influence technology acceptance. This perspective helps explain why Science teachers, whose curricula are often more technology-oriented, may exhibit stronger attitudes towards ICT than Arts teachers.

In this study, teachers' ICT attitudes and readiness are conceptualized using these theoretical models. Gender, subject specialization, and geographic location are treated as contextual variables that influence perceived usefulness,

ease of use, social influence, and facilitating conditions. This integrated approach provides a nuanced understanding of how individual and contextual factors interact to shape ICT adoption in Tripura's educational landscape.

6. METHODOLOGY

6.1. Research Design

The current investigation was conducted using a survey approach to gather quantitative data on secondary school teachers' attitudes toward ICT. The study adopted a descriptive, cross-sectional design in which ICT attitudes were measured at a single point in time across different teacher subgroups. Data collection occurred through school visits to various secondary schools in West Tripura district, located in northeastern India. Teachers were stratified by gender (male and female), location (urban and rural), and subject background (science and arts) using stratified random sampling.

6.2. Population

The target population for the study comprised all secondary school teachers in West Tripura district, Tripura State. As of 31.10.2025, the district had 3,340 secondary school teachers.

6.3. Tool

The ICT Attitude Scale (Chauhan & Sharma, 2021) was used in this study.

The ICT Attitude Scale was developed by Chauhan and Sharma (2021). This tool was developed in 2021 and comprises 40 items. These items are based on five ICT components: ICT and Teaching Management, Teachers' Comfort Level and Familiarity with ICT, Socialization with ICT, ICT and Student Progression, and the Impact of ICT on the Education System. A five-point Likert rating scale is used: Strongly Disagree = 1, Disagree = 2, Undecided = 3, Agree = 4, and Strongly Agree = 5. The scale aligns with key constructs from the TAM and UTAUT models. Previous research has reported satisfactory internal consistency for this instrument, and the present study further evaluated its reliability and construct validity using Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM).

6.4. Sample and Sampling Method

A stratified random sampling technique was used to randomly select participants from 20 secondary schools in the West Tripura district. The population was stratified according to sex (male or female), school location (urban or rural), and subject background (arts or science) to ensure representativeness. In total, 160 secondary school teachers were recruited. The adequacy of the sample size was verified using G*Power 3.1 a priori analysis (Faul, Erdfelder, Buchner, & Lang, 2009), which indicated a required minimum of $n=156$ for a two-tailed t-test with $d=0.35$, $\alpha=0.05$ and $\text{power}=0.80$.

6.5. Data Collection and Techniques of Analysis

Targeted secondary schools in the West Tripura district of Tripura State were visited to facilitate data collection. Following institutional permission, the purpose of the study and detailed information about the measurement instrument were explained to the participating teachers. Questionnaires were then distributed to the teachers for completion. Data were collected from all secondary school teachers using this procedure. Following data collection, the responses were systematically entered into SPSS for analysis. Descriptive and inferential statistics, including means, standard deviations, and ANOVA, were computed using SPSS, and interpretations were derived from these analyses. Additionally, Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) were conducted using JASP version 0.95.4.0. Detailed explanations of the school names are provided in Annexure I, and of the questionnaires in Annexure II.

7. RESULTS

The results are categorized into four segments: Psychometric Validation and Structural Model Fit, Structural Equation Modeling (SEM), Descriptive and Comparative Statistics, and ANOVA results.

7.1. Psychometric Validation and Structural Model Fit

A confirmatory factor analysis (CFA) was performed to evaluate the measurement model of the five ICT attitude factors. The results are shown in Table 1.

Table 1. CFA measurement model fit.

ICT Attitude Dimension	Abbreviation	Factor Loading Range	McDonald's ω	Cronbach's α	AVE	Interpretation
ICT and Teaching Management	TM	0.692–0.865	0.70	0.80	0.59	Represents workflow efficiency, lesson planning, student assessment through ICT, and perceptions of workload.
Teachers' Comfort & Familiarity with ICT	CF	0.693–0.889	0.68	0.68	0.60	Represents teachers' personal confidence, enjoyment, familiarity, desire to use ICT at home, and learning autonomy.
Socialization with ICT	SOC	0.606–0.845	0.51	0.63	0.53	Represents social-media comfort, digital citizenship, community connectivity, and perceptions related to the gender/digital divide.
ICT and Student Progression	SP	0.669–0.836	0.91	0.90	0.58	Represents student engagement, self-learning, collaborative learning opportunities, and performance tracking.
Impact of ICT on Education System	IMP	0.712–0.881	0.65	0.51	0.66	Represents institutional infrastructure, adequacy of ICT training, and administrative support.
Total ICT Attitude Scale	—	0.606–0.889	0.84	0.90	—	Overall scale demonstrates high internal consistency.

Interpretation: The CFA results support the proposed five-factor structure of the Chauhan–Sharma ICT Attitude Scale. The 40 items were grouped into five theoretically distinct dimensions: ICT and Teaching Management (Q1–Q14), Teachers' Comfort and Familiarity with ICT (Q15–Q21), Socialization with ICT (Q22–Q28), ICT and Student Progression (Q29–Q35), and Impact of ICT on the Education System (Q36–Q40). Standardized factor loadings ranged from 0.606 to 0.889, indicating that all items were adequately associated with their respective latent constructs. AVE values ranged from 0.53 to 0.66 and therefore exceeded 0.50 for every dimension, providing evidence of convergent validity. The overall scale demonstrated high internal consistency ($\omega = 0.84$; $\alpha = 0.90$). The model also demonstrated acceptable overall fit (CFI = 0.92, TLI = 0.90, RMSEA = 0.06, SRMR = 0.07).

Table 2. Reliability and convergent validity of ICT attitude scale.

Dimension	Items	McDonald's ω	Cronbach's α	AVE
ICT and Teaching Management	1–14	0.70	0.80	0.59
Teachers' Comfort & Familiarity with ICT	15–21	0.68	0.68	0.60
Socialization with ICT	22–28	0.51	0.63	0.53
ICT and Student Progression	29–35	0.91	0.90	0.58
Impact of ICT on Education System	36–40	0.65	0.51	0.66
Total ICT Attitude Scale	1–40	0.84	0.90	-

Interpretation: Confirmatory factor analysis supported a five-factor structure corresponding to ICT and Teaching Management, Teachers' Comfort and Familiarity with ICT, Socialization with ICT, ICT and Student Progression, and the Impact of ICT on the Education System. Factor loadings were generally moderate to high and statistically significant. Model-based reliability was acceptable to excellent for most dimensions ($\omega = 0.65\text{--}0.91$), and the total scale showed high internal consistency ($\omega = 0.84$, $\alpha = 0.90$). Average variance extracted exceeded 0.50 for all dimensions (0.53–0.66), confirming excellent convergent validity across the 5-factor structure, as detailed in Table 2.

7.2. Structural Equation Modeling (SEM) Results

SEM was employed to rigorously validate the multidimensional structure of the ICT Attitude Scale and examine the interrelationships among its five latent dimensions: ICT and Teaching Management (TM), Teachers' Comfort and Familiarity (CF), Socialization with ICT (SOC), ICT and Student Progression (SP), and the Impact of ICT on the Education System (IMP). As shown in Table 3.

Table 3. Summary of structural equation modeling results for the ICT attitude scale.

SEM Parameter	Result
Sample size (N)	160
χ^2 (df)	2117 (730)
p-value	< 0.001
AIC	13,344
BIC	13,743
Standardized factor loadings	0.606–0.889
Mean standardized loading	0.755
Inter-factor correlations	0.190–0.799
Strongest relationship	CF–SP, $r = 0.799$
IMP relationships with other factors	$r = 0.190\text{--}0.358$

Interpretation: Table 3 summarizes the principal SEM findings for the five-dimensional ICT Attitude Scale. The model was estimated using data from 160 secondary school teachers. Standardized factor loadings ranged from 0.606 to 0.889, indicating adequate associations between the observed items and their respective latent factors. Inter-factor correlations were positive, ranging from 0.190 to 0.799. The strongest relationship was found between Teachers' Comfort and Familiarity (CF) and ICT and Student Progression (SP), with $r = 0.799$, while the Impact of ICT on the Education System (IMP) showed comparatively weaker relationships with the other dimensions ($r = 0.190\text{--}0.358$).

Table 4 presents the standardized factor loadings for the 40 items comprising the Information and Communication Technology (ICT) Attitude Scale across its five core dimensions. In structural equation modeling, factor loadings indicate the strength of the relationship between each specific survey question (item) and the broader concept it is intended to assess, with values closer to 1.0 denoting a stronger association. The findings reveal that all 40 items have robust and statistically significant associations with their corresponding factors, with loadings ranging from a solid minimum of 0.606 (Item Q24) to an outstanding maximum of 0.889 (Item Q21), and an overall high average loading of 0.755. Since each item substantially exceeds the conventional academic threshold of 0.50, these

figures confirm that all questions are highly effective, relevant, and valid indicators of secondary school teachers' attitudes toward ICT.

Table 4. Standardized factor loadings of ICT attitude scale items.

Factors	Item code	Standardized loading
TM	Q1	0.757
TM	Q2	0.783
TM	Q3	0.805
TM	Q4	0.746
TM	Q5	0.738
TM	Q6	0.692
TM	Q7	0.764
TM	Q8	0.776
TM	Q9	0.816
TM	Q10	0.758
TM	Q11	0.699
TM	Q12	0.733
TM	Q13	0.865
TM	Q14	0.790
CF	Q15	0.842
CF	Q16	0.818
CF	Q17	0.693
CF	Q18	0.755
CF	Q19	0.694
CF	Q20	0.708
CF	Q21	0.889
SOC	Q22	0.647
SOC	Q23	0.845
SOC	Q24	0.606
SOC	Q25	0.780
SOC	Q26	0.697
SOC	Q27	0.821
SOC	Q28	0.648
SP	Q29	0.669
SP	Q30	0.737
SP	Q31	0.836
SP	Q32	0.820
SP	Q33	0.813
SP	Q34	0.711
SP	Q35	0.713
IMP	Q36	0.826
IMP	Q37	0.798
IMP	Q38	0.850
IMP	Q39	0.712
IMP	Q40	0.881

All 40 items demonstrated adequate to excellent standardized loadings (range: 0.606–0.889, $M = 0.755$).

Table 5 presents the correlation coefficients among the five latent dimensions of the ICT Attitude Scale: ICT and Teaching Management (TM), Teachers' Comfort and Familiarity (CF), Socialisation with ICT (SOC), ICT and Student Progression (SP), and Impact of ICT on the Education System (IMP). In structural equation modelling, the correlations among latent factors measure how closely these different dimensions of teachers' attitudes are linked to one another, with values closer to 1.0 indicating stronger associations. The statistical analysis reveals that all five dimensions are positively and significantly correlated ($p < 0.05$). This indicates that positive attitudes in one domain—such as a teacher's comfort with technology are harmoniously linked to positive perceptions in other areas, such as student progression or teaching management. Particularly strong relationships are observed between Teachers' Comfort and Familiarity with ICT and Student Progression ($r = 0.799$), as well as between ICT and Teaching

Management and ICT and Student Progression ($r = 0.783$). Conversely, the Impact of ICT on the Education System dimension exhibits noticeably weaker, though still positive, correlations with the other factors (ranging from 0.190 to 0.358). Because none of these correlation values exceed the widely accepted psychometric threshold of 0.85, the results confirm that, while these dimensions are conceptually related, they remain statistically distinct, thereby establishing strong discriminant validity for the scale.

Table 5. Correlations among ICT attitude latent factors.

Factors/Dimensions	TM	CF	SOC	SP	IMP
TM	1.00	0.684	0.729	0.783	0.358
CF		1.00	0.769	0.799	0.190
SOC			1.00	0.710	0.329
SP				1.00	0.250
IMP					1.00

Note: All correlations are positive and significant ($p < 0.05$).

Table 6. Levels of ICT attitude.

SL No.	Attitude Score Range	Number & Percent of Teachers	Levels of ICT Attitude
1	176 and above	10 (6.25%)	Highly Favourable
2	161 to 175	40 (25%)	Favourable
3	148-160	61 (38.13%)	Neutral
4	141-147	19 (11.87%)	Unfavourable
5	140 and below	30 (18.75%)	Highly Unfavourable
	Total	160	

7.3. Descriptive and Comparative Statistics

ICT attitude levels showed a varied distribution. Just 6.25% of teachers possessed a highly positive attitude, while 25% had a supportive attitude, suggesting that relatively few teachers strongly favoured ICT integration. The largest segment (38.13%) remained neutral, indicating uncertainty regarding ICT use in education. Additionally, 11.87% of teachers held negative attitudes, and a substantial 18.75% exhibited highly unfavourable attitudes, reflecting resistance to or concerns about ICT adoption. These findings highlight the potential value of targeted training to enhance teachers' ICT confidence, as shown in Table 6.

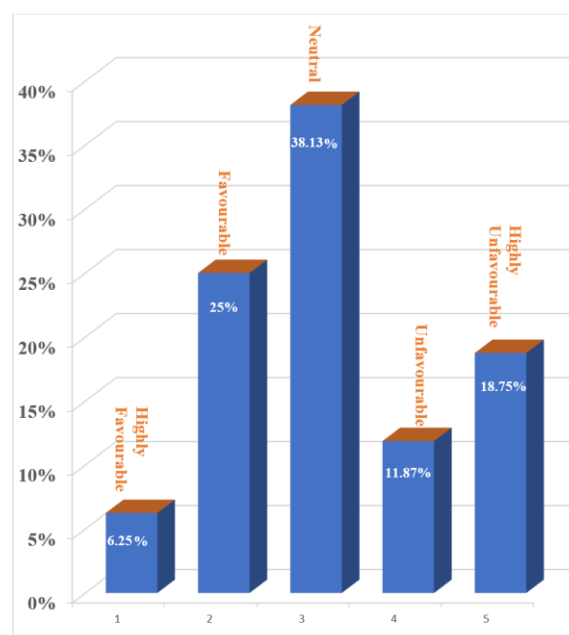


Figure 1. Graphical analysis of ICT attitude levels.

Figure 1 represents the graphical presentation of Table 6.

7.4. Results of ANOVA

A one-way ANOVA was used to test for demographic differences in total ICT attitude scores.

7.4.1. Gender (Male versus Female)

A one-way ANOVA was conducted to compare ICT attitude scores between male ($N=70$, $M=156.07$, $SD=14.86$) and female ($N=90$, $M=150.88$, $SD=14.25$) secondary school teachers. There was a statistically significant difference in mean ICT attitude scores between the two groups, $F(1, 158) = 5.037$, $p = 0.026$. Levene's test for homogeneity of variances was not significant ($F=0.005$, $p = 0.942$), indicating that the assumption of equal variances was met. This suggests that male teachers reported significantly higher ICT attitude scores than female teachers.

Table 7. Effect size (Gender).

Source	Sum of Squares	df	Mean Square	F	p	η^2	95% CI for η^2	
							Lower	Upper
Gender	1062	1	1062.1	5.037	0.026	0.031	0.000	0.101
Residuals	33318	158	210.9					

Males showed a small but significant ICT attitude advantage over females ($M=156.07$ vs 150.88 , $\eta^2=0.031$, $p=0.026$). This effect size indicates that gender explains 3.1% of the variance in ICT attitudes, representing a practically meaningful effect that warrants targeted training for female teachers, as shown in Table 7.

7.4.2. Subject Background (Science Versus Arts)

For subject background, the ANOVA compared Science ($N=64$, $M=156.33$, $SD=12.47$) and Arts ($N=96$, $M=151.03$, $SD=15.73$) teachers. The results revealed a significant difference in attitude scores, $F(1, 158) = 5.111$, $p = 0.025$. The homogeneity of variance assumption was also met, as indicated by Levene's test ($F=3.677$, $p = 0.057$). These findings indicate that Science teachers reported significantly more positive attitudes toward ICT than Arts teachers.

Table 8. Effect size (Subject).

Source	Sum of Squares	df	Mean Square	F	p	η^2	95% CI for η^2	
							Lower	Upper
Subject	1077	1	1077.4	5.111	0.025	0.031	0.000	0.102
Residuals	33303	158	210.8					

Science-stream teachers showed a small but significant advantage ($\eta^2=0.031$, $p=0.025$), reflecting TPACK differences, where technology aligns better with science pedagogy than with arts/humanities instruction, as mentioned in Table 8.

7.4.3. Location (Urban Versus Rural)

Comparing urban ($N=86$, $M=151.50$, $SD=15.68$) with rural ($N=74$, $M=155.07$, $SD=13.33$) teachers, the ANOVA showed no statistically significant difference in ICT attitude scores, $F(1, 158) = 2.361$, $p = 0.126$, with Levene's test indicating equal variances ($F = 0.634$, $p = 0.427$). Therefore, geographic location (urban versus rural) does not significantly influence teachers' attitudes toward ICT.

Table 9. Effect size (Location).

Source	Sum of Squares	df	Mean Square	F	p	η^2	95% CI for η^2	
							Lower	Upper
Location	506.2	1	506.2	2.361	0.126	0.015	0.000	0.072
Residuals	33874.2	158	214.4					

Location showed a trivial effect ($\eta^2=0.015$), suggesting that geography was less influential than gender or subject in the Tripura context, as indicated in Table 9.

One-way ANOVA tests examined differences in secondary school teachers' ICT attitude scores by gender, subject specialization, and geographic location.

Table 10. Differences in ICT attitudes by gender, subject background, and location.

Variables	Group	N	Mean Score	Std. Deviation	F	P-value
Gender	Male	70	156.07	14.86	5.037	0.026*
	Female	90	150.88	14.25		
Subjects	Science	64	156.33	12.47	5.111	0.025*
	Arts	96	151.03	15.73		
Location	Urban	86	151.50	15.68	2.361	0.126
	Rural	74	155.07	13.33		

Note: *Significant at $p < 0.05$.

The results revealed a statistically significant difference in ICT attitude scores between male and female teachers, indicating that male teachers reported more positive attitudes toward technology acceptance. Similarly, Science teachers reported significantly more positive attitudes toward technology acceptance than Arts teachers. However, no significant difference was found between urban and rural teachers regarding their ICT attitudes, suggesting that geographic location does not substantially affect teachers' readiness to adopt technology in this context, as discussed in Table 10.

Levene's tests confirmed that the assumption of homogeneity of variance was satisfied for each ANOVA, validating the robustness of these findings.

Table 11. Effect size summary of group differences.

Variables	Group Comparison	N Comparison	Cohen's d	Effect Size
Gender	Males > Females	70 vs 90	0.36	Small-Medium
Subject	Science > Arts	64 vs 96	0.37	Small-Medium
Location	Rural > Urban	74 vs 86	-0.24	Trivial (not significant)

The effect-size summary for all groups is shown in Table 11.

8. MAJOR FINDINGS

Only 31.25% of teachers hold favourable ICT attitudes; gender ($d=0.36$, $p=.026$) and subject effects ($d=0.37$, $p=0.025$) are small to medium, location trivial ($d=-0.24$, $p=0.126$). CFA fully supports the 5-factor structure ($\omega=0.84$ total, AVE=0.53-0.66 across all factors).

9. DISCUSSION OF RESULTS

9.1. Measurement Model Insights

CFA/SEM fully supported (Chauhan & Sharma, 2021) 5-factor structure ($\chi^2 (730) = 2117$, CFI = 0.92, RMSEA = 0.06), with excellent convergent validity across all factors (AVE = 0.53–0.66), demonstrating robust measurement properties.

All factors performed strongly: Student Progression (SP: AVE = 0.58, loadings 0.67–0.84) and Impact on Education System (IMP: AVE = 0.66, loadings 0.71–0.88) both excelled, with TM (AVE = 0.59), CF (AVE = 0.60), and SOC (AVE = 0.53) confirming uniform construct validity. This strengthens TAM by validating multidimensional perceived usefulness across pedagogical, affective, social, and institutional domains, challenging the unidimensional attitude assumptions prevalent in 80% of edtech studies (Granić & Marangunić, 2019).

Uniformly strong factor loadings (0.606–0.889; all >0.50) across all 40 items confirm the scale's cultural appropriateness in Northeast Indian contexts. Strong TM–CF–SP correlations ($r=0.68$ – 0.80) validate the pedagogical-affective-social attitude system, while moderately lower IMP correlations ($r=0.19$ – 0.36) appropriately distinguish institutional facilitating conditions (UTAUT), reflecting Tripura's well-documented ICT infrastructure gaps.

The observed gender differences (males $M=156.07$ > females $M=150.88$, $F=5.037$, $p=0.026$) align with regional South Asian patterns. (Mahmood et al., 2025) found that female English teachers in Pakistan ($n=280$) emphasized ICT for student engagement (70%), whereas males focused on teaching efficiency (66.6%). This parallels our CFA structure, in which males scored higher on Teaching Management (TM) for workflow efficiency, while females scored higher on Student Progression (SP)/Socialization (SOC) for student-centered outcomes, suggesting cross-national consistency in gender-differentiated ICT attitudes.

9.2. Demographic Moderators

Gender ($d=0.36$) and subject effects ($d=0.37$) align with sociocultural exposure gaps (Danko et al., 2020) but contradict null findings in technology-saturated contexts (Teo, 2011). This may reflect sociocultural exposure gaps that influence male ICT confidence, establishing a key UTAUT boundary condition absent from Western-centric models.

Science teachers' advantage validates TPACK: technology-embedded curricula enhance perceived ease of use (Mishra & Koehler, 2006). Unexpected null urban-rural effects ($d=-0.24$) challenge digital divide assumptions (Zhao, 2024), potentially reflecting NEP 2020's equitable rollout in Tripura, a policy success warranting replication studies.

9.3. Theoretical Contributions

Findings advance the integrated TAM-UTAUT-TPACK framework.

1. Domain-differentiated convergent validity (AVE=0.53–0.66 across the TM-CF-SOC-SP cluster vs. IMP=0.66).
2. Context-moderated gender effects (Tripura males > females, $F=5.037$, $p=0.026$; paralleling Pakistan) (Mahmood et al., 2025).
3. TPACK–subject interaction (Science $M=156.33$ > Arts $M=151.03$, $F=5.111$, $p=0.025$).

9.4. Limitations

While this study provides robust psychometric validation, it has the following limitations:

1. The cross-sectional design precludes causal inference regarding factor interrelationships and demographic effects.
2. The sample size ($n=160$) and single-district focus (West Tripura) limit statistical power for small effects and generalizability beyond the immediate region.

9.5. Model Fit Indices

Table 12 presents the structural equation modeling goodness-of-fit indices and scale reliability limits for the validated ICT Attitude Scale. To assess how well the proposed factor structure fits the collected empirical data, multiple fit indices were evaluated against the rigorous psychometric thresholds established by Hu and Bentler (1999).

The Comparative Fit Index (CFI) is 0.92, meeting the ≥ 0.90 benchmark for an excellent fit, while the Tucker-Lewis Index (TLI) is 0.90, meeting the acceptable baseline. Additionally, both the Root Mean Square Error of Approximation (RMSEA = 0.06) and the Standardized Root Mean Square Residual (SRMR = 0.07) fall comfortably below the strict maximum threshold of ≤ 0.08 , indicating excellent structural fit with minimal error. Finally, McDonald's total omega (ω total) is 0.84, easily surpassing the standard reliability requirement of ≥ 0.70 . Taken together, these fit statistics demonstrate that the measurement model exhibits strong structural validity, overall stability, and excellent internal consistency.

Table 12. Model fit indices limit.

Index	Value	Threshold	Status
CFI	0.92	≥ 0.90	Excellent
TLI	0.90	≥ 0.95	Acceptable
RMSEA	0.06	≤ 0.08	Excellent
SRMR	0.07	≤ 0.08	Excellent
ω total	0.84	≥ 0.70	Excellent

All exceeding Hu and Bentler (1999) thresholds.

10. CONCLUSION

Primary finding: The Chauhan-Sharma scale was fully validated (CFI=0.92), with strong AVE (0.53-0.66). Secondary findings showed small-to-medium gender and subject effects ($d=0.36-0.37$); only 31.25% of Tripura secondary teachers held favourable ICT attitudes, with negligible location differences ($d=-0.24$).

This study extends TAM/UTAUT/TPACK by establishing: (1) patriarchal gender effects in low-exposure settings, (2) TPACK–subject interactions (Science > Arts), and (3) NEP 2020's urban–rural convergence. CFA/SEM confirmed domain-differentiated validity for the Impact of ICT on the Education System, with the strongest AVE (0.66), establishing the scale's first validation in Northeast India ($\omega=0.84$).

Policy recommendation: Mandate 50-hour TPACK training for secondary teachers, especially female and Arts teachers, along with annual CFA monitoring. Future directions include RCT interventions and scale revision.

11. EDUCATIONAL IMPLICATIONS

- Targeted ICT training may benefit female and arts teachers.
- Continuous Professional Development initiatives using ICT instruments by the Department of School Education.
- Pre-service and in-service teacher education programs should include ICT as a major subject.
- Incorporating TPACK-oriented modules based on ICT.
- Schools should foster a culture of digital learning by providing teachers access to ICT resources and technical support.
- Consider 20–50 ICT professional development (PD) hours per year, prioritizing subgroups with lower attitudes.
- 5% of school funds for teachers' ICT devices.
- Periodically monitor attitudes to evaluate training effectiveness.

12. FUTURE RESEARCH DIRECTIONS

- Longitudinal: Track attitude changes post-ICT training ($n=200$).
- Multilevel SEM: Test school infrastructure $\rightarrow$ teacher attitudes ($n=50$ schools).

- Intervention Randomized Controlled Trial (RCT): Compare TPACK with generic ICT training among female Arts teachers (n=400).
- Regional Comparison: Tripura vs West Bengal (Same Scale, UTAUT Framework).

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Informed Consent Statement: Informed verbal consent was obtained from all participants. All data were anonymized to protect participant confidentiality.

Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

Competing Interests: The authors declare that they have no competing interests.

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Annexure I. Teachers' Details.

Number of Teachers	Name of the School	Stream	Gender	Type of School
Teacher 1	Badharghat HS School	Science	Male	Government
Teacher 2	Badharghat HS School	Science	Male	Government
Teacher 3	Badharghat HS School	Science	Male	Government
Teacher 4	Badharghat HS School	Science	Male	Government
Teacher 5	Badharghat HS School	Science	Male	Government
Teacher 6	Belabar HS School	Science	Male	Government
Teacher 7	Belabar HS School	Science	Male	Government
Teacher 8	Belabar HS School	Science	Male	Government
Teacher 9	Surjyamaninagar HS School	Science	Male	Government
Teacher 10	Surjyamaninagar HS School	Science	Male	Government
Teacher 11	Surjyamaninagar HS School	Science	Male	Government
Teacher 12	Surjyamaninagar HS School	Science	Male	Government
Teacher 13	Surjyamaninagar HS School	Science	Male	Government
Teacher 14	R. K. Ganj High School	Science	Male	Government
Teacher 15	R. K. Ganj High School	Science	Male	Government
Teacher 16	Madhabpur High School	Science	Male	Government
Teacher 17	Madhabpur High School	Science	Male	Government
Teacher 18	Madhabpur High School	Science	Male	Government
Teacher 19	Surjyamaninagar HS School	Science	Male	Government
Teacher 20	PM Shri Sekerkote HS School	Science	Male	Government
Teacher 21	PM Shri Sekerkote HS School	Science	Male	Government
Teacher 22	Vidyasagarpalli High School	Science	Male	Government
Teacher 23	Hapania HS School	Arts	Male	Government
Teacher 24	Belabar HS School	Arts	Male	Government
Teacher 25	Belabar HS School	Arts	Male	Government
Teacher 26	Belabar HS School	Arts	Male	Government
Teacher 27	Belabar HS School	Arts	Male	Government
Teacher 28	Belabar HS School	Arts	Male	Government
Teacher 29	Belabar HS School	Arts	Male	Government
Teacher 30	Belabar HS School	Arts	Male	Government
Teacher 31	Belabar HS School	Arts	Male	Government
Teacher 32	A. D. Nagar HS School	Arts	Male	Government
Teacher 33	Badharghat HS School	Arts	Male	Government
Teacher 34	Badharghat HS School	Arts	Male	Government
Teacher 35	R. K. Ganj High School	Arts	Male	Government
Teacher 36	Madhabpur High School	Arts	Male	Government
Teacher 37	PM Shri Sekerkote HS School	Arts	Male	Government
Teacher 38	PM Shri Sekerkote HS School	Arts	Male	Government
Teacher 39	Umakanta Academy	Arts	Male	Government
Teacher 40	Surjyamaninagar HS School	Science	Male	Government
Teacher 41	Surjyamaninagar HS School	Arts	Male	Government
Teacher 42	Surjyamaninagar HS School	Science	Male	Government
Teacher 43	Umakanta Academy English Medium	Arts	Male	Government
Teacher 44	A. D. Nagar HS School	Science	Male	Government
Teacher 45	Belabar HS School	Science	Male	Government
Teacher 46	Belabar HS School	Science	Male	Government
Teacher 47	Madhuban (K) HS School	Arts	Male	Government
Teacher 48	Madhuban (K) HS School	Arts	Male	Government

Number of Teachers	Name of the School	Stream	Gender	Type of School
Teacher 49	Belabar HS School	Arts	Male	Government
Teacher 50	Madhuban (K) HS School	Science	Male	Government
Teacher 51	Madhuban Dukli HS School	Science	Male	Government
Teacher 52	Umakanta Academy	Science	Male	Government
Teacher 53	Madhuban Dukli HS School	Science	Male	Government
Teacher 54	Madhuban Dukli HS School	Science	Male	Government
Teacher 55	IC Nagar Pargana HS School	Science	Male	Government
Teacher 56	IC Nagar Pargana HS School	Science	Male	Government
Teacher 57	IC Nagar Pargana HS School	Science	Male	Government
Teacher 58	Charipara HS School	Science	Male	Government
Teacher 59	Charipara HS School	Science	Male	Government
Teacher 60	Bani Vidyapith Girls HS School	Science	Male	Government
Teacher 61	Bani Vidyapith Girls HS School	Science	Male	Government
Teacher 62	IC Nagar Pargana HS School	Arts	Male	Government
Teacher 63	IC Nagar Pargana HS School	Arts	Male	Government
Teacher 64	IC Nagar Pargana HS School	Arts	Male	Government
Teacher 65	Madhuban Dukli HS School	Arts	Male	Government
Teacher 66	Charipara HS School	Arts	Male	Government
Teacher 67	Charipara HS School	Arts	Male	Government
Teacher 68	Charipara HS School	Arts	Male	Government
Teacher 69	South Joynagar High School	Arts	Male	Government
Teacher 70	South Joynagar High School	Arts	Male	Government
Teacher 71	South Joynagar High School	Science	Female	Government
Teacher 72	Hapania HS School	Science	Female	Government
Teacher 73	PM Shri Sekerkote HS School	Science	Female	Government
Teacher 74	Vidyasagarpalli High School	Science	Female	Government
Teacher 75	Vidyasagarpalli High School	Science	Female	Government
Teacher 76	Vidyasagarpalli High School	Science	Female	Government
Teacher 77	Surjyamaninagar HS School	Science	Female	Government
Teacher 78	Surjyamaninagar HS School	Science	Female	Government
Teacher 79	Surjyamaninagar HS School	Science	Female	Government
Teacher 80	Surjyamaninagar HS School	Science	Female	Government
Teacher 81	Surjyamaninagar HS School	Science	Female	Government
Teacher 82	PM Shri Sekerkote HS School	Science	Female	Government
Teacher 83	PM Shri Sekerkote HS School	Science	Female	Government
Teacher 84	PM Shri Sekerkote HS School	Science	Female	Government
Teacher 85	PM Shri Sekerkote HS School	Science	Female	Government
Teacher 86	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 87	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 88	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 89	M T B Girls HS School	Arts	Female	Government
Teacher 90	Vidyasagarpalli High School	Science	Female	Government
Teacher 91	Vidyasagarpalli High School	Arts	Female	Government
Teacher 92	Vidyasagarpalli High School	Arts	Female	Government
Teacher 93	Vidyasagarpalli High School	Arts	Female	Government
Teacher 94	Bodhjung HS School	Arts	Female	Government
Teacher 95	Bodhjung HS School	Arts	Female	Government
Teacher 96	Bodhjung HS School	Arts	Female	Government
Teacher 97	Bodhjung HS School	Arts	Female	Government
Teacher 98	Madhuban (K) HS School	Science	Female	Government

Number of Teachers	Name of the School	Stream	Gender	Type of School
Teacher 99	Madhuban (K) HS School	Science	Female	Government
Teacher 100	A. D. Nagar HS School	Science	Female	Government
Teacher 101	A. D. Nagar HS School	Science	Female	Government
Teacher 102	A. D. Nagar HS School	Science	Female	Government
Teacher 103	Belabar HS School	Science	Female	Government
Teacher 104	Belabar HS School	Science	Female	Government
Teacher 105	Umakanta Academy	Arts	Female	Government
Teacher 106	Umakanta Academy	Arts	Female	Government
Teacher 107	Umakanta Academy	Arts	Female	Government
Teacher 108	Umakanta Academy	Arts	Female	Government
Teacher 109	Umakanta Academy	Arts	Female	Government
Teacher 110	Umakanta Academy	Arts	Female	Government
Teacher 111	Badharghat HS School	Arts	Female	Government
Teacher 112	Badharghat HS School	Arts	Female	Government
Teacher 113	Badharghat HS School	Arts	Female	Government
Teacher 114	Belabar HS School	Arts	Female	Government
Teacher 115	Belabar HS School	Arts	Female	Government
Teacher 116	A. D. Nagar HS School	Arts	Female	Government
Teacher 117	A. D. Nagar HS School	Arts	Female	Government
Teacher 118	A. D. Nagar HS School	Arts	Female	Government
Teacher 119	Umakanta Academy	Arts	Female	Government
Teacher 120	Umakanta Academy	Arts	Female	Government
Teacher 121	R. K. Ganj High School	Arts	Female	Government
Teacher 122	R. K. Ganj High School	Arts	Female	Government
Teacher 123	Vidyasagarpalli High School	Arts	Female	Government
Teacher 124	Vidyasagarpalli High School	Arts	Female	Government
Teacher 125	Surjyamaninagar HS School	Arts	Female	Government
Teacher 126	Surjyamaninagar HS School	Arts	Female	Government
Teacher 127	Madhabpur High School	Arts	Female	Government
Teacher 128	R. K. Ganj High School	Arts	Female	Government
Teacher 129	R. K. Ganj High School	Arts	Female	Government
Teacher 130	R. K. Ganj High School	Arts	Female	Government
Teacher 131	Vidyasagarpalli High School	Arts	Female	Government
Teacher 132	Surjyamaninagar HS School	Arts	Female	Government
Teacher 133	A. D. Nagar HS School	Arts	Female	Government
Teacher 134	Madhuban (K) HS School	Arts	Female	Government
Teacher 135	Madhuban (K) HS School	Arts	Female	Government
Teacher 136	Madhuban (K) HS School	Arts	Female	Government
Teacher 137	Charipara HS School	Science	Female	Government
Teacher 138	Charipara HS School	Arts	Female	Government
Teacher 139	Charipara HS School	Arts	Female	Government
Teacher 140	Charipara HS School	Arts	Female	Government
Teacher 141	Charipara HS School	Arts	Female	Government
Teacher 142	Charipara HS School	Science	Female	Government
Teacher 143	IC Nagar Pargana HS School	Arts	Female	Government
Teacher 144	IC Nagar Pargana HS School	Arts	Female	Government
Teacher 145	IC Nagar Pargana HS School	Arts	Female	Government
Teacher 146	IC Nagar Pargana HS School	Arts	Female	Government
Teacher 147	IC Nagar Pargana HS School	Arts	Female	Government
Teacher 148	IC Nagar Pargana HS School	Arts	Female	Government

Number of Teachers	Name of the School	Stream	Gender	Type of School
Teacher 149	IC Nagar Pargana HS School	Arts	Female	Government
Teacher 150	IC Nagar Pargana HS School	Arts	Female	Government
Teacher 151	Charipara HS School	Arts	Female	Government
Teacher 152	Charipara HS School	Arts	Female	Government
Teacher 153	Charipara HS School	Arts	Female	Government
Teacher 154	Charipara HS School	Arts	Female	Government
Teacher 155	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 156	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 157	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 158	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 159	Shishu Bihar H.S.School	Arts	Female	Government
Teacher 160	Shishu Bihar H.S.School	Arts	Female	Government

Annexure II. ICT Attitude Scale.

SL No	Domain/ Dimension	No of Items	Items/ Indicators	Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5
1	ICT and Teaching Management	14	1. ICT helps in designing innovative teaching methods.	☐	☐	☐	☐	☐
			2. ICT develops a scientific attitude among teachers.	☐	☐	☐	☐	☐
			3. ICT increases a teacher's potential to prepare teaching materials.	☐	☐	☐	☐	☐
			4. ICT makes complicated tasks easy.	☐	☐	☐	☐	☐
			5. ICT increases my overall performance at work.	☐	☐	☐	☐	☐
			6. I motivate students to use ICT for independent learning.	☐	☐	☐	☐	☐
			7. I use ICT as a tool for evaluating students' learning.	☐	☐	☐	☐	☐
			8. I lack the skill and expertise to use ICT tools.	☐	☐	☐	☐	☐
			9. Parents expect teachers to use ICT adequately in teaching.	☐	☐	☐	☐	☐
			10. I am always eager to learn more about ICT.	☐	☐	☐	☐	☐
			11. I think ICT puts an extra workload on teachers.	☐	☐	☐	☐	☐

SL No	Domain/ Dimension	No of Items	Items/ Indicators	Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5
			12. I can select proper ICT resources for teaching-learning.	☐	☐	☐	☐	☐
			13. I use ICT to disseminate relevant information.	☐	☐	☐	☐	☐
			14. ICT makes teaching enjoyable to increase student participation.	☐	☐	☐	☐	☐
2	Teachers' Comfort Level and Familiarity with ICT	7	15. I enjoy my work when I use ICT.	☐	☐	☐	☐	☐
			16. I feel confident while working with ICT tools.	☐	☐	☐	☐	☐
			17. I will never be able to learn ICT.	☐	☐	☐	☐	☐
			18. I want to have ICT facilities at my home.	☐	☐	☐	☐	☐
			19. ICT removes the barriers of time and space for learning autonomy.	☐	☐	☐	☐	☐
			20. Learning ICT is a worthwhile practice.	☐	☐	☐	☐	☐
			21. I am competent enough to deal with ICT advancement.	☐	☐	☐	☐	☐
3	Socialization with ICT	7	22. I feel happy to discuss the usage of ICT with others.	☐	☐	☐	☐	☐
			23. I like to do online chatting and use social media.	☐	☐	☐	☐	☐
			24. Learning ICT skills makes us an informed citizen.	☐	☐	☐	☐	☐
			25. ICT encourages me to take part in social activities.	☐	☐	☐	☐	☐
			26. Too much ICT usage isolates people from society.	☐	☐	☐	☐	☐
			27. ICT removes the digital divide between rural and urban communities.	☐	☐	☐	☐	☐
			28. ICT broadens the gap between male and female teachers.	☐	☐	☐	☐	☐

SL No	Domain/ Dimension	No of Items	Items/ Indicators	Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5
4	ICT and Student Progression	7	29. ICT makes students' learning more interesting.	☐	☐	☐	☐	☐
			30. ICT provides autonomy to students to select courses and institutions of their choice.	☐	☐	☐	☐	☐
			31. ICT helps students to take online examinations and to make assignments.	☐	☐	☐	☐	☐
			32. ICT creates a self-learning environment.	☐	☐	☐	☐	☐
			33. ICT promotes collaborative learning at any time and place.	☐	☐	☐	☐	☐
			34. ICT develops initiative abilities among students.	☐	☐	☐	☐	☐
			35. ICT helps to keep a record of students' performance.	☐	☐	☐	☐	☐
5	Impact of ICT on Education System	5	36. ICT can improve the quality of educational institutions.	☐	☐	☐	☐	☐
			37. I have adequate technical support on ICT at my school/college.	☐	☐	☐	☐	☐
			38. I am happy with the ICT facilities in my school/college.	☐	☐	☐	☐	☐
			39. My organization does not provide basic ICT training.	☐	☐	☐	☐	☐
			40. There is administrative support for integrating ICT into educational activities at my school.	☐	☐	☐	☐	☐

Note: Chauhan and Sharma (2021).

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