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ICT - An Innovatory Intervention in Secondary School Education - A Focus Study on Quasi-Government Schools

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Abstract

ICT, an acronym, denotes the integration of 'Information Processing, Computing and Communication Technologies' in a continuum and a range of different, albeit, rapidly converging technologies that fall into the union of Information Technologies (IT) and Telecommunications. An umbrella term 'ICT', refers to the processing and maintenance of information and the use of all forms of computer, communication, network and mobile technologies for transmission, processing, storing, creating, displaying, sharing or exchanging information by electronic means. ICT Teaching-Learning means and modes inter alia include radio, television, video, DVD, telephone (both fixed-line and mobile phones), satellite systems, computer and network, hardware and software, as well as the equipment and services associated with these technologies, viz., video conferencing, e-mail, and blogs.

In the era of digital transformation, Information and Communication Technology (ICTs) plays an incredible role and catalyses achieving Sustainable Development Goals (SDGs). To realise SDG-4, a transformative and innovative approach, a committed and concerted effort would be required across all levels of Secondary Education from curricula, pedagogy, ICT technologies, and collaborations to governance and funding. In this context, an earnest attempt has been made to evaluate the impact of the integration of ICT in Teaching-Learning Pedagogy in Quasi-Government, Secondary Schools (Classes from VIII, IX and X) of the West Godavari District, Andhra Pradesh. The study also examines the level of integration of ICT in Mathematics, Physics, Natural Sciences and Social studies. Further, it suggests the ways and means for the efficient and effective integration of ICT in Secondary School Education.

The results indicate a significant difference in the adoption of ICT across various classes of instruction between Rurban and Tribal regions selected for the study. The confidence level in the adoption and implementation of ICT varies significantly across different Degrees of Freedom (DF) in integrating Telugu, English, Hindi, Mathematics, Physics, Natural Sciences and Social Sciences. ICT touches every sphere and space of human life profoundly influencing how we live, work and interact. ICT recognises the importance of subject and domain knowledge, didactic improvisations and an openness of mind in the moments of Teaching-Learning. ICT is undoubtedly an innovative intervention and a collaborative concierge in Secondary education that chisels educators, teachers, and students within and out of the persona of educators, teachers, and students. ICT has revolutionised teaching-learning in the 21st century by introducing innovative pedagogical approaches that enhance engagement and accessibility.

Keywords: **ADB, DBR, HEI, ICT, IMT, SDG, SSE, TPACK, UNESCO.**

JEL Classification Code: I21, I28, O33, Q01, C83

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1. Introduction and Theoretical Background

1.1 ICT in Secondary Education - A Global Perspective

The ICT functionalities and desired support are provided to European teachers through the European e-learning portal in Europe that integrates the classrooms with ICT tools and techniques. The European teachers can share resources and give and take feedback from stakeholders about the efficacy of ICT implementation in European schools. The ICT pedagogues' centres and pedagogical services were established in Sweden in 1994 to integrate ICT in Secondary School Education (SSE) and also to provide support to the teaching community (Gutterman, Rahman, Supelano, Thies, & Yang, 2009). The Education Policy of Finland specifically recognises ICT as a prime tool in the teaching and learning process and states that technology is necessary albeit not sufficient in a knowledge or information society. Keeping in view this, a proto-type information model i.e., closer to network society is recommended for the improvement of technical knowledge and skills among Finnish students (Castells & Cardoso, 2006). Competence, credentials and commitment are necessary for the adoption and implementation of ICT (Flanagan, 2011). In Greece's education system, digital competence and complacency are serious limitations to adopting ICT, yet, teachers' positive attitude towards ICT integration is crucial for successful implementation (Jimoyiannis and Komis, 2006).

The digital disruptions of ICT in 'Developing Economies' are relatively scarce (Walsham *et al.* 2007) though gradually the scenario is changing. Digital literacy as enunciated in SDG-4 is the prime concern, especially in Secondary Education in India and the rate of ICT adoption is around 45 percent in Secondary Schools compared to 17 percent in Primary Schools in India (ADB, 2012). Many countries in Asia and the Pacific region have developed policies on ICT teacher training and they need to be looked at more carefully with broader educational objectives and the evolving landscape of ICT (UNESCO, 2004).

The 4-Asian Tigers in terms of growth and development viz., South Korea, Singapore, Hong Kong, Taiwan and Japan have also formulated educational policies concerning SSE (ADB, 2012).

Japan introduced and implemented the 'E-Japan Strategy' in 2001, a proactive approach, to enhance intellectual ability and creativity. The successful integration of ICT takes place in Singapore in two phases. The ICT Master plan was designed in 1997 to incorporate technologies into the school system (Mui, Kan, & Chun, 2004). Thereafter, the systematic and holistic approach was introduced in 2002, and it was aimed at integrating ICT in pedagogy, professional development, examinations, assessment, and school culture. The curriculum was reduced by 10 to 30 per cent and allowed technology integration in all subject areas (R. B. Kozma, 2005; Law et al., 2008).

The school enrolment and completion rates in Sub-Saharan Africa-Secondary education are identified as serious concerns to meet SDG-4. Some of the reasons pertaining to the low deployment of ICT in Secondary School education are the traditional teaching practices, outdated curricula, examination system, digi-infrastructure, poverty and brain drain per se (GEM, 2016).

The teacher-to-student ratio, teachers' management, and ICT adoption in Kenya, Mauritius and Zimbabwe have achieved consistency in SSE. (Bashir *et al.*, 2018). The smart school project was initiated by the Government of Malaysia with a specialised feature of browser-based Teaching-Learning in Mathematics, Science and Languages. The ICT adoption and implementation in Thailand's Education System is aimed at developing learning skills and talents, reasoning capacities and competencies (Anderson, 2010; Plomp, 2009).

The Instruction, Media, and Technology (IMT) Strategy in the Malawian perspective, the significance of practicum teaching, pedagogical awareness and content knowledge in South Africa's context, the DBR (Design-Based Research) and LS (Learning Study) models in Chinese Primary Education, the contextualised e-learning interventions in Higher Educational Institutions (HEI) of Zimbabwe, the Design-Based Research (DBR) in Kenya pre-primary schools through a dialogic lens, the Professional Development Programmes (PDPs) for teachers in Finland, and the 'Japanese Education System' in the present era of 'Reiwa' and Society- 5. O are some of the innovative interventions across the globe (Agnes Chigona, Helen Crompton & Nyarai Tunjera, 2024).

1.2 ICT in Secondary Education - The Empirical Evidences

Teachers and the pedagogical approaches play a vital role in ICT-enabled education. The adoption of ICT pedagogy (curriculum and practicum) in secondary education depends on the skills and competencies of the teacher**.** Bariu, T.N. (2020) opined that ICT plays a transforming role in secondary schools in Meru County, Kenya and also evaluated the state of ICT infrastructure and the process of delivery and instruction in secondary schools of Kenya. Japhet E. Lawrence and Usman A. Tar (2018) opined that digitalisation and integration of ICT in teaching and learning indeed provide a plethora of avenues including personalised learning experiences, collaboration networks and professional development in a globalised space. ICT plays a pivotal role in classroom delivery and instruction, administration, online instruction, and other activities. The integration and implementation of ICT improves the Quality of Teaching (QoT) and enhances the Quality of Learning (QoL). Pervaiz Memon *et al*., (2018) described the scenario and status of SSE in the Ghotki, a Sindh province. Some of the observations *inter alia* include irrespective of ICT infra and interests, the unavailability of electricity and high costs of maintenance can significantly impact the implementation of ICT in secondary schools.

P. Mailavelan and Dr. M. Baskaran (2018) studied the level of adoption of ICT among secondary schools in and around Chennai, Tamil Nadu. They found out that most of the students have a moderate level of ICT awareness and there is no significant difference observed in ICT awareness between boys and girls. Sanat Kumar Mallick *et al*., (2018) explicitly expounded on the importance of education reforms and innovations including ICT in secondary and higher school education in 24 North Paraganas of West Bengal viz., Nadia, Hooghly, Purulia and Malda Districts. They suggested the digi-infrastructure including the digi-library, and digi-technologies for enhancing student engagement and teachers' enrichment making ICT integration a success in/out of the classroom. Xiang Hu *et al*., (2018) elucidated the adoption of ICT in 44 countries at the school and student level and also examined the relationship between ICT and mathematics, reading and scientific literacy. The observations reveal that there exists a positive relationship between ICT adoption and students' interests, competencies, and autonomy. Moreover, a negative relationship exists between ICT use for entertainment purposes and the academic performance of students.

Gil-Flores *et al*., (2017) explored the factors influencing the adoption and use of ICT in SSE in Spain. The significant barriers to ICT use in classrooms include snags in software and hardware, organisational barriers, perceived lack of usefulness of ICT, and lack of integration of ICT in pedagogy and curriculum, etc. Therefore, it is suggested to re-orient the Spanish educational system that support teachers, engage students and prepare the next generation for a digital future. Lucian V. Ngeze (2017) empirically examined the integration of ICT in teaching and learning in secondary schools in Tanzania and found that there is a high level of adoption of ICT among secondary grade teachers. The recommendations include imparting ICT Training among teachers at an increasing pace, providing ICT infrastructure in many schools, and setting up an ICT framework for implementing ICTs in teaching and learning.

Prema Basargekar & Chandan Singhavi (2017) investigated the impact of non-manipulative and manipulative teachers' factors on their perceived proficiency in using ICT at high schools in Maharashtra, India. Gender, age group, work experience, and experience of working with computers are significant non-manipulative factors while manipulative factors include type of school board, language of delivery and teachers training program facilities. The suggestions inter alia include there is a need for orientation programs for teachers on ICT adoption

and the introduction of e-content in regional languages have a positive impact on perceived proficiency in using ICT in classrooms.

The integration of ICT in SSE is imperative and imminent to build knowledge societies, provide digital skills, (UNESCO, 2003), and meet the needs and demands of the 21st century (Alsied & Pathan, 2013). The competence and confidence in relation to the pedagogical use of ICT mostly depend on course material, course design, digital infrastructure, and classroom practices (Law & Chow, 2008). The diffusion of technologies persuades individuals to change either to reinvent or innovate.

Piet Kommers and Margriet Simmerling (2005) opined that ICTs emerged as vital factors in the 'sustainable development of education' as enunciated in SDG-4. Secondary education is a decisive stage of learning and studying and ICT has an impact on the 'age' of secondary school students. Hence, it is suggested that educational institutions promote ICT infrastructure, and restructure classroom-based learning and its complement to home-based learning, vocational training, and most importantly web-based learning networks and learning communities. The study of Niel McLean (2003) on the adoption of ICT in secondary schools evinced ICT as a central for improving standards and also acts as a catalyst in terms of pupil attainment, motivation, and attendance. The results reveal that there is a clear and positive relationship between ICT learning opportunities and pupil achievement in secondary education.

2. Research Design

Data plays a pivotal role in evaluating the efficiency and efficacy of ICT Teaching and Learning. It provides valuable insights and inferences to gauge the effectiveness of ICT adoption in Classroom Teaching and Learning. The meta-analysis of data focuses on qualitative and quantitative insights thereby synthesising the results. The study is based on both primary and secondary data. The primary data is collected by canvassing a semi-structured questionnaire among 1167 secondary school teachers and 6022 students of classes VIII, IX and X including 62 ICT instructors in 12 revenue mandals of the West Godavari district of Andhra Pradesh and the responses were duly pilot tested. The scholarly articles from ScienceDirect, Springer, Taylor & Francis, MDPI, Frontiers, IJRCT, and the working group studies of UNESCO, UNICEF, RMSA, DISE, performance and review reports of the Directorate of School Education (DSE), and Office of the District Education Officer (DEO), Eluru, form the basis of secondary sources.

2.1 Objectives of the Study

The prime objective of the study is to evaluate the impact of the integration of ICT in teaching-learning pedagogy in quasi-government, secondary schools (Classes from VIII, IX and X) of the West Godavari District, Andhra Pradesh. The study also examines the level of integration of ICT in Mathematics, Physics, Natural Sciences and Social Studies. Further, the study suggests ways and means for the efficient and effective integration of ICT in SSE.

2.2 Hypotheses of the Study

H_1: There is a significant association between ICT integration and the teaching-learning pedagogy in secondary school education.

H_2 : ICT integration has a significant impact on students' learning outcomes in Mathematics, Scientific Literacy, and Social Studies in Classes VIII, IX, and X.

2.3 Need for the Study

The digi-skills and competencies in the continuum influence education practices, processes and provisions. In the era of Artificial Intelligence (AI) and Generative Artificial Intelligence (GEN-AI), ICT has become an integral part of our lives especially linked to the education landscape. ICT is crafting the role of future education in India in the sphere of teaching, learning and assessment. There is an impact of ICT-enabled education across the globe and SDG-4 enunciated the Universal Vision of Education i.e., the provision of inclusive and equitable quality education at all levels, for all people, and across the life course. The integration of the ICT curriculum has a significant and positive impact on student achievement, specifically in terms of knowledge, comprehension, practical and presentation skills, Mathematics, Science and Social Study. In this context, an earnest attempt has been made in the study to evaluate the impact of

ICT-enabled teaching-learning pedagogy in quasi-government, secondary schools of the West Godavari district, Andhra Pradesh.

2.4 Sample Design

The elicited responses and reflections from 1167 secondary school teachers and 6022 students who are studying in classes - VIII, IX and X including the views and opinions of 62 ICT instructors are considered for the study from a sample of 12-revenue mandals in the West Godavari District of Andhra Pradesh. The Stratified Random Sampling Method was adopted for the study and the Semi-Structured Questionnaire and Focused Group Discussions (FGDs) form the basis for the study.

2.5 Time Period of the Study

ICT-enabled teaching-learning pedagogy adopted in quasi-government, secondary schools (Class VIII, IX, and X) in the West Godavari district of Andhra Pradesh is considered for the study. The elicited responses and reflections from the secondary school teachers, students and ICT instructors are collected for pertinent analysis. The time period i.e., 01st April, 2022, to 31st March, 2023 is considered for the study.

Table 1. An overview of mandals, quasi-government, secondary schools, teachers, students and ICT instructors (classes VIII, IX and X) - The West Godavari district, Andhra Pradesh (academic year 2022-2023)

No. of Mandals			48
No. of Quasi Govt., Secondary Schools			475
No. of Students	Boys		43999
	Girls		48731
	Total		92730
No. of Teachers	Maths	Male	763
		Female	180
	Physics	Male	665
		Female	72
	Biology	Male	705
		Female	78
	Telugu	Male	460
		Female	11
	English	Male	650
		Female	123
	Hindi	Male	501
		Female	18
	Total	Male	3744
		Female	482
ICT Instructors			276

Source: Office of DEO (2022-23), Eluru, West Godavari district, Andhra Pradesh.

Table 2. Sample design of no. of mandals, quasi-government, secondary schools, teachers, students and ICT instructors (classes of viii, ix and x) - the West Godavari district, Andhra Pradesh (academic year 2022-2023) (25% of the total population)

No. of Mandals			48
No. of Quasi-Government, Secondary Schools			475
No. of Students	Boys		2754 (11016)
	Girls		3268 (13072)
	Total		6022 (24088)
No. of Teachers	Maths	Male	47 (187)
		Female	12 (50)
	Physics	Male	42 (169)
		Female	6 (25)
	Biology	Male	45 (178)
		Female	7 (28)
	Telugu	Male	30 (121)
		Female	1 (4)
	English	Male	43 (171)
		Female	9 (36)
	Social Studies	Male	43 (171)
		Female	7 (27)
	Total	Male	249 (997)
		Female	43 (170)
ICT Instructors			62

Hindi Teaching Community	Tribal		Rural		Urban	
	Male	Female	Male	Female	Male	Female
	15	0	82	8	38	3

Source: Office of DEO, (2022-23), Eluru, West Godavari district, Andhra Pradesh

Table 3. Sample design of no. of mandals, no. of quasi-government, schools and no. of students (Classes of VIII, IX and X) - The West Godavari district, Andhra Pradesh (academic year 2022-2023) (25% of total population)

Area	Name of the Mandal	No. of Quasi-Govt., Schools	No. of Students		Total
			No. of Boys	No. of Girls	
Rural Area	Dwaraka Tirumala	9	529 (39.28)	818 (60.72)	1347 (100)
	Bhimadolu	7	792 (37.58)	1316 (62.42	2108 (100)
	Pedapadu	10	649 (41.60)	911 (58.39)	1560 (100)
	Denduluru	7	795 (49.84)	800 (50.15	1595 (100)
Urban Area	Tadepalligudem	24	2100 (48.45)	2234 (51.54)	4334 (100)
	Eluru	24	2248 (48.64)	2373 (51.35)	4621 (100)
	Tanuku	11	1332 (45.14)	1619 (54.86)	2951 (100)
	Bhimavaram	18	1402 (42.83)	1871 (57.16)	3273 (100)
Tribal Area	Jeelugumilli	3	271 (55.87)	214 (44.13)	485 (100)
	Buttaigudam	2	239 (48.26)	149 (51.74)	388 (100)
	Polavaram	2	166 (46.24)	193 (53.76)	359 (100)
	T. Narasapuram	5	493 (46.20)	574 (53.80)	1067 (100)
Total		**122**	**11016 (45.73)**	**13072 (54.23)**	**24088 (100)**

3. Data Analysis and Interpretation

Table 1 gives an overview of mandals, quasi-government, secondary schools, teachers, students and ICT instructors of classes VIII, IX and X in the West Godavari district, Andhra Pradesh for the academic year 2022-2023

Table 2 contains the Sample design of no. of mandals, quasi-government, secondary schools, teachers, students and ICT instructors of classes of viii, ix and x in the West Godavari district, Andhra Pradesh for the academic year 2022-2023 (25% of the total population)

Table 4. Sample design of no. of mandals, no. of quasi-government, schools and teachers -The West Godavari district, Andhra Pradesh (academic year 2022-2023) (25% of Total population)

Area	Name of the Mandal	No. of Quasi-Govt., Schools	No. of Teachers		Total	ICT Instructors
			Male	Female		
Urban Area	Dwaraka Tirumala	9 (7.37)	55 (96.49)	2 (3.51)	57 (100)	1
	Bhimadolu	7 (5.73)	73 (71.56)	29 (28.44)	102 (100)	6
	Pedapadu	10 (8.19)	87 (91.57)	8 (8.43)	95 (100)	6
	Denduluru	7 (5.73)	69 (87.34)	10 (12.66)	79 (100)	5
Rural Area	Tadepalligudem	24 (19.67)	188 (90.38)	20 (9.62)	208 (100)	12
	Eluru	24 (19.67)	176 (80)	44 (20)	220 (100)	11
	Tanuku	11 (9.01)	110 (78.01)	31 (21.99)	141 (100)	6
	Bhimavaram	18 (14.75)	153 (88.43)	20 (11.57)	173 (100)	9
Tribal Area	Jeelugumilli	3 (2.45)	21 (100)	0 (0)	21 (100)	2
	Buttaigudam	2 (1.63)	16 (84.21)	3 (15.79)	19 (100)	1
	Polavaram	2 (1.63)	12 (92.30)	1 (7.70)	13 (100)	1
	T. Narasapuram	5 (4.17)	37 (94.87)	2 (5.13)	39 (100)	2
Total		**122** (100)	997 (85.43)	170 (14.57)	1167 (100)	62

Source: Office of DEO, (2022-23), Eluru, West Godavari District, Andhra Pradesh

Note: Numbers in parentheses indicate the percentage of total

Table 3 shows the Sample design of number of mandals, no. of quasi-government, schools and number of students of Classes of VIII, IX and X in the West Godavari district, Andhra Pradesh for the academic year 2022-2023 (25% of total population)

Table 4 depicts the Sample design of number of mandals, no. of quasi-government, schools and teachers in the West Godavari district, Andhra Pradesh for academic year 2022-2023 (25% of Total population)

ICTs are powerful educational tools that play a significant role in transforming teaching-learning pedagogy **(Ludvigsen & Morch, 2010; Sutherland *et al.*, 2009).** The methods of education are continuously evolving and the interactive teaching-learning methods make school Math and Science blossom and bloom **(Aija Cunska & Inga Savicka, 2012).** The integration of ICT can be effective in enhancing competency in physical, natural, social sciences and mathematics among teachers, particularly in the context of Technology Pedagogy and Content Knowledge (TPACK). The hands-on experience in micro-teaching, lesson design, teaching plans, and sharing views and opinions with peers significantly influence the TPACK among teachers **(Ayoub Kafyulilo, 2011).**

Table 5 provides a comprehensive overview of the integration of ICT in Subject Knowledge, reinforcing the idea that ICT permeates all areas of education. The diffusion of ICT in Language Education is at an earlier stage compared to that in Applied Sciences. It reveals a critical need for individuals to learn ICT skills to effectively connect and communicate, particularly during times of turbulence.

4. Key Findings

The adoption of ICT has profound effects on economies and societies, and it plays a crucial role in promoting sustainability. From a Secondary school perspective, the adoption of ICT plays a pivotal role in stimulating

Table 5. Integration of ICT in maths, sciences, social studies and languages sample secondary school teachers

Integration of ICT in Subject Knowledge	Residential Status			Total
	Urban	Rural	Tribal	
Mathematics	39 (65)	16 (26.6)	5 (8.33)	60 (100)
Physical Sciences and Natural Sciences	44 (57.89)	26 (34.22)	6 (7.89)	76 (100)
Social Studies	44 (65.67)	18 (26.86)	5 (7.47)	67 (100)
Telugu	18 (64.29)	7 (28)	3 (10.71)	28 (100)
Hindi	9 (64.28)	4 (28.57)	1 (7.14)	14 (100)
English	12 (57.14)	6 (28.57)	3 (14.28)	21 (100)
ICT-Skills	20 (74.07)	6 (22.23)	1 (3.70)	27 (100)
Total	186 (63.48)	83 (28.33)	24 (8.19)	293 (100)

Source: Questionnaire

Note: Numbers in parentheses indicate the percentage of total

Table 6. Integration of ICT in maths, sciences and social studies (Classes VIII, IX, and X)

ICT Applications in Mathematics Learning - The Level of Confidence			
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**
	126.474[a]	6	0.000
ICT Applications in Physics and Natural Sciences Learning - The Level of Confidence			
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**
	261.534[a]	6	0.000
ICT Applications in Social Sciences Learning - The Level of Confidence			
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**
	194.18[a]	8	0.000
ICT Applications in Telugu Language Learning - The Level of Confidence			
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**
	189.986[a]	6	0.000
ICT Applications in Hindi Learning - The Level of Confidence			
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**
	10.244[a]	4	.037
ICT Applications in English Language Teaching - Learning - The Level of Confidence			
Pearson Chi-Square Test	Value	df	Asymp. Sig., (2-Sided)
	131.860[a]	8	0.000

Source: Questionnaire

Table 7. Integration of ICT in classroom learning (Classes VIII, IX and X).

ICT Adoption in VIII Class Learning - The Impact and Incidence				
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**	
	329.163[a]	6	0.000	
ICT Adoption in IX Class Learning - The Impact and Incidence				
Total No. of Valid Cases	3795	1652	575	6022
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**	
	26.285[a]	6	0.000	
ICT Adoption in X Class Learning - The Impact and Incidence				
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**	
	223.923[a]	6	0.000	
ICT-Integration in Classroom Learning - The Level of Confidence				
Pearson Chi-Square Test	**Value**	**df**	**Asymp. Sig., (2-Sided)**	
	484.958[a]	8	0.000	

Source: Questionnaire

academic performance and enhancing the overall effectiveness and efficiency of the learning process. Adoption of ICT skills and talents can have a positive influence on both academic performance and academic success. Teachers with higher ICT competence tend to use ICT more frequently in their teaching practices. Incorporating ICT into Science education can be a transformative tool for increasing student engagement and motivating the learning environment. Integrating ICT into 'Language Pedagogy' significantly enhances communicative competence, fosters creative learning, and enhances listening and speaking skills.

From the **Factor analysis**, it can be observed that the primary factors influencing ICT integration in teaching pedagogy include internet connectivity, infrastructural bottlenecks and lack of integration between pedagogy and curriculum. Some of the secondary influences on ICT integration in teaching pedagogy comprise educational policies and planning, the need for ICT training, language barriers, etc., The infrastructural bottlenecks, lack of competencies, and digital illiteracy are deep-rooted inequalities observed in rural and urban areas. There exists a significant education gap and gender gap at its peak, along with an alarming digital divide among the urban, rural and tribal areas selected for the study.

It can be observed from **Table 6**, that the level of confidence in the adoption and implementation of ICT varies significantly across different df in the integration of Telugu, English, Hindi, Mathematics, Physics, Natural Sciences and Social Sciences. Among the various subtleties, the most prominent issues include a lack of ICT infrastructure, digital incompetence and web illiteracy. Technology Enhanced Language Learning (TELL), Computer Assisted Language Learning (CALL), Computer Aided Assessment (CAA), and Web-Based Learning (WBL) promote cognitive development and linguistic performance. From **Table 7**, the results indicate a significant difference in the adoption of ICT across various classes of instruction between rurban and tribal regions selected for the study, with df of 6, 4, 6, and 8, and corresponding Chi-Square values of 329.163a, 26.285a, 223.923a, 484.958a respectively. ICT touches every sphere and space of human life profoundly influencing how we live, work, and interact. ICT recognises the importance of subject and domain knowledge, didactic improvisations and an openness of mind in the moments of teaching-learning.

Conclusion

ICT is undoubtedly an innovative intervention and a collaborative concierge in secondary education that chisels within and out persona of educators, teachers and students. ICT has revolutionised teaching-learning in the 21st century by introducing innovative pedagogical approaches that enhance engagement and accessibility. To be globally competitive and develop engaged citizens, our schools should weave innovative skills and competencies throughout the teaching-learning process. The 21st century education offers life skills for work and life. These include the development of critical thinking, complex problem solving, collaboration and multi-media communication in the teaching of traditional academic subjects. **(Culp, k. m. *et al.*, 2005).** Talking books, hypertexts, micro-worlds, interactive whiteboards, dynamic geometry systems, simulations and modelling environments have a positive effect on pupils' attainment and enhance ICT adoption among the students. Yet, the crucial component remains with the teachers and their pedagogical approaches.

ICT lies not just in theories but in practical application. It enhances performance, significantly impacts classroom learning, and provides valuable insights into educational processes. ICT is all-inclusive in nature. To thrive in the digital era, it is suggested that educators, instructors, and learners collaboratively build MOOCs, cMOOCS, xMOOCS, NOOCs, and crowd learning to delve into unexplored knowledge and skills. For the successful integration and implementation of ICT, reforms in the teaching-learning pedagogy of secondary education are recommended to foster learning and inspire Gen-Z, including those living in remote areas, enabling them to learn more effectively and acquire skills to meet the demands of tomorrow's India and the world.

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