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An ICT-integrated Modular Training Program Enhancing the Digital Research Skills of Research Scholars

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Abstract

The teaching profession in higher education demands strong research skills, and with rapid technological advancements, university teaching professionals must familiarize themselves with digital research skills. Thus, university teachers and PhD research scholars across the globe are eager to develop their digital research skills to enhance their work efficiency. Acquiring digital research skills on the job or during the PhD program has proven to be challenging. These skills assist higher education professionals in various ways, such as supervising doctoral students, conducting research, working on research projects, and publishing research articles.

Thus, the present study attempted to provide ICT-integrated modular training (MT) to facilitate the higher education teaching faculty and PhD scholars with digital research skills. The study employed a repeated cross-sectional research design and measured the effectiveness of the MT through a single group pre and post-test design. Researchers conducted three modular training sessions annually on digital research skills over five consecutive years. In total, 300 scholars attended the training and participated in the pre-test, post-test, and satisfaction survey. Findings from paired sample t-tests (t-value varied between 4.117 to 7.525, $p < 0.05$) revealed that modular training has been significantly effective with a large effect size ($d > 0.8$).

Furthermore, the satisfaction survey revealed a high degree of satisfaction among participants. Future research may explore ways to strengthen the technological and pedagogical content knowledge of modular training programs in developing digital research skills.

KEYWORDS: Digital-Research Skills, Digital Competence, Modular Training, Research Scholars.

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1. Introduction

The introduction of Information and Communication Technologies (ICT) in educational settings has revolutionized the landscape of higher education globally (Yadav et al., 2018). In India, this transformation is particularly significant, given the country's rapid expansion of the higher education sector and the increasing demand for advanced research capabilities (To & Yu, 2020). Currently, India's contribution to academic publications is nearing 8% (Dimitrije, 2023), making it a significant contributor to global research and development. The education sector views ICT as essential for educators (Kruskopf et al., 2024) and higher education institutions. Countries like Morocco have also recognized the need to integrate ICT into researcher training (El Hammoumi et al., 2022). Beyond the education sector, ICT has transformed the operations of individuals across various industries (Benos & Zotou, 2014; Jorgenson & Vu, 2016; Venturini, 2015). It has also been shown to positively impact the construction sector and contribute to project success (Moshood et al., 2020). ICT

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facilitates the integration of technological knowledge globally (Kano et al., 2021), which is why many ICT firms prefer to participate in global innovation networks (Chaminade et al., 2021).

Although ICT faces backlash due to excessive phone usage, time consumption, difficulties in adoption, and resistance to changes in work routines (Stein & Sim, 2020), Myovella et al. (2020) highlighted how education can positively influence ICT usage. ICT is crucial for fostering digital literacy and lifelong learning (Jiménez Sabino & Cabero Almenara, 2021). However, ICT skills are unevenly distributed and tend to be lower among certain demographics, such as the elderly, women, and immigrants (Ben Youssef et al., 2015; Castillo-Merino & Serradell-López, 2014; Fratto et al., 2016a; Vacek & Rybenska, 2015).

They recommend offering free courses tailored to the needs and interests of these groups to improve their ICT skills. Projects such as "ICT Go Girls!" (Fernandez-Morante et al., 2020) can help break down stereotype barriers that prevent women from engaging in ICT. Koutska (2023) advocates for the need for teachers to use ICT tools effectively for teaching and learning, and studies have also addressed the impact of ICT on students' academic performance (Mondal & Culp, 2017; Ramirez et al., 2018). Both Fratto et al. (2016b) and Magalhães et al. (2020) revealed that ICT usage positively impacts academic performance. The importance of its integration has already been emphasized (Abazi & Hajrizi, 2018; Ceker & Uzunboylu, 2016), along with the significance of professional education and certifications in ICT.

The implementation of ICT in the research process is influenced by factors such as access to digital resources, digital skills (Guillén-Gámez et al., 2023), and students' belief in the necessity of ICT for research. Students who consider ICT essential tend to value it more highly, leading to better ICT skills and increased usage (De Wit et al., 2014). According to Khasawneh (2023), ICT can yield beneficial outcomes for research though researchers must be aware of ethical practices. Researchers are more likely to use ICT to analyze research hotspots, innovations, and key authors, shaping the research landscape within the academic community (Zhu et al., 2023).

The current landscape of research skills among scholars in India is characterized by considerable variability (Sahoo et al., 2017). Some scholars exhibit a robust command of digital tools and methodologies, enabling them to conduct sophisticated analyses and effectively disseminate their findings. However, many scholars face challenges in utilizing these tools due to a lack of prior exposure and uneven access to technological resources (Anjaiah, 2016; Krishnamurthy & Shettappanavar, 2019). There is a correlation between ICT usage by professors and their students (Adetimirin, n.d.). Educators must commit to incorporating ICT into their teaching-learning environments through innovative pedagogies, ensuring active participation in the classroom (Durán Cuartero et al., 2016).

While some students and supervisors may view ICT as essential tools that encourage active thinking and support the planning and management of research, others may see ICT as challenging or unnecessary interruptions (Koşar, 2021). Currently, ICT has become an essential skill in educational research, enhancing ideas, improving effectiveness, and facilitating research processes (Stein & Sim, 2020). Estrada Villa et al. (2021) suggest that mobile devices can support digital research processes and improve research skills.

ICT competence varies among university faculties. Many university professors primarily use ICT for searching and accessing information, rather than engaging in more advanced tasks such as data analysis or citation management (Guillén-Gámez et al., 2023). However, conducting research actively promotes digital competence, as research activities encourage professors to enhance their digital skills. Interestingly, while gender does not significantly influence the use of ICT tools among lecturers (Oguguo et al., 2023), teaching experience appears to have a negative impact on overall digital competence. This suggests that more experienced professors may have lower levels of digital proficiency (Guillén-Gámez & Mayorga-Fernández, 2020). Professors with higher digital pedagogical competence tend to achieve better results in their research, and exposure to diverse research environments improves ICT utilization in research (Guillén-Gámez & Mayorga-Fernández, 2020). Therefore, the present study aims to introduce effective ICT-integrated modular training for researchers in higher education to enhance their digital research competence.

2. Theoretical Framework

The following theories guided the present study: Moore's theory of transactional distance, Knowles's adult learning theory, and the principles of modular instruction developed by Goldschmid and Goldschmid. Moore (1997), in his theory of transactional distance, proposes that transactional distance exists in distance education, influenced by instructional dialogue, communication, media, and program structure. The instructional dialogue must be constructive and purposeful, as it is a process in which the most meaningful construction occurs. This is also applicable to the online modular training introduced in the present study to develop digital research competence among researchers in higher education. Furthermore, it is noted that the dialogue is affected by the medium used by both the teacher and the student. Therefore, based on the medium, it is essential to design suitable programs, content, and lesson structures.

Knowles's (1978) adult learning theory outlines several assumptions about how adults learn. Adults possess an evolved concept of self and are intrinsically motivated to learn. They are ready to learn when they have a strong reason to build their knowledge, and the knowledge acquired should be applicable to their daily lives. A self-directed approach to learning is preferred over an instructor-led approach. In the present study, researchers are motivated to attend modular training to enhance their knowledge in research and publications, particularly under the guidance of experts in the field. Adults bring rich prior experiences that instructors must recognize and incorporate into their instruction. In their principles of modular instruction, Goldschmid and Goldschmid (1973) identified three major aspects: content, study time, and sequence. In modular learning, extensive content is divided into smaller modules and arranged sequentially, with each module building on the previous one. The objectives of each content module are clearly communicated to the learner, and study materials are accessible at any time.

An experimental study on improving the digital competence of special education teaching showed a significant increase in problem-solving, internet-browsing, and communication skills among the study participants (Compagno et al., 2016).

An eTwinning international training program with pre and post-webinar event for teachers showed improvement in their technology skills and reported enriching satisfaction with the conducted program (Cinganotto, 2017). An Italian study on E-learning 2.0 included web-2 technologies to supplement classroom learning and reported that online digital training could enhance learning, and participants are more satisfied with the training (Spadavecchia, 2009).

3. Context of the Study

In India, PhD aspirants can pursue their programs in two modes: full-time and part-time. However, coursework is mandatory for both part-time and full-time scholars, typically conducted at the beginning of the PhD program. Doctoral scholars from various disciplines encounter challenges at different stages of their doctoral journey. One of the most significant challenges is writing and publishing two research articles in international academic journals indexed in Scopus or Web of Science. To ensure success in research and publication, scholars require extensive research knowledge and proficient digital research skills. Currently, newer versions of data analysis software are being introduced, which both scholars and professors must master to advance their careers. In the near future, research software may incorporate even more complex artificial intelligence (AI) features, making their adoption inevitable.

However, in India, researchers often lack the digital skills needed for data analysis and scholarly writing. They encounter difficulties in organizing and systematically processing data, as well as performing appropriate statistical tests using research software. Although the doctoral coursework covers aspects of data analysis, the extensive content at that stage increases their cognitive load. Therefore, timely guidance on conducting analysis and editing manuscripts is necessary and can be highly beneficial. This study aimed to provide a unique modular training program for researchers in higher education, referred to as research scholars. The study's operational definition of research scholars includes university teaching staff, project research fellows, research associates, and full-time and part-time PhD scholars at various stages of their doctoral journey. The study sought to assess the effectiveness of its modular training program through a repeated cross-sectional research design. The online training focused on developing digital research skills for both PhD scholars and faculty members.

4. Objectives of the study

The primary objective of this study is to examine the impact of the ICT-integrated modular training (MT) program on enhancing the digital research skills of researchers in higher education. Researchers include doctoral students, university teachers, and project fellows. Therefore, the researchers have framed the following specific objectives:

- To measure the impact of an ICT-integrated modular training programme through single group pre-test and post-test design over a period of 5 consecutive years.
- To determine the participants' learning satisfaction level of digital research skills through the ICT-integrated modular training programme.

5. Method

5.1 Study design

The study employed a quasi-experimental design with a repeated measure cross-sectional data analysis. The quasi-experiment included a pre-test and post-test single-group design.

5.2 Sample of the Study

The study sample included researchers such as faculty members, doctoral students, and project associates from Universities across India who attended the ICT-integrated MT. The training has been conducted three times a year for five successive years. The researchers restricted the cohort size to 20 to 30 per session. The cohort size is restricted between 20 and 30 as this is training in data analysis, and the facilitator could engage them meaningfully and troubleshoot their technical hiccups quickly, which is otherwise difficult. Eventually, the researcher could collect data from 300 researchers who successfully participated. Further, the study conducted a satisfaction survey to understand the impact of the modular training program in developing digital research skills. Table 1 below presents the sample of the study.

Table 1- Showing the details of the study sample.

Total years of training	5
Training sessions/ year	3
N/ training session	20
Total Participants in 5 years	300
Participants age range in years	26-50
Participants Designation	Faculty members/ Doctoral students/ Project associates

The ICT-integrated modular training included modules on quantitative data analysis, qualitative data analysis, and research publications. That included ICT tools such as SPSS software, Dedoose, Open access sources for data collection, publication databases, and reference management software. Table 2 presents the details of the modules of modular training.

At each modular training session, the researcher administered a pre-test at the beginning, provided hands-on training, and administered a post-test. The pre-test or post-test had 50 questions in total. Each question was for three marks. Therefore, the minimum score can be 0, and the maximum is 150. A satisfaction survey was also conducted as and when modular trainings were completed. The nature of modular training is usually an expert demonstration followed by interactive in-class exercises to be practiced by participants on a computer device under the supervision of the expert teacher.

Each year, training on quantitative data analysis, qualitative data analysis, and research publication was conducted for five years. Each session had a new set of participants. Thus, pre-test, post-test, and learning-satisfaction-scale were administered at the end of each training session.

As the study followed a single-group pre-test and post-test quasi-experimental design, the researchers planned to conduct parametric or non-parametric differences in mean tests based on the normality test results. The difference in mean score would measure the impact of ICT-integrated modular training in developing digital research skills. Furthermore, the researchers planned to administer a learning satisfaction survey at the end of each training session to understand learner satisfaction.

Table 2 - Showing the training modules' details of modular training sessions.

Training modules on quantitative data analysis (Statistical Package for the Social Sciences-SPSS)
Data entry, Data cleaning, Data setting, basic working knowledge, normality testing, descriptive statistical analysis, parametric tests: Chi-square, t-tests, ANOVA, ANCOVA, MANOVA, Correlation, Regression, Graphs and charts, Cronbach alpha, Factor analysis.
Training modules on qualitative data analysis (Dedoose)
Organise qualitative research data: Text, audio, video, pictures, images. Data Coding, Word clouds, Data mining, Excerpting, Memos. Plots, tables, charts, graphs, Working with projects, Inter-rater reliability, Data filtering, exporting, Document searching
Training modules on research publication
Research search engines: CORE, Microsoft Academics, BASE, Semantic scholar, PubMed, Google Scholar. Research Data bases: Scopus, Web of science, Master journal list Clarivate analytics, DOAJ, Ebsco, JSTOR, Wiley, Our world in Data, Survey monkey, Redcap, Scimago, Resurchify. Reference mangers: Mendeley, Zotero, Grammarly, Journal templates, Journal guidelines, Submission sites and processes.

5.3 Validity of the Learning Satisfaction Survey Questionnaire

Researchers constructed a learning satisfaction survey questionnaire to assess the satisfaction levels of participants in the ICT-integrated modular training program. The survey initially included twelve components, but after removing overlapping ideas based on the expert panel's feedback, eight components were retained: efficiency, interaction, perceived usefulness, ICT integration, learning flexibility, personalization, practice opportunity, and delivery style. These components were included in the satisfaction survey based on the digital research tasks embedded in the intervention. Researchers established face validity and content validity through a panel of experts. Responses to the questionnaire were measured on a 5-point Likert scale ranging from strongly agree (SA) to strongly disagree (SD).

Furthermore, the reliability of the survey questionnaire was assessed using Cronbach's alpha internal consistency test. During pilot testing, the Cronbach's alpha coefficient was found to be 0.86, indicating that the questionnaire is highly reliable (Nunnally, 1978). Figure 1 in the results section presents the satisfaction ratings revealed by the training program participants.

5.4 Ethical Considerations

The study sought permission from the Institutional Review Board (IRB) to conduct the research. The researchers adhered to the ethical guidelines established by the IRB. They ensured participant confidentiality, obtained informed consent, and stored the data securely in a password-protected file accessible only to the researchers.

6. Results

The results of the study are presented in two sections. Section one presents the results of the experimental impact, and section two presents the satisfaction survey result. Table 3 presents the results of the Normality tests. Table 4 presents the descriptive statistical result, Table 5 presents the inferential statistical result of the experiment, and Table 6 presents the effect size of the paired sample t-test.

Table 3 indicates the Kolmogorov-Smirnov normality test results and the Shapiro-Wilk normality test. As the sample size is small (< 50), we shall utilize Shapiro-Wilk statistics to interpret the normality. Accordingly, the mean scores between the post-test and pre-test of all the years' training sessions are normal ($p > 0.05$). Thus, researchers decided to analyze the study data using a parametric t-test.

However, Table 4 presents the preliminary descriptive analysis before conducting the paired sample t-test statistics. The mean value of post-test scores is higher in all the training sessions conducted for five successive years. Post-test mean scores were highest in 2nd training session of year one and first training session of year 3. The average range value was found to be 135. That means the highest score minus the lowest score for each session. Overall, there has been a consistent increase in the mean post-test score in all five years and at each time of the modular training sessions held.

Table 5 presents the inferential statistical analysis result of paired sample t-test. Results in Table 5 indicate that the ICT-integrated modular training programme had enhanced the researchers' digital-research skills. A statistically significant difference existed in the mean scores of the pre-test and post-test of all the modular training sessions successively for all five years. In the first year, the first training session had a significant mean difference ($t = 4.122$, $p < 0.001$). The first year's second and third training sessions also had a significant mean difference ($t = 7.525$, $p < 0.001$) and ($t = 7.325$, $p < 0.001$), respectively. In the second year, the first training session had a significant mean difference ($t = 7.149$, $p < 0.001$). The second year's second and third training sessions also had a significant mean difference ($t = 6.948$, $p < 0.001$) and ($t = 7.024$, $p < 0.001$), respectively. In the third year, the first training session had a significant mean difference ($t = 4.185$, $p < 0.001$). The third year's second and third training sessions also had a significant mean difference ($t = 4.142$, $p < 0.001$) and ($t = 4.189$, $p < 0.001$), respectively. In the fourth year, the first training session had a significant mean difference ($t = 4.117$, $p < 0.001$). The fourth year's second and third training sessions also had a significant mean difference ($t = 4.127$, $p < 0.001$) and ($t = 4.117$, $p < 0.001$), respectively. In the fifth year, the first training session had a significant mean difference ($t = 4.189$, $p < 0.001$). The fifth year's second and third training sessions also had a significant mean difference ($t = 4.186$, $p < 0.001$) and ($t = 4.123$, $p < 0.001$), respectively.

Table 6 presents the effect size (d) of all the paired sample t-test results, indicating the strength of the significant difference. It presents Cohen's d effect size and effect size with Hedges' correction. The conventional interpretation of Cohen's effect size is if $d = 0.2$ small effect, if $d = 0.4$ medium effect, and if $d = 0.8$ large effect. Similarly, the conventional interpretation of Hedges correction (g) varies from $g = 0.15$ small effect, if $g = 0.40$ medium effect, and if $g = 0.75$ large effect (Cohen, 1988; Lakens, 2013). From Table 4, Cohen's (d) point estimate values ranged from 0.884 to 1.683 and are > 0.8, indicating a large effect size. Furthermore, Hedge's correction (g) values ranged from 0.884 to 1.615 and are > 0.75, indicating a large effect size. Thus, these results indicate the strength of the ICT-integrated modular training program.

The survey result yielded a high degree of satisfaction and is presented below. Figure 1 presents the satisfaction survey results the study participants responded to after completing each modular training session. It had eight items to respond to on a 5-point Likert scale varying from strongly agree (SA) to disagree strongly (SDA). Figure 1 below presents the average satisfaction survey scores for 15 sessions conducted in five consecutive years. Figure 1 shows that the participants are highly satisfied with the ICT-integrated modular training program they participated in. Most participants rated 4 (agree) and 5 (Strongly agree) to each program component, and very few or no participants rated the programme components as neutral (3), disagree (2), or strongly disagree (l). Thus, it indicates that the participants are satisfied with the modular training program and that it successfully developed their digital research skills. Further, from the modular training program's eight survey components (Efficiency, Interaction, Perceived usefulness, ICT integration, Learning flexibility, Personalisation, Practice opportunity, and Delivery style). Survey participant ratings were high for the components program's delivery style and perceived usefulness.

Table 3 - Shows the results of the Normality test.

Year wise training sessions conducted	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Year 1, Training I	.136	20	.200*	.942	20	.259
Year 1, Training II	.144	20	.200*	.943	20	.271
Year 1, Training III	.137	20	.200*	.940	20	.244
Year 2, Training I	.130	20	.200*	.948	20	.339
Year 2, Training II	.141	20	.200*	.933	20	.179
Year 2, Training III	.140	20	.200*	.934	20	.185
Year 3, Training I	.125	20	.200*	.942	20	.266
Year 3, Training II	.137	20	.200*	.941	20	.251
Year 3, Training III	.139	20	.200*	.940	20	.245
Year 4, Training I	.137	20	.200*	.940	20	.242
Year 4, Training II	.159	20	.198	.955	20	.447
Year 4, Training III	.136	20	.200*	.943	20	.270
Year 5, Training I	.139	20	.200*	.941	20	.246
Year 5, Training II	.126	20	.200*	.943	20	.268
Year 5, Training III	.136	20	.200*	.940	20	.243

Note: Where Y1, Y2, Y3, Y4, & Y5 stand for years one to four. I, II, & III are training session numbers in a particular year.
*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 4 - Showing the descriptive statistical result of Modular training sessions.

Year & Modular Training	(Pre-Post test)	Mean	N	Std. Deviation	Std. Error Mean
Year 1, Training I	Post-test	64.30	20	41.303	9.236
	Pre-test	51.30	20	40.467	9.049
Year 1, Training II	Post-test	69.65	20	41.803	9.347
	Pre-test	46.30	20	40.467	9.049
Year 1, Training III	Post-test	67.35	20	41.243	9.222
	Pre-test	44.30	20	40.467	9.049
Year 2, Training I	Post-test	68.35	20	41.242	9.222
	Pre-test	45.70	20	40.306	9.013
Year 2, Training II	Post-test	66.35	20	41.271	9.228
	Pre-test	43.85	20	40.737	9.109
Year 2, Training III	Post-test	65.35	20	41.230	9.219
	Pre-test	42.80	20	41.526	9.285
Year 3, Training I	Post-test	69.40	20	41.396	9.256
	Pre-test	56.25	20	40.286	9.008
Year 3, Training II	Post-test	67.30	20	41.319	9.239
	Pre-test	54.30	20	40.343	9.021
Year 3, Training III	Post-test	68.35	20	41.344	9.245
	Pre-test	55.20	20	40.297	9.011
Year 4, Training I	Post-test	66.30	20	41.303	9.236
	Pre-test	53.30	20	40.320	9.016
Year 4, Training II	Post-test	65.30	20	41.371	9.251
	Pre-test	52.30	20	40.290	9.009
Year 4, Training III	Post-test	67.30	20	41.331	9.242
	Pre-test	54.30	20	40.313	9.014
Year 5, Training I	Post-test	67.40	20	41.448	9.268
	Pre-test	54.20	20	40.344	9.021
Year 5, Training II	Post-test	68.30	20	41.360	9.248
	Pre-test	55.20	20	40.339	9.020
Year 5, Training III	Post-test	66.30	20	41.440	9.266
	Pre-test	53.30	20	40.342	9.021

Note: Where Y1, Y2, Y3, Y4, & Y5 stand for years one to four. I, II, & III are training session numbers in a particular year.

Table 5 - Showing the result of the Paired-sample t-test for the Modular training session.

Modular training		Paired Differences					*t*	*df*	Significance	
		Mean	SD	Std. Error Mean	95% Conf. Interval Lower	Upper			One-Sided *p*	Two-Sided *p*
Y1, I	Pre, Post test	13.000	14.105	3.154	6.399	19.601	4.122	19	<.001	<.001
Y1, II	Pre, Post test	23.350	13.876	3.103	16.856	29.844	7.525	19	<.001	<.001
Y1, III	Pre, Post test	23.050	14.073	3.147	16.464	29.636	7.325	19	<.001	<.001
Y2, I	Pre, Post test	22.650	14.169	3.168	16.019	29.281	7.149	19	<.001	<.001
Y2, II	Pre, Post test	22.500	14.482	3.238	15.722	29.278	6.948	19	<.001	<.001
Y2, III	Pre, Post test	22.550	14.358	3.211	15.830	29.270	7.024	19	<.001	<.001
Y3, I	Pre, Post test	13.150	14.054	3.142	6.573	19.727	4.185	19	<.001	<.001
Y3, II	Pre, Post test	13.000	14.038	3.139	6.430	19.570	4.142	19	<.001	<.001
Y3, III	Pre, Post test	13.150	14.039	3.139	6.580	19.720	4.189	19	<.001	<.001
Y4, I	Pre, Post test	13.000	14.053	3.142	6.423	19.577	4.137	19	<.001	<.001
Y4, II	Pre, Post test	13.000	14.086	3.150	6.407	19.593	4.127	19	<.001	<.001
Y4, III	Pre, Post test	13.000	14.120	3.157	6.392	19.608	4.117	19	<.001	<.001
Y5, III	Pre, Post test	13.200	14.092	3.151	6.605	19.795	4.189	19	<.001	<.001
Y5, III	Pre, Post test	13.100	13.996	3.130	6.550	19.650	4.186	19	<.001	<.001
Y5, III	Pre, Post test	13.000	14.101	3.153	6.400	19.600	4.123	19	<.001	<.001

Note: Where Y1, Y2, Y3, Y4, & Y5 stand for years one to four. I, II, & III are training session numbers in a particular year.

Table 6 - Shows the effect size for the Paired Sample *t*-test.

Effect sizes Cohen's d and Hedges' correction for all the training sessions			Standardizer[a]	Point Estimate	95% Confidence Interval Lower	Upper
Year 1, Training I	Post – Pre test	Cohen's d	14.105	.922	.387	1.439
		Hedges' correction	14.694	.885	.372	1.382
Year 1, Training II	Post – Pre test	Cohen's d	13.876	1.683	.985	2.362
		Hedges' correction	14.456	1.615	.946	2.267
Year 1, Training III	Post – Pre test	Cohen's d	14.073	1.638	.951	2.306
		Hedges' correction	14.661	1.572	.913	2.214
Year 2, Training I	Post – Pre test	Cohen's d	14.169	1.599	.921	2.258
		Hedges' correction	14.761	1.534	.884	2.167
Year 2, Training II	Post – Pre test	Cohen's d	14.482	1.554	.887	2.202
		Hedges' correction	15.087	1.491	.851	2.114
Year 2, Training III	Post – Pre test	Cohen's d	14.358	1.571	.900	2.223
		Hedges' correction	14.958	1.508	.864	2.134
Year 3, Training I	Post – Pre test	Cohen's d	14.054	.936	.399	1.456
		Hedges' correction	14.640	.898	.383	1.397
Year 3, Training II	Post – Pre test	Cohen's d	14.038	.926	.391	1.444
		Hedges' correction	14.624	.889	.375	1.387
Year 3, Training III	Post – Pre test	Cohen's d	14.039	.937	.400	1.457
		Hedges' correction	14.625	.899	.383	1.399
Year 4, Training I	Post – Pre test	Cohen's d	14.053	.925	.390	1.443
		Hedges' correction	14.639	.888	.374	1.385
Year 4, Training II	Post – Pre test	Cohen's d	14.086	.923	.388	1.441
		Hedges' correction	14.674	.886	.373	1.383
Year 4, Training III	Post – Pre test	Cohen's d	14.120	.921	.386	1.438
		Hedges' correction	14.709	.884	.371	1.381
Year 5, Training I	Post – Pre test	Cohen's d	14.092	.937	.399	1.457
		Hedges' correction	14.681	.899	.383	1.399
Year 5, Training II	Post – Pre test	Cohen's d	13.996	.936	.399	1.456
		Hedges' correction	14.580	.898	.383	1.398
Year 5, Training III	Post – Pre test	Cohen's d	14.101	.922	.387	1.440
		Hedges' correction	14.690	.885	.372	1.382

a. The denominator is used to estimate the effect sizes. Cohen's d uses the sample standard deviation of the mean difference. Hedges' correction uses the sample standard deviation of the mean difference plus a correction factor.

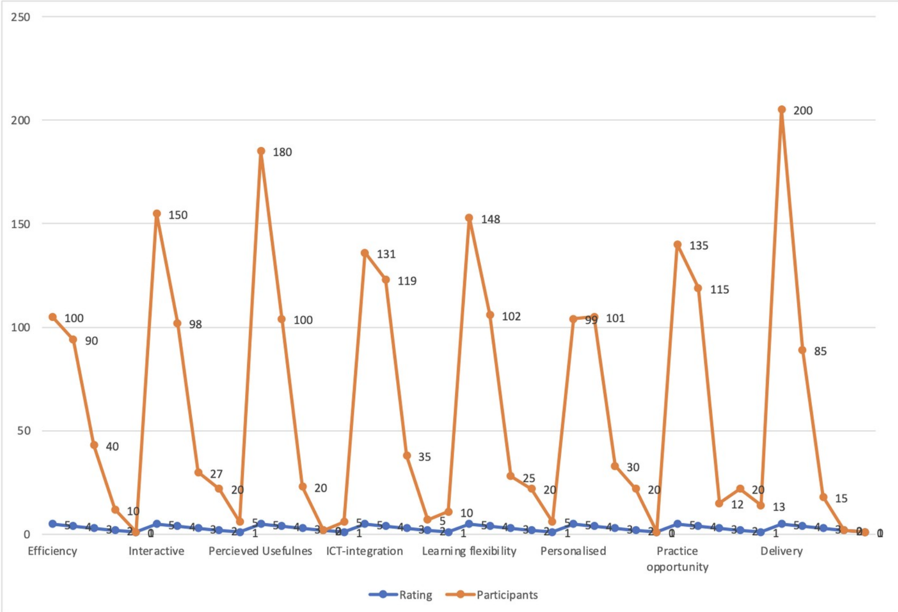

Figure 1 - Presents the results of the satisfaction survey.

7. Discussion

The present study aimed to examine whether the ICT-integrated modular training (MT) program enhances the digital research skills of researchers in higher education. The researchers involved include faculty members from universities or colleges, doctoral scholars, and research associates. The research confirmed that the program enhanced their digital research skills and that they were satisfied with the modular instruction.

Thus, the present study achieved its intended objectives by employing a quasi-experimental research design. The study measured the impact of ICT-integrated modular training through repeated measure cross-sectional design with the administration of single group pre and post-tests three times a year for a period of five consecutive years. The present study revealed that the modular training sessions on quantitative data analysis, qualitative data analysis, and research publication via digital software and various e-resources have successfully developed research scholars' digital research skills. Similar observations are found by (Cavite & Gonzaga, 2023). A recent study by Ambayon (2020) found that modular instruction improved achievement in literature. As ICT-integrated research data analysis and publication learning demands immense scholarly knowledge, learning them with ICT and software makes it even more complicated when taught in a non-modular approach. In the present study, modular instructions have enhanced learning productivity despite learning digital research skills via software and the more profound background domain knowledge.

All the pre-test and post-test scores showed a significant difference in the mean scores after each modular training session, and their effect size was also large. This articulates the lasting effect of modular learning or nano-learning and agrees with the recent work (Yousef et al., 2023).

The present study makes a unique contribution to existing training practices in higher education. Until recently, research scholars worldwide received data analysis and academic writing skills through lengthy workshops, semester-long coursework, or intensive faculty development programs. The impact of these methods was found to be weak, and participants in these learning modes tended to be passive.

With the advent of various new digital resources for conducting research and data analysis, along with artificial intelligence-enabled digital software, the traditional approach to training scholars in research skills is becoming less effective. Additionally, research has found that the attention spans of Generation Z and Generation Alpha learners are declining (Lamsal, 2022; Hermawati et al., 2018). Therefore, modular or nano-training significantly equips scholars with more sophisticated digital research skills (Hamilton et al., 2021). Modular training is effective as it caters to learners' short attention spans and engages their metacognitive processes, allowing them to learn small-sized content more effectively. This is supported by the present study and aligns with the findings of Vivekananth (2022).

The satisfaction survey administered to participants of the modular training program revealed a high level of satisfaction with their learning experiences through the modular approach, and they exhibited enhanced digital research skills compared to their capabilities before the training. A similar observation was noted by Mwangi (2023). Participants indicated that the ICT-integrated interactive modular training program incorporated effective time management, facilitated high levels of peer interaction, and imparted valuable research analysis skills in each module. They found the combination of software and online resources to be appropriate and appreciated the flexible approach to developing their digital research skills. A recent study reported analogous findings (Emara et al., 2023). Furthermore, the training sessions provided individualized attention to participants' learning and offered ample practice opportunities. Given that the information was presented in manageable chunks, participants were able to comprehend 100% of the material.

Earlier studies which are similarly in agreement with the present study are mostly at school level teaching; an experimental study on improving the digital competence of special education teaching showed a significant increase in problem-solving, internet-browsing, and communication skills among the study participants (Compagno et al., 2016). An eTwinning international training program with pre and post webinar event for teachers showed improvement in their technology skills and reported enriching satisfaction with the conducted programme (Cinganotto, 2017). An Italian study on E-learning 2.0 included web-2 technologies to supplement classroom learning and reported that online digital training could enhance learning, and participants are more satisfied with the training (Spadavecchia, 2009). The present study stands out as unique as higher education learners with the age range of 26 to 50 and especially on digital research data analysis skills with theoretical background knowledge had an improved research productivity. Research productivity is the most important contributor to the economic prosperity of the country and the world (Jorgenson & Vu, 2016).

8. Conclusion

Overall, the study on ICT-integrated modular training programs aimed at enhancing the digital research skills of research scholars has significantly contributed to the development of digital research skills among both scholars and faculty members. Their learning satisfaction also remained high. Given the technological advancements and the diminishing attention span during long lecture hours, educators are encouraged to adopt a more modular approach to their teaching and learning processes. Unlike traditional, lengthy training practices, modular training enhances students' learning and engagement. Students can maintain focus as the content is presented in smaller segments, which alleviates cognitive overload, provides ample practice time, reduces the duration of teaching, and minimizes learning anxiety and stress. However, the present study has its limitations regarding sampling. Specifically, participation was voluntary, data were collected over a five-year period, the data were not analyzed based on demographic differences, and all types of scholars were treated as researchers.

Since a different set of participants was involved in the study each time, the generalizability is limited despite the observed significant differences. Furthermore, the learning satisfaction questionnaire, along with the pre-test and post-test tools, was constructed by the researchers, and the lack of standardization limits the generalizability of the research. Future research could conduct modular training for each module with a larger sample to achieve better generalizability.

As modular training has gained popularity in recent years, particularly in the post-pandemic era and with the given context of technological advancements, future researchers must gather sufficient evidence of its effectiveness to understand the paradigm shift it is bringing to Generation Z and Generation Alpha learners Consequently, researchers highlight the necessity for both quantitative and qualitative research to gain a deeper understanding of the nuances of modular or nano training.

Conflict of interest

The authors of this study affirm that they have no competing interests. We extend our gratitude to all the participants for their cooperation throughout the study.

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Appendix - Satisfaction survey

Items of the satisfaction survey	Strongly Dis-agree (1)	Dis-agree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
I found the ICT-integrated modular training workshop efficient					
I found the ICT-integrated modular training workshop interactive					
I found the ICT-integrated modular training workshop useful					
I found the ICT-integrated modular training workshop had sufficient ICT-tools integration					
I found the ICT-integrated modular training workshop had learning flexibility					
I found the ICT-integrated modular training workshop personalised					
I found the ICT-integrated modular training workshop had enough opportunity for practice					
I found the ICT-integrated modular training workshop had appropriate style of content delivery					