

ASSESSING THE EFFECTIVENESS OF ICT TOOLS AMONG THE ACADEMIC RESEARCH SCHOLARS THROUGH A PCA-BASED INDEX DEVELOPMENT APPROACH

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ABSTRACT

ICTs, as is evident from the post-COVID-19 situation, have become a major facilitator in the dissemination of quality educational content for various institutions. Yet, the effectiveness of the ICT tools concerning the various dimensions needs to be studied to gain fruitful insight into the determinants of effectiveness of ICT tools. For this purpose, an ex post facto study taking into purview the situation, was undertaken for the 179 academic research scholars in two state agricultural universities namely Dr. PDKV, Akola in Maharashtra and IGKV, Raipur. A novel ICT effectiveness index was developed following the Principal Components analysis approach. The results revealed that readability of content (4.454), ease of handling ICT tools (4.317) and communication skills of the presenter (3.941) were the major determinants of the effectiveness of ICT tools. Further 39.65 per cent and 32.96 per cent of the research scholars perceived the effectiveness of ICT tools to be “very high” and “high” respectively. Most scholars perceived the effectiveness to be very high in terms of content quality (50.84%) followed by 45.81% (in terms of communication efficacy). Thus, overall effectiveness was high but efforts can be made towards improvement of presentation quality which was perceived to be high by 43.02 per cent which was comparatively lower against the other two components of effectiveness.

Keywords: ICT tools, effectiveness, academic, research scholars, content quality, presentation quality

INTRODUCTION

The ubiquitous presence of numerous communication devices since ancient times was found significant for the propagation of information among social groups. These tools have changed forms and channels. A major breakthrough in communication came through the invention of the internet which further led to the development of a sophisticated domain of Information and communication tools (ICTs). ICT have been known for their speed, accuracy and timeliness of information. This has led to their diffusion across different domains and disciplines for sharing and reception of information (Mallick et al., 2023). As far as education is concerned the ICT tools have led to a revolution in providing a novel educational experience to the facilitators, coaches and trainers on one side while the learners on the other (Horton & Horton, 2021; Samadder et al., 2024). Numerous ICT Tools have been at the disposal of society over the last two decades and deemed useful in multifarious situations but a major cue to action which led to an overt change was the COVID-19 pandemic situation (Lee et al., 2021; Ziemba & Eisenhardt, 2022). Since the lockdown situation restrained

the smooth running of educational institutions, ICT tools were observed as an innovative solution to answer the grievance. The paradigm shift in educational dissemination was observed when numerous novel tools like webinar applications, social media and MOOCs were utilized for distance learning (Kumar et al., 2020; Soledispa et al., 2021; Rathwa et al., 2024). Further, a reinvention was observed in the traditional media like TV and radio wherein these tools were modified to suit the needs of disseminating quality education content to the students. It has been observed that individuals from different nationalities possessed varied perceptions for ICT tools. Further these perceptions have witnessed sharp transitions in COVID pandemic scenario. This creates a need to understand the effectiveness in a solid quantitative manner for agricultural universities in Indian context. Taking this backdrop into consideration a study was designed to understand the effectiveness of ICT tools wherein an index has been devised containing suitable components and indicators to assess the construct. In order to address this need, an attempt has been made to delineate appropriate attributes which could be utilized to indicate the effectiveness construct thereby used further to develop an index to measure the effectiveness. This analysis

will help to understand the current effectiveness of ICT tools. Further, the study underpins the constraints perceived by agricultural research scholars in the utilisation of ICT tools. For this, a quantitative as well as qualitative approach has been followed. Thus, this paper attempts to address two objectives.

OBJECTIVES

- (1) To assess the extent of the perceived effectiveness of ICT tools in the dissemination of educational content among the research scholars
- (2) To ascertain the determinant indicators of perceived effectiveness of ICT tools

METHODOLOGY

An ex-post facto research design-based study was carried out wherein a sample of 179 agricultural research scholars conducting research work in the second year of their master's degree from two state agricultural universities namely Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra and Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. While the universities were selected purposively, the students from various departments of the study were selected by simple disproportionate random sampling wherein 10 per cent of students from each department were selected. Since the students were doing coursework during the COVID-19 lockdown situation, hence agricultural research scholars were assumed to use ICT tools for online learning were selected. In order to quantitatively assess the effectiveness of ICT tools, an index approach was followed. For this, PCA based index development technique was used using the following steps.

- (1) An extensive review of the literature followed by a discussion with experts was done in order to select the appropriate indicators for the study. A total of 12 indicators were selected for further Principal Component Analysis (PCA) based assessment in order to study the suitability of indicators for entering into the further procedure.
- (2) The commonality values so obtained from PCA were used for assessing the suitability of the indicators. A cut-off value of .5 was decided wherein the indicators above the value were selected while the indicators with a value less than .5 were discarded. Since all the indicators had a communality value of above .5, all the indicators were retained for further study.
- (3) Further, the indicators were grouped into components by use of eigen values obtained from rotated component matrix. Based on the analyses, a framework was

developed to conceptualize the effectiveness index (It has been elaborated in the results and discussion section)

- (4) Further, the weightage of the indicators was calculated. Determining the relative importance of the various indicators in the study is essential, necessitating the calculation of individual indicator weights. The PCA-based weighing technique was employed, where weightage was calculated as the sum of all the products of the eigenvalue of each component with all the values in the component matrix. The variability of the indicators aids in the determination of the weights. This method has been widely used in numerous researches.
- (5) After obtaining the weightage of each indicator, the final value for a subcomponent can be calculated using the following formulas:

$$a. \text{ Communication Efficacy} = \frac{\sum W_i \times nI_i}{\sum W_i}$$

$$b. \text{ Presentation quality} = \frac{\sum W_i \times nI_i}{\sum W_i}$$

$$c. \text{ Content quality} = \frac{\sum W_i \times nI_i}{\sum W_i}$$

where, W_i = Weightage of respective indicators; nI_i = Normalized value of each indicator

- (6) After the calculation of values for each of these, a comprehensive value for Effectiveness Index is calculated by determining the weighed mean using the following formula:

Where,

$$EFF_i = \frac{W_E C_i + W_S P_i + W_{AC} Q_i}{W_C + W_P + W_Q}$$

- EFF_i = Perceived effectiveness of individual 'i'
 - W_C, W_P and W_Q are the weightages of indicators for each component namely Communication Efficacy, Presentation quality and Content quality respectively
- (7) Based on the values obtained for each respondent, the respondents were categorized into five categories namely very low (0 to 0.2), low (0.201 to 0.4), moderate (0.401 to 0.6), high (0.601 to 0.8) and very high (0.801 to 1) for each component as well as overall effectiveness index.

RESULTS AND DISCUSSION

The results have been presented for the study under two sections. The prior section comprises of the results

pertaining to analysis carried out for conceptualization and development of index for measurement of effectiveness of ICT tools. The second section comprises of distribution of respondents according to perceived effectiveness based on the index values.

Development of Index

The 12 indicators as presented in Table 1 were chosen for development of required index after a review of literature and discussion with experts. In order to test

the suitability of the indicators for further operations, communality values were obtained for all the indicators as presented in Table 1. Since all the indicators chosen possessed communality value above 0.5, they were found to be suitable for further analysis. These chosen indicators were tested under rotated component matrix to categorize the highly correlated indicators under common component. Further, these components were conceptualized into suitable constructs.

Table 1 : Communality values for testing suitability of indicators and rotated component matrix

Sr. No.	Indicators	Communality testing		Rotated component matrix		
		Initial	CV	PC 1	PC 2	PC 3
1	Information provided	1.000	0.590	0.145	-0.002	0.755*
2	Correctness of information	1.000	0.674	-0.051	0.555	0.603*
3	Orderliness of information	1.000	0.536	0.011	0.462	0.568*
4	Attractiveness	1.000	0.545	0.494*	0.369	0.406
5	Ease of handling ICT tools	1.000	0.640	0.780*	0.146	0.105
6	Readability of content	1.000	0.705	0.766*	0.335	0.082
7	Photo clarity	1.000	0.695	0.529	0.643*	-0.053
8	Voice clarity	1.000	0.672	0.257	0.766*	0.137
9	Video quality	1.000	0.643	0.280	0.721*	0.210
10	motivation to learn	1.000	0.560	0.386	0.123	0.629*
11	Ease of feedback	1.000	0.510	0.453*	0.323	0.428
12	Communication skills of presenter	1.000	0.665	0.650*	0.073	0.487

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Note: Principal component has been abbreviated as PC. Indicators belonging to a component have been marked with Asterisk (*).

Developing a conceptual framework based on principal component analysis

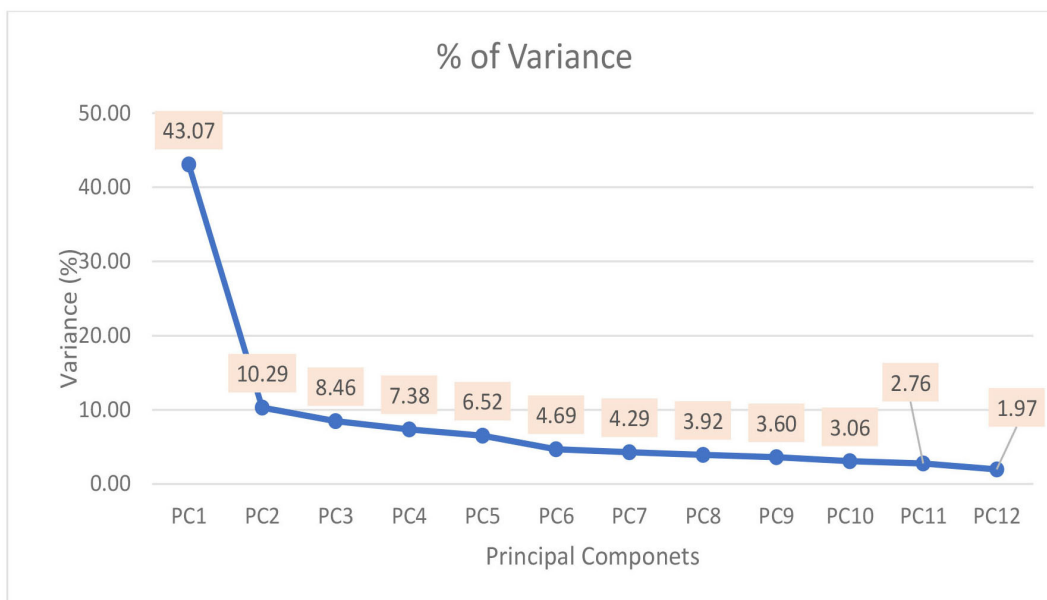


Fig. 1 : Scree plot depicting the variance (in %) explained by all the components

As it is evident from the Fig. 1, a total of maximum 12 component were extracted from the PCA operations. The three components namely PC1, PC2 and PC3 were significant as they could explain the 61.822 per cent of the variance. Hence, the three components were used in the subsequent process of index development. A total of three

components were derived which could explain the 61.822 per cent of the variation as shown in Fig. 1. Further, the conceptualization of the index based on categorization of indicators under different dimensions has been presented in Fig 2.

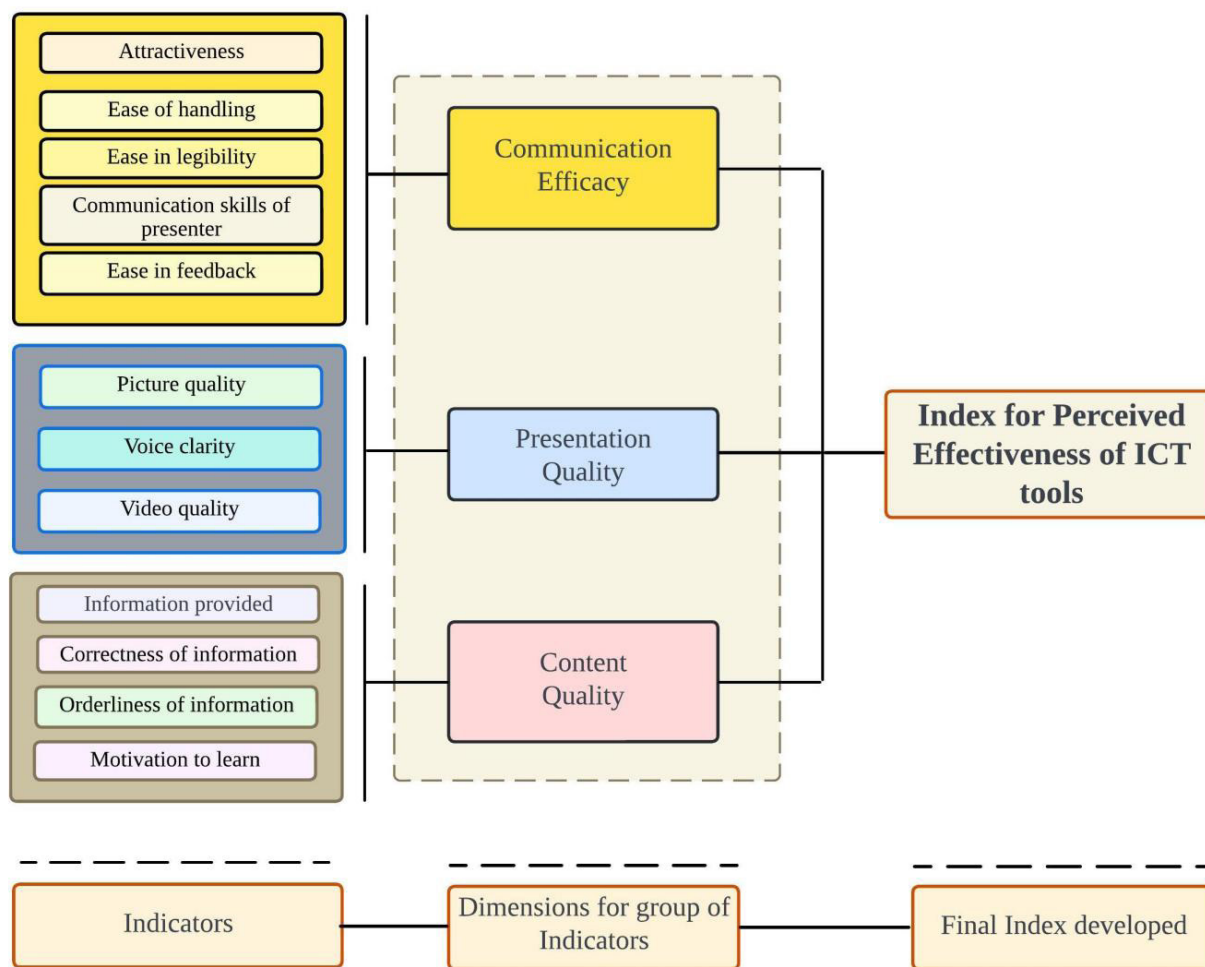


Fig. 2 : Conceptual framework for index development

In order to develop a conceptual framework for assessing the effectiveness of ICT tools, the rotated component matrix and initial eigenvalues were used. As is evident from the table 1, components were extracted from the PCA operation.. From the table 1 regarding the grouping of indicators as per the components, it was found that component 1 consisted of “Attractiveness”, “Ease of handling ICT tools”, “Ease in Legibility”, “Ease of feedback” and “Communication skills of presenter”. Component 2 consisted of three indicators namely, “Picture

quality”, “Voice clarity” and “video quality”. Component 3 consisted of four indicators namely, “Information provided”, “Correctness of information”, “Orderliness of information “ and “motivation to learn”. Based on the homogeneity of indicators under each component, the components were named as unique constructs which can describe the nature of indicators well. Component 1 contains the 5 indicators which aptly suggest the efficacy on the part of the communicator to propagate the information with minimal distortion hence it was termed *Communication efficacy*. Since the

indicators under component 2 point towards the quality of presentation of the educational materials, it was termed as *presentation quality*. Further, the underlying indicators in component 3 imply with the quality of content hence it was termed as *content quality*. Thus, these aforementioned three components constituted the effectiveness of ICT tools. The three dimensions conceptualized by means of PCA have been defined as given below:

- **Communication efficacy:** it is the degree to which the ICT tools were perceived as efficient in the communication of information to the Individuals. It was constituted of five indicators namely, Ease of handling ICT tools attractiveness, legibility, ease of feedback and communication skills of the presenter.
- **Presentation quality:** it is the degree to which the material presented was perceived to possess the Ease of handling ICT tools the ICT tools (on the part of the presenter), Photo clarity during the presentation, video clarity during a presentation and video quality.
- **Content quality:** it is the degree to which the ICT tools were perceived effective on the part of the information provided, the orderliness of information, correctness of the information and instigating motivation to learn among the students.

Weightages of the indicators

Table 2 : Weightages of the indicators

Sr. No.	Indicators	Value of weightages
1	Readability of content	4.454639
2	Ease of handling ICT tools	4.317159
3	Communication skills of presenter	3.941698
4	Photo clarity	3.578946
5	Attractiveness	3.422956
6	Ease of feedback	3.171833
7	Motivation to learn	2.78419
8	Video quality	2.548785
9	Voice clarity	2.41565
10	Correctness of information	1.561024
11	Information provided	1.518921
12	Orderliness of information	1.204044

An absolute sum of product of eigen values for each indicator with their respective values in three components was done to determine the weightages of the indicators which have been presented in Table 2. The weightage of each indicator was calculated by summation of the absolute values of the eigenvalues for each indicator in the three components. The weights have been presented in the table. It is quite evident from the table that cases in Legibility, Ease of handling ICT tools, communication skills of presenter and picture clarity were having higher weightages. Hence these were the major determinants of the effectiveness of ICT tools. Thus, it could be observed that the communication efficacy and presentation quality metrics played an important role in determining the effectiveness of ICT tools.

Extent of Perceived effectiveness towards ICT tools among the research scholars

Table 3 : Extent of perceived effectiveness towards ICT tools among research scholars

(n=179)

Sr. No.	Attributes	Content Quality		Presentation Quality		Communication Efficacy		Overall Effectiveness of ICT tools	
1	Very High (0.801 to 1)	91	50.84%	77	43.02%	82	45.81%	71	39.65%
2	High (0.601 to 0.8)	53	29.61%	29	16.20%	51	28.49%	59	32.96%
3	Moderate (0.401 to 0.6)	30	16.76%	66	36.87%	33	18.44%	43	24.02%
4	Low (0.201 to 0.4)	04	2.23%	06	3.35%	10	5.59%	06	3.35%
5	Very Low (0.00 - 0.2)	01	0.56%	01	0.56%	03	1.68%	0	0.00%

A majority of scholars (50.84%) perceived that ICT tools possessed very high content quality followed by 29.61 per cent having high content quality. Thus, a majority of scholars had a perception regarding content quality ranging from high to very high. This suggested that the scholars found the ICT tools reliable in terms of the information disseminated. This implies that instructors were able to formulate precise, correct and well-ordered study material to be presented to the scholars. Similarly, a majority of

scholars (43.02%) perceived that ICT tools possessed very high presentation quality followed by 36.87 per cent having the perception that ICT tools had moderate content quality. Thus, a majority of scholars had a perception regarding content quality ranging from moderate to very high presentation quality. This suggested that the scholars found the ICT tools were able to disseminate information in a well-structured and presentable form. This also implies success on the part of instructors in developing educational

material possessing high voice clarity, video quality and picture clarity.

In terms of communication efficacy, 45.81 per cent of scholars perceived that ICT tools possessed very high communication efficacy followed by 28.49 per cent who perceived it to possess high communication efficacy. Thus, most scholars perceived high to very high communication efficacy pertaining to ICT tools. The overall effectiveness index so developed suggested that 39.65 per cent of the scholars perceived that the ICT tools possessed very high effectiveness followed by 32.96 and 24.02 per cent possessing high and moderate effectiveness respectively. A mere 3.35 per cent of the scholars perceived that ICT tools possessed low effectiveness.

Since the research scholars prefer notes taking during online classes whether synchronous or asynchronous, hence the ease of legibility plays an important role in aiding scholars to collect crucial information from the ongoing classes. Similar findings were posed by studies conducted in Tanzania (Kafyulilo & Keengwe, 2014) and Dhaka (Kazoka et al., 2019). The Ease of handling ICT tools on the part of scholars as well as the instructors was deemed important reason being that the difficulty in handling the ICT tools can hamper the learning experience for the instructors as well as scholars (Albugami et al., 2015; Ghavifekr et al., 2023). The coherence and flow of communication may get obstructed leading to failure at the creation of a teaching-learning environment suitable for the scholars under consideration. Further, the communication skills of presenters were considered a major determinant. The extent of the skills of the communicator in handling the ICT tools can greatly affect the learning experience. The credibility of instructors may be judged by their ability to handle the ICT instruments well. In case of failure to do so, a resultant diminishing interest of the scholars to learn leading to reduced motivation may negatively affect the further continuance of the learning on the part of the students. This fact was consolidated by previous findings by numerous studies across the globe (Gudmundsdottir et al., 2020; Liesa-Orús et al., 2020; Rubach & Lazarides, 2021, Vaishnavi and Ramesh, 2023). Since pictures and video speak louder than mere words, the clarity of these elements may profoundly aid in the understanding of the abstract or pragmatic concepts. They can save the time of instructors hence the picture and video clarity were deemed to be major determinants (Kim, 2020; Lange & Costley, 2020; Tanis, 2020; Pratik and Vinaya, 2021). The above results imply that to make the utility of ICT tools effective, the focus should be put on improving the communication efficacy and presentation quality. These both require rigorous training and

hands-on teaching experiences for the instructors. Hence the educational policies should attempt to integrate ICT-related hands-on training for the instructors in the teachers' training curricula.

Thus, the overall picture depicts that most scholars perceived that ICT tools have high effectiveness in general in terms of all three components. This implies that instructors' endeavours to disseminate quality education were successful as the overall perception of the majority of students was positive. Further, the index also suggested that communication efficacy and content quality had received more positive perceptions when compared to presentation quality. So, efforts need to be taken by the instructors to develop presentations which have greater video clarity, picture quality and voice clarity.

CONCLUSION

The study on the effectiveness of ICT tools among agricultural research scholars highlights the transformative impact of these tools in educational settings, particularly during the COVID-19 pandemic. By employing Principal Component Analysis (PCA), the research identified key indicators such as communication efficacy, presentation quality, and content quality, which collectively form the basis of the effectiveness index. The findings reveal that a significant majority of scholars perceive ICT tools to have high to very high effectiveness in disseminating educational content. Notably, readability of content, handling, and communication skills of presenters emerged as major determinants of effectiveness. The results suggest that while content quality and communication efficacy are well-regarded, there is room for improvement in presentation quality, especially regarding video, picture, and voice clarity. The study underscores the need for comprehensive training programs for instructors to enhance their ICT skills, ensuring the continued success and reliability of online education. In conclusion, ICT tools have proven to be invaluable in maintaining educational continuity during disruptions, and their effective integration into the educational framework is crucial for the advancement of learning experiences.

RECOMMENDATIONS

Since communication efficacy and content quality are highly valued by scholars, educational policies should mandate comprehensive ICT training programs for instructors. These programs should focus on improving their communication skills, handling of ICT tools, and developing well-structured presentations with high-quality visuals and clear audio. This will ensure instructors can effectively utilize ICT tools and enhance the online learning

experience.

The study revealed a gap in presentation quality, especially in video, picture, and voice clarity. Policies should encourage the development of standardized guidelines and technical support for creating high-quality educational content. Institutions should invest in better ICT infrastructure and provide access to tools that can improve the clarity of presentations.

Since the ease of handling ICT tools and their effective use are critical for both students and instructors, ICT-related skills should be integrated into teacher training curricula and academic programs. Regular assessments and hands-on practice should be prioritized to ensure both scholars and educators are proficient in utilizing these technologies for more effective communication and learning.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this paper.

REFERENCES

- Albugami, S., & Ahmed, V. (2015). Success factors for ICT implementation in Saudi secondary schools: From the perspective of ICT directors, head teachers, teachers and students. *Int. J. of edu. and dev. using ICT*, 11(1).
- Gudmundsdottir, G. B., Gassó, H. H., Rubio, J. C. C. and Hatlevik, O. E. (2020). Student teachers' responsible use of ICT: Examining two samples in Spain and Norway. *Comput. Educ.*, 152. <https://doi.org/10.1016/j.compedu.2020.103877>
- Horton, W. and Horton, K. (2021). E-learning tools and technologies: A customer guide for trainers, teachers, educators, and instructional designers.
- Kafyulilo, A. and Keengwe, J. (2014). Teachers' perspectives on their use of ICT in teaching and learning: A case study. *Educ. Inf. Technol.*, 19(4): 913–923. <https://doi.org/10.1007/s10639-013-9259-7>
- Kaur, K. (2023). Teaching and learning with ICT tools: Issues and challenges. *Int. J. Cybern. Inform.*, 12(3):15–

22. <https://doi.org/10.5121/ijci.2023.120302>

- Kazoka, J. E., & Mwantimwa, K. (2019). Perceived usefulness and ease of use of Web 2.0 tools in university teaching and learning in Tanzania. *University of Dar es Salaam Library Journal*, 14(2): 19-37.
- Kim, J. (2020). Learning and teaching online during COVID-19: Experiences of student teachers in an early childhood education practicum. *Int. J. Early Child.*, 52(2), 145–158. <https://doi.org/10.1007/s13158-020-00272-6>
- Kukulska-Hulme, A. and Traxler, J. (2005). Mobile learning: A handbook for educators and trainers. <https://doi.org/10.4324/9780203003428>
- Kumar, A., Malhotra, S., Katoch, A., Sarathkar, A. and Manocha, A. (2020). Webinars: An assistive tool used by higher education educators during COVID-19 case study. *Proc. - Int. Conf. Comput. Intell. Commun. Netw.*, 2020, 327–332. <https://doi.org/10.1109/CICN49253.2020.9242597>
- Lange, C. and Costley, J. (2020). Improving online video lectures: Learning challenges created by media. *Int. J. Educ. Technol. High. Educ.*, 17(1). <https://doi.org/10.1186/s41239-020-00190-6>
- Lee, Y. C., Malcein, L. A. and Kim, S. C. (2021). Information and communications technology (ICT) usage during COVID-19: Motivating factors and implications. *Int. J. Environ. Res. Public Health*, 18(7). <https://doi.org/10.3390/ijerph18073571>
- Liesa-Orús, M., Latorre-Cosculluela, C., Vázquez-Toledo, S. and Sierra-Sánchez, V. (2020). The technological challenge facing higher education professors: Perceptions of ICT tools for developing 21st-century skills. *Sustainability (Switzerland)*, 12(13). <https://doi.org/10.3390/su12135339>
- Mallick, B., Lal, S. P. and Gaur, R. S. (2023). Utilization Pattern of Diverse Ict Tools By Coastal Farmers During the Warning Stages of Cyclones. *Gujarat Journal of Extension Education*, 36(1), 90–96. <https://doi.org/10.56572/gjoee.2023.36.1.0017>
- Mallick, Biswajit, Sudhanand, Prasad Lal and Gaur, Rishabh Singh (2023) Utilization pattern of diverse ICT tools by coastal farmers during the warning stages of cyclones. *Gujarat Journal of Extension Education*, 36(1):90-96. <https://doi.org/10.56572/gjoee.2023.36.1.0017>.

- Pratik Kiritkumar Patel and Vinaya Kumar, H. M. (2021). Farmers socio- economic status and constraints using social media for sustainable agriculture development. *Guj. J. Ext. Edu.* 32 (1): 34-39.
- Rathwa, M. S., Christian, B. M. and Patel, D. N. (2024). Relationship Between Farmers' Profile and Their Social Media Utilisation Behaviour. *Gujarat Journal of Extension Education*, 37(1), 82–86. <https://doi.org/10.56572/gjoee.2024.37.1.0013>
- Rubach, C. and Lazarides, R. (2021). Addressing 21st-century digital skills in schools – Development and validation of an instrument to measure teachers' basic ICT competence beliefs. *Comput. Hum. Behav.*, 118. <https://doi.org/10.1016/j.chb.2020.106636>
- Samadder, S., Panday, S. P. and Lal, S. P. (2024). Utilization Pattern of Ict Tools Among Potato Growers To Facilitate Appropriate Agricultural Practices *Gujarat Journal of Extension Education*, 37(1), 39–45. <https://doi.org/10.56572/gjoee.2024.37.1.0006>
- Soledispa, C., Soledispa, M., Mejía, J. and Tomalá, M. (2021). Positive and negative impacts of MOOCs and Webinars in times of COVID-19 Ecuador. *Sinergias Educ.*, 6(2), 1–14. <http://sinergiaseducativas.mx/index.php/revista/>
- Tanis, C. J. (2020). The seven principles of online learning: Feedback from faculty and alumni on its importance for teaching and learning. *Res. Learn. Technol.*, 28, 2020. <https://doi.org/10.25304/rlt.v28.2319>
- Vaishnavi, P. and Ramesh, P. (2023) Relationship between profile characteristics of women SHG members and their empowerment through TNCDW in cuddalore district. *Gujarat Journal of Extension Education*, 35(2):55-58. <https://doi.org/10.56572/gjoee.2023.35.2.0012>.
- Ziemba, E. W. and Eisenhardt, M. (2022). The effect of the COVID-19 pandemic on ICT usage by academics. *J. Comput. Inf. Syst.*, 62(6), 1154–1168. <https://doi.org/10.1080/08874417.2021.1992806>

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