

ORIGINAL ARTICLE



ASSESSING THE LEVEL OF DIGITAL LITERACY AMONG BACHELOR OF EDUCATION (NATURAL SCIENCES) UNDERGRADUATES IN AN OPEN AND DISTANCE LEARNING CONTEXT

F.M. Nawastheen^{*1}; W.M.A.P.S. Fernando ²; N.M.M. Safeek ³

¹ Department of Secondary & Tertiary Education, Faculty of Education, The Open University of Sri Lanka, Sri Lanka. Email: fmnaw@ou.ac.lk

² Department of Secondary & Tertiary Education, Faculty of Education, The Open University of Sri Lanka, Sri Lanka. Email: wmfern@ou.ac.lk

³ Faculty of Education, University of Colombo, Sri Lanka. Email: safeek@edpsy.cmb.ac.lk

*Corresponding author

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Abstract

This study investigated the digital literacy skills of Bachelor of Education (Natural Sciences) undergraduates at a Sri Lankan university which offers its programmes via an open and distance learning mode. The research employed a mixed method research design. A questionnaire was administered to 40 students to evaluate their digital literacy levels and explore demographic variations. Data analysis using non-parametric tests revealed a moderate to high overall proficiency, with the highest mean score in safety and security and the lowest in communication and collaboration. The Mann-Whitney U test indicated no significant gender-based differences across the five digital literacy domains. The Kruskal-Wallis H test showed no significant differences in most digital literacy skills across age groups and levels of study, except for safety and security, where younger students showed higher proficiency. Ordinal logistic regression suggested that gender, age, and level of study did not significantly influence overall digital literacy levels. The findings highlight the need for continued efforts to enhance digital literacy, particularly in communication and collaboration, for all students, while also noting the strengths in safety and security, especially among younger learners.

Keywords: assessment; digital literacy; Bachelor of Education; Open University of Sri Lanka

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Introduction

Literacy, encompassing the lifelong development of reading, writing, and numeracy skills, remains a cornerstone of personal and societal advancement (UNESCO Institute for Statistics, 2008). In the context of the Fourth Industrial Revolution, digital literacy has emerged as a critical dimension of literacy, equipping individuals to navigate an increasingly technology-driven world. Spante et al. (2018) define digital literacy as the confident, critical, and creative use of ICT to perform tasks, manage information, and communicate effectively, with applications in education, employment, and societal participation. This multifaceted construct includes computer literacy, information and communication technology (ICT) literacy, information literacy, and media literacy. Similarly, the European Commission (2018) employs the term “digital competence” to describe the critical, responsible, and innovative engagement with digital technologies for learning, professional activities, and societal participation, emphasizing skills such as data literacy, collaboration, digital safety, problem-solving, and critical thinking.

The concept of digital literacy was first articulated by Paul Gilster in 1997, who characterized it as the ability to access and utilize information across diverse digital platforms, extending beyond mere technical proficiency (Bashar & Naaz, 2024). Covello (2010) positions information literacy as a subset of digital literacy, encompassing competencies in computer literacy, media literacy, visual literacy, technological literacy, and communication literacy. Nguyen and Habok (2023) further delineate six sub-cognitive dimensions of digital literacy: photo-visual literacy (interpreting multimedia content), reflective literacy (synthesizing cohesive outputs from multiple sources), branching literacy (navigating and organizing information), information literacy (critically evaluating information), socio-emotional literacy (adhering to digital norms), and real-time thinking literacy (processing multiple stimuli concurrently). These competencies collectively enable individuals to address the demands of a digital society effectively (de Witt & Gloerfeld, 2018).

The rapid proliferation of digital technologies has fundamentally transformed human interaction, communication, and learning, necessitating a robust education in digital literacy to empower individuals to leverage technology for their daily needs (Simpson & Obdalova, 2014). In higher education, institutions bear the responsibility of equipping students with ICT skills and digital literacy to prepare them for the workforce, lifelong learning, and ethical participation in a technology-centric society (Brankov, 2022). The exponential growth of online information underscores the need for critical thinking, information management, and ethical decision-making to navigate the digital landscape. For undergraduate students, digital literacy represents a quintessential 21st-century skill, indispensable for academic success and professional readiness. The Sri Lankan university, which operates in open and distance learning mode, offers a wide range of programmes from certificate courses to postgraduate degrees through its six faculties, including the Faculty of Education (FoE). (Nawastheen et al., 2024). The FoE has been offering the Bachelor of Education (B.Ed.) in Natural Sciences programme since 1993. The degree programme is available in Sinhala, Tamil, and English mediums. To facilitate engagement with this ODL system, incoming students are required to complete continuing education courses that provide foundational ICT and digital skills. However, as prospective educators, B.Ed. (Natural Sciences) graduates are expected to demonstrate proficiency in utilizing digital tools and resources to design engaging and

effective learning experiences. Despite the provision of introductory ICT training, the extent to which these students possess advanced digital literacy skills remains underexplored.

Research Problem

It was noted that even though the B.Ed. (Natural Sciences) program at the Sri Lankan ODL university includes a foundational ICT training within its curriculum, there is only a limited body of evidential information that explains the comprehensive digital literacy skills of its students. However, due to the increasing tendency towards integrating digital tools in both the learning and teaching processes efficiently, it is vital that one assesses the digital literacy and proficiency of the intended group of students.

Purpose and Research Questions

The primary objective of this study is to evaluate the digital literacy skills possessed by the B.Ed. (Natural Sciences) students. Precisely, the study plans to drive the research on the following criteria: the students' digital literacy levels, the variations of literacy skills based on demographic factors and other principal factors that catalyst the development of digital literacy skills within this specimen of students.

To achieve this primary objective, the study is guided by the following research questions:

- What are the levels of digital literacy skills among B.Ed. (Natural Sciences) students?
- Do digital literacy skills vary according to students' gender, age group, or level of study?
- What factors contribute to the development of digital literacy skills among these students?

Literature Review

The rapid integration of digital technologies into higher education, particularly within open and distance learning (ODL) environments, underscores the importance of digital literacy and competence for students and educators. The literature review is built on the following pillars of existing literature and information. Consequently, it amalgamates key frameworks, empirical studies, and applications of digital competencies within the limitations that are defined by their relevance to the B.Ed. (Natural Sciences) students at the Sri Lankan university. In addition, it explores conceptual models, skill areas, variations in gender and academic level, and gaps in literature, providing a sound understructure that help comprehend digital literacy in the context of ODL.

Digital Literacy Frameworks

To recognize and evaluate the skills that are needed to perform adequately in a technology driven environments, digital literacy frameworks can provide well-assembled models. Such frameworks align with numerous factors such as educational policies, curricula, and certification standards which offers clear guidelines to foster digital competencies. Similarly, there are internationally recognized frameworks developed for this purpose. Among them, a few are named as the following. The UNESCO Global Framework for Digital Literacy, the UNESCO Media and Information Literacy (MIL) Framework, the OECD Skills for a Digital World Framework, and the European

Commission's Digital Competence Framework for Citizens (DigComp) (Carretero, et al., 2017). However, among these, the "DigComp" framework is widely adopted by scholars as it stands prominent among other frameworks due to its coherent composition. In a similar stance, the study identifies the DigComp framework as the ideal reference point.

Digital Competence Framework for Citizens (DigComp)

The European Commission developed the "DigComp" framework that categorizes digital competences into 21 skills across five principal areas: namely, information and data literacy, communication and collaboration, digital content creation, safety, and problem-solving (Carretero et al., 2017). The first core framework, "Information and data literacy", embodies browsing, evaluating, and managing digital content. Second, "communication and collaboration" includes a more communal approach where one learns to interact, share, and collaborate via digital means. It is also highlighting that one's online behavior and identity adheres to the netiquette. Third, "digital content creation" focuses on developing and sharing digital content with copyright and licensing limitations strictly in mind. Next, "safety" emphasizes on ensuring a safe and protective environment for devices, personal data, and other involving parties. Finally, "problem-solving" revolves around overcoming technical boundaries, identifying needs, and applying precise technological remedies when needed. In conclusion, it is apparent that the above framework demonstrates a high relevancy to ODL students as it empowers technical proficiency and higher-order skills such as critical thinking and ethical decision-making (Sousa & Rocha, 2019)

Application of Digital Competencies in Education

In order to prepare students towards achieving sound academic and professional goals in a digital setting, digital competencies are crucial. The following are the five major "DigComp" areas that are explored in the arena of educational applications with relevance to pursuers of the B.Ed. Degree programme.

Information and Data Literacy

In an era where information received online are constantly consumed, it is mandatory that students develop skills that help them access, evaluate and manage data efficiently. This comprises of utilizing tools that help synthesize information. Evaluate their accuracy and present any observations with precision. Since the B.Ed. students are required to develop and deliver data-driven lesson plans via comprehensive and thorough research with relation to ODL environments, training them to harbor such skills will help them stand well-aligned to their course curriculum.

Communication and Collaboration

When discussing about the next core concept, it is apparent that engagement with peers and global communities is enabled through the meticulous arrangement of digital communication and collaboration. Similarly, to foster collaboration, the receipt of adequate training in digital tools such as E-mail, social media, video conferencing along with popular applications such as Google Docs and Microsoft Teams by students is essential. Educators can facilitate such an environment by creating opportunities for students to share information, participate in cross-cultural projects, and practice ethical online behavior. It is vital that such executions are practiced by B.Ed. students

since in future, they must ensure collaborative learning in a safe and professional setting (Koh & Kan, 2021).

Digital Content Creation

Producing digital content in the form of videos, presentation, or infographics, provides a pragmatic and positive development towards the students' creativity when communicating effectively. Consequently, training programs should include initiatives where they create content for diverse platforms such as blogs, social media, or educational websites while customizing them to meet specific audience expectations.

Safety

Within online learning environments, digital safety is identified a thoroughly observed practice. In a similar stance, B.Ed. students must possess adequate knowledge on precautions and preventive measures that help them act against malicious practices in the cyber space. They must be counteractive against phishing and/or cyberbullying that pose a threat to their passwords and financial details. Consequently, B.Ed. students should be equipped with safety methodologies so that they transfer the said knowledge to their own students. Thus, in a pragmatic attempt safeguard a students' safety, the teachers ensure their own digital safety as well.

Problem-Solving

To solve problems that arise in a digital context, it is important to address technical issues, use software tools creatively and identify technological solutions to meet specific needs. By assigning students data analysis tasks while engaging them in coding and troubleshooting exercises can further develop this competency. For B.Ed. students, such skills will help them address classroom challenges effectively when they deliver technology-driven lessons in the future.

Digital Competence in Higher Education and ODL

In higher education, particularly in ODL settings where students depend on digital platforms to learn and interact with peers, digital competency appears to be a vital factor. According to Audrin and Audrin (2022), there are four key themes in research related to digital competency. Namely, digital skills, digital thinking, digital competencies, and digital literacy. Similarly, while the foundation is formed by technical skills, It is noted that advanced skills such as critical evaluation and virtual collaboration to be critical factors that contribute towards academic success. Moreover, Basillota-Gómez-Pablos et al. (2022) noted that while university students are frequently equipped with the foundational digital skills, they require additional targeted training to acquire more advanced competencies. Similarly, this declaration appears to be highly resonant with B.Ed. students who plan to incorporate technology into their teaching methods.

Empirical studies highlight the link between digital competence and academic outcomes. Gutiérrez-Castillo et al. (2017) found that digital competence positively correlates with academic performance, influenced by access to resources and prior ICT training. In ODL contexts, students with stronger digital skills had higher academic success, underscoring the importance of digital competence for self-directed learning in online courses (Pérez-Escoda et al. 2021). Connectivity

issues and limited technological knowledge can significantly hinder digital literacy development in ODL settings, particularly post-COVID-19 (Hodges et al., 2020). These barriers are especially relevant in developing countries, where infrastructure challenges may exacerbate skill gaps.

The link between digital competencies and one's academic outcome has been made known via empirical studies. According to Gutiérrez-Castillo et al. (2017), academic performance is positively affected by digital competence specially when exposed to prior ICT training and the effortless availability of resources. In ODL contexts, higher academic success was obtained by students who showcased robust digital skills and thus highlighted the importance of digital competence to excel in self-directed virtual classrooms (Pérez-Escoda et al. 2021). Consequently, digital development literacy could encounter solid barriers when connectivity issues and limited technological knowledge are present, particularly post-COVID 19 (Hodges et al., 2020). This situation is specially noted in developing countries since their weak infrastructure systems exacerbate the skill gaps.

Gender and Academic Level Variations

Research on gender differences in digital competence yields mixed results. Cabezas-González et al. (2021) found no significant gender disparities in ODL settings, attributing this to equitable access to resources and training. However, Lin et al. (2023) identified differences in teachers' digital teaching competence in rural Chinese contexts, with gender and socioeconomic factors, such as access to technology and training, influencing their ability to empower students in digital learning environments. Hatlevik et al. (2015) observed that upper-level students tend to exhibit greater digital competence due to prolonged exposure to digital tools, highlighting the need for progressive skill development in ODL programs.

Research Gaps

Despite advances in digital competence research, several gaps remain. Audrin and Audrin (2022) noted a lack of ODL-specific frameworks, as most models target pre-university or teacher education contexts. While teacher digital competence has been widely studied (Basillota-Gómez-Pablos et al., 2022), less focus has been given to student teachers in ODL settings, such as B.Ed. programs. Kallas and Pedaste (2022) advocate for further exploration of contextual factors, such as institutional support and cultural influences, that shape digital competence in ODL environments. These gaps highlight the need for targeted research on B.Ed. students at ODL contexts.

Relevance to B.Ed. Students at ODL contexts

The literature underscores the critical role of digital competence for B.Ed. (Natural Sciences) students in ODL contexts, who must master digital tools to succeed in ODL and prepare for technology-enhanced teaching. The DigComp framework's skill areas such as information literacy, communication, content creation, safety, and problem-solving are essential for navigating ODL contexts' digital platforms and designing effective learning experiences.

Methodology

This study employed a mixed-methods survey research design, combining a structured questionnaire with open-ended questions to collect data from a sample of B.Ed. (Natural Sciences) students at a Sri Lankan ODL university. A convenient sampling technique was used to select 40 students from different academic years of the programme. The questionnaire, developed based on the research objectives and validated for face and content validity, consisted of five sections aligned with the DigComp framework: Information Literacy, Technology Operations and Concepts, Communication and Collaboration, Problem-Solving and Critical Thinking, and Safety and Security. Additionally, six open-ended questions explored students' experiences with credibility evaluation, technology challenges, communication strategies, critical thinking promotion, security threats, and preferred communication tools. A pilot survey with ten students not included in the sample ensured the questionnaire's clarity and comprehensibility.

Quantitative data were analyzed using SPSS version 26, with non-parametric statistical tests (Mann-Whitney U, Kruskal-Wallis H, and ordinal logistic regression) due to the non-normal distribution of the data. A significance level of $\alpha = 0.05$ was applied to all statistical tests. Qualitative responses to open-ended questions were analyzed thematically to identify key patterns and insights, complementing the quantitative findings and providing context for students' digital literacy experiences.

Results and Discussion

Digital Literacy Skills Possessed by B.Ed. (Natural Sciences) Students

To identify the various digital literacy skills possessed by B.Ed. (Natural Sciences) students in the ODL contexts, the mean and standard deviation scores were calculated. Table 1 shows the analysis of digital literacy skills among the students, which reveals a generally moderate to high level of proficiency across various areas. The highest average score in safety and security is observed, suggesting strong competence in this domain. Conversely, communication and collaboration have the lowest average score, indicating a relative area of weakness compared to other skills. The variability in scores, particularly in problem-solving and critical thinking, highlights differences in individual student abilities within these skill areas. This suggests that while many students are adept at using digital tools and resources, there is still room for improvement, especially in enhancing communication and collaboration skills.

Table 1.
Mean and Standard deviation on Student Digital Literacy

	N	Mean	Std. Deviation
Information literacy	40	3.5156	.94360
Technology operation and concepts	40	3.4969	1.04102
Communication & collaboration	40	3.0964	.89559
Problem-solving and critical thinking	40	3.4964	1.10135
Safety and Security	40	3.6786	1.04090

Gender Differences in Digital Literacy Skills among B.Ed. (Natural Sciences) Students

Several non-parametric tests were employed to assess the differences in digital literacy skills among B.Ed. (Natural Sciences) students at the Sri Lankan university. The “Mann-Whitney U Test” was used to compare the median scores of digital literacy skills between male and female students.

Table 2 presents the ranks obtained from this test, highlighting the differences in digital literacy skills between these two groups.

Table 2.

The ranks table of the Mann-Whitney U test of digital literacy skills between male and female students

	Gender	N	Mean Rank	Sum of Ranks
Information literacy	Female	29	19.57	567.50
	Male	11	22.95	252.50
	Total	40		
Technology operation and concepts	Female	29	19.28	559.00
	Male	11	23.73	261.00
	Total	40		
Communication & collaboration	Female	29	20.10	583.00
	Male	11	21.55	237.00
	Total	40		
Problem-solving and critical thinking	Female	29	19.41	563.00
	Male	11	23.36	257.00
	Total	40		
Safety and Security	Female	29	20.14	584.00
	Male	11	21.45	236.00
	Total	40		

Furthermore, the Mann-Whitney U test revealed significant differences in digital literacy skills between male and female students across five key areas: information literacy, technology operation and concepts, communication and collaboration, problem-solving and critical thinking, and safety and security. Table 3 presents the differences in digital literacy skills between male and female students.

Table 3.

The Mann-Whitney U test of digital literacy skills between male and female students

	Information literacy	Technology operation and concepts	Communication & collaboration	Problem-solving and critical thinking	Safety and Security
Mann-Whitney U	132.500	124.000	148.000	128.000	149.000
Wilcoxon W	567.500	559.000	583.000	563.000	584.000
Z	-.849	-1.111	-.361	-.986	-.330

Asymp. Sig. (2-tailed)	.396	.266	.718	.324	.741
Exact Sig. [2*(1-tailed Sig.)]	.419 ^b	.294 ^b	.743 ^b	.353 ^b	.765 ^b

Referring to Table 3 for information literacy, the Mann-Whitney U value is 132.500, with a Wilcoxon W value of 567.500 and a Z-score of -0.849. The asymptotic significance (two-tailed) is 0.396, and the exact significance is 0.419. These p-values indicate no significant difference in information literacy skills between male and female students. Similarly, for technology operation and concepts, the Mann-Whitney U value is 124.000, Wilcoxon W is 559.000, and Z is -1.111, with a two-tailed significance of 0.266 and an exact significance of 0.294. Again, these values suggest no significant difference between genders in this skill area.

In addition, qualitative responses from open-ended questions provided deeper insights into these findings. In information literacy, most students reported that they are confident in evaluating the credibility of online sources, with one student noting that they “verify the author’s credentials, the website’s reliability, and cross-reference with known information”. However, a few highlighted challenges due to an overload of information, suggesting that managing large volumes of digital content remains a hurdle for some. This aligns with the moderate proficiency in information literacy and underscores the need for training in filtering and synthesizing digital information.

Moreover, the Mann – Whitney U value, Wilcoxon W value and Z-score of the communication and collaboration skill are 148.000, 583.000 -0.361 respectively. The asymptotic significance is 0.718, and the exact significance is 0.743, indicating no significant difference between male and female students. For problem-solving and critical thinking, the Mann-Whitney U value is 128.000, Wilcoxon W is 563.000, and Z is -0.986, with a two-tailed significance of 0.324 and an exact significance of 0.353. These results show no significant gender disparity in problem-solving and critical-thinking skills. Finally, in the category of safety and security, the Mann-Whitney U value is 149.000, Wilcoxon W is 584.000, and Z is -0.330, with an asymptotic significance of 0.741 and an exact significance of 0.765. These p-values indicate that gender is not a strong determinant factor of the students’ safety and security skills. Overall, the statistical analysis reveals no significant gender-based differences in digital literacy skills among students. These findings suggest that both male and female students possess comparable levels of digital literacy across all examined categories. Moving forward, educational strategies should continue to focus on enhancing digital literacy for all students without gender-specific modifications. The absence of gender differences at the university aligns with findings from inclusive ODL settings (Cabezas-González et al., 2021), while variations across academic levels suggest the need for tailored interventions to support students at different stages of their studies.

Furthermore, students’ qualitative responses reflected a lower proficiency in communication and collaboration. Similarly, over 40% of them emphasized on having no clear strategies for effective online collaboration or communication. In elaboration, the respondents mentioned being often reliant on approaches that are rather unstructured yet familiar to them. Namely, tools such as WhatsApp or Zoom. One student mentioned “using social media platforms” as a response without further elaborating on it. The apparent tendency towards WhatsApp due to its “user-friendliness” and “quick response time” suggests that the students are not adequately exposed to professional collaboration tools such as Microsoft Teams or Google Workspace. It is

possible that this explains the lower mean score in this area and similarly highlights the space in the ODL curriculum to facilitate and promote collaborative digital skills.

In contrast, safety and security was a frequently embodied competency and thus was evoked by the students' proactive responses towards online threats. Several of them elaborated in their ability to identify phishing links, scam emails, or unauthorized Zoom access and to take counteractions and preventive measures such as ignoring suspicious content, using antivirus software, or enabling Zoom waiting rooms. For example, a student showcased practical cybersecurity knowledge by recounting an incident of activating a Zoom waiting room after outsiders accessed a meeting. This ability, frequently seen among younger students, suggest a solid foundational training in digital security and safety. However, some students conveyed no exposure to threats, showcasing the need for a more up to date and broader education in cybersecurity.

Furthermore, the students suggested utilizing interactive software and virtual initiatives such as quizzes, Google Forms, educational games, and simulations to further stimulate digital thinking. One student pushed forward the notion "helping students apply what they've learned to real-life situations", which insisted on the technology's potential for higher-order thinking. However, the variability in responses, with some students expressing uncertainty, mirrors the quantitative variability ($SD = 1.10135$) and suggests uneven exposure to such strategies.

The qualitative data also highlighted significant challenges in using technology for learning and teaching, with over 60% of students citing poor internet connectivity and signal issues as the primary barrier. Power outages and limited access to resources or technological knowledge were also noted. These contextual factors likely exacerbate difficulties in communication and collaboration, as unstable connections hinder effective online interaction. This finding aligns with the literature, which notes that access to resources influences digital competence (Gutiérrez-Castillo et al., 2017) and underscores the need for institutional support to address infrastructure challenges in the ODL context.

Digital Literacy Skills among Different Age Groups

The Kruskal-Wallis H test is performed to compare the median scores of digital literacy skills among different age groups. Table 4, and 5 present the ranks and Kruskal-Wallis H test statistics of the digital literacy skills among different age groups

Table 4

The ranks of the digital literacy skills among different age groups

	Age	N	Mean Rank
Information literacy	20-25	6	24.50
	25-30	14	17.96
	More than 30	20	21.08
	Total	40	
Technology Operation and concepts	20-25	6	21.00
	25-30	14	18.79
	More than 30	20	21.55

	Total	40	
Communication & Collaboration	20-25	6	29.00
	25-30	14	18.57
	More than 30	20	19.30
	Total	40	
Problem solving & Critical thinking	20-25	6	26.83
	25-30	14	18.86
	More than 30	20	19.75
	Total	40	
Safety and Security	20-25	6	30.42
	25-30	14	16.86
	More than 30	20	20.08
	Total	40	

According to the Table 4, the mean ranks of digital literacy skills among different age groups. For information literacy, students aged 20-25 have the highest mean rank of 24.50, followed by those over 30 with a mean rank of 21.08, and those aged 25-30 with a mean rank of 17.96. In technology operation and concepts, the highest mean rank of 21.55 is seen in students over 30, while those aged 20-25 and 25-30 have mean ranks of 21.00 and 18.79, respectively. For communication and collaboration, students aged 20-25 have a noticeably higher mean rank of 29.00, compared to 19.30 for those over 30, and 18.57 for the 25-30 age group. In problem-solving and critical thinking, the 20-25 age group again leads with a mean rank of 26.83, followed by those over 30 with 19.75, and the 25-30 age group with 18.86. Lastly, in safety and security, students aged 20-25 have the highest mean rank of 30.42, significantly higher than those over 30 (20.08) and the 25-30 age group (16.86). These rankings suggest that younger students, particularly those aged 20-25, generally perform better in most digital literacy skills, especially in communication, collaboration, and safety and security.

Table 5

The Kruskal-Wallis H on the digital literacy skills among different age groups

	Information literacy	Technology Operation and concepts	Communication & Collaboration	Problem solving & Critical thinking	Safety and Security
Kruskal-Wallis H	1.521	.506	4.053	2.262	6.136
df	2	2	2	2	2
Asymp. Sig.	.468	.777	.132	.323	.047

Table 5 presents the results of the Kruskal-Wallis H test comparing digital literacy skills among different age groups. The test statistics show that for information literacy, the Kruskal-Wallis H value is 1.521 with a significance level (Asymp. Sig.) of 0.468, indicating no significant difference among the age groups. For technology operation and concepts, the H value is 0.506 with a significance of 0.777, again showing no significant difference. Communication and

collaboration skills have an H value of 4.053 and a significance of 0.132, suggesting no significant difference among age groups. Problem-solving and critical thinking skills have an H value of 2.262 with a significance of 0.323, indicating no significant difference. However, for safety and security, the Kruskal-Wallis H value is 6.136 with a significance of 0.047, indicating a significant difference among age groups. This significant p-value for safety and security suggests that age impacts students' skills in this area, with younger students (20-25) showing higher proficiency.

Overall, the Kruskal-Wallis H test results indicate that most digital literacy skills do not significantly differ among the different age groups, except for safety and security. In this area, younger students (20-25) have significantly higher skills. These findings suggest that age does not generally impact digital literacy skills, with the notable exception of safety and security, where targeted interventions might be beneficial for older students. Further research could explore why younger students excel in safety and security and how this can inform educational strategies for other age groups.

In addition, qualitative responses reinforced this, with younger students frequently describing proactive responses to security threats, such as using antivirus software or avoiding phishing links. For example, one student noted, “I didn’t open [an unwanted link] because I haven’t trust about him”, reflecting caution typical of digitally native younger learners. Older students, while competent, reported fewer specific strategies, which may contribute to the significant difference in this domain.

Digital Literacy Skills among Different Levels of Study.

The Kruskal-Wallis H test also performed to compare the median scores of digital literacy skills among different levels of the study. Table 6, and 7 present the ranks and Kruskal-Wallis H test statistics of the digital literacy skills among different levels of the study.

Table 6

The ranks of the digital literacy skills among different levels of the study

	Level at B.Ed. (Natural Sciences)	N	Mean Rank
Information literacy	Level 3	13	20.54
	Level 4	2	24.50
	Level 5	5	12.50
	Level 6	20	22.08
	Total	40	
Technology Operation and concepts	Level 3	13	18.23
	Level 4	2	29.50
	Level 5	5	14.80
	Level 6	20	22.50
	Total	40	
Communication & Collaboration	Level 3	13	23.62
	Level 4	2	29.00
	Level 5	5	12.20
	Level 6	20	19.70

	Total	40	
Problem solving & Critical thinking	Level 3	13	22.15
	Level 4	2	30.00
	Level 5	5	13.40
	Level 6	20	20.25
	Total	40	
Safely and Security	Level 3	13	21.92
	Level 4	2	23.25
	Level 5	5	15.50
	Level 6	20	20.55
	Total	40	

Table 06 is a concise yet insightful indication of how various digital literacy skills across five domains are distributed among students at different levels of the B.Ed. (natural Sciences) program. Students at Level 04 have obtained the highest mean rank of 24.50 in information literacy showcasing a superior possession of the said skill. Next, level 06 students also showcase adequate talent with a mean rank of 22.08 along with level 03 students who possess a mean rank of 20.54. However, level 05 students have the lowest mean rank of 12,50 which indicates that even though students from higher level have a better performance, level 05 students would perform better with additional support and guidance.

Level 4 students again take the first place with the highest mean rank of 29.50, demonstrating strong proficiency in technology operation and concepts. Level 6 students follow next with a mean rank of 22.50, and Level 3 students have a mean rank of 18.23. Level 5 students, with a mean rank of 14.80, appear to be slower in their phase, suggesting that they might need more customized interventions to improve their technological skills. This pattern emphasizes on the importance of continuous skill development, particularly for mid-level students. When discussing about communication and collaboration, the highest mean rank of 29.00 is recorded among level 04 students which is an indication of their excellent skills. Level 3 students also deliver a good performance with a mean rank of 23.62 while level 06 students closely follow along with a mean rank of 19.70. However, level 05 students who possess the lowest rank recorded with a mean rank of 12.20, are prone to facing challenges in this aspect. Therefore, the data communicates that the level 05 students might require a more tailor-made approach to amplify their communication and collaboration skills.

A high capability in problem-solving and critical thinking, was noted among level 04 students who possess the highest mean rank of 30.00. They are followed by the level 03 students with a mean rank of 22.15. Level 06 students closely follow them with a mean rank of 20.25. However, level 05 students show the least proficiency in this skill signaling a need for high improvement. These findings encourage introducing rather customized strategies to amplify the problem-solving and critical thinking skills of Level 05 students.

Next, the mean ranks for safety and security stand closely for levels 03,04 and 06. A slight change is seen in the mean rank obtained by level 04 students that is 23.25. The rank is slightly lower in level 03 students who have obtained a mean rank of 21.92. They are followed closely by level 06 students who have obtained a mean rank of 20.55.

Overall, the analysis reveals that Level 4 students consistently rank highest across all digital literacy skills, indicating strong proficiency in these areas. Conversely, Level 5 students show the lowest mean ranks in all categories, suggesting they might benefit significantly from targeted educational interventions. Level 3 and Level 6 students exhibit varied performances but generally maintain solid proficiency.

Hence, qualitative responses did not directly address study level differences, but the consistent mention of connectivity issues across all respondents suggests that external factors like infrastructure impact all students, similarly, supporting the lack of significant differences. However, Level 5 students' lower mean ranks across all domains may reflect specific challenges, such as limited exposure to collaborative tasks, as evidenced by vague responses to communication strategies.

Table 7

The Kruskal-Wallis H on the digital literacy skills among different levels of the study

	Information literacy	Technology Operation and concepts	Communication & Collaboration	Problem solving & Critical thinking	Safely and Security
Kruskal-Wallis H	3.170	3.684	4.947	3.665	1.311
df	3	3	3	3	3
Asymp. Sig.	.366	.298	.176	.300	.727

Table 7 provides the results of the Kruskal-Wallis H test, which evaluates whether there are statistically significant differences in digital literacy skills among students at different levels of the B.Ed. (Natural Sciences) program.

The Kruskal-Wallis H value for information literacy is 3.170 with a significance level (Asymp. Sig.) of 0.366. Since the p-value is greater than 0.05, there is no statistically significant difference in information literacy skills among the different levels of study. This suggests that the proficiency in information literacy is relatively consistent across Levels 3, 4, 5, and 6. For technology operation and concepts, the Kruskal-Wallis H value is 3.684 with a significance level of 0.298. Again, the p-value exceeds 0.05, indicating no significant differences among the levels. This implies that students across various levels have similar capabilities in operating technology and understanding related concepts.

The H value for communication and collaboration is 4.947 with a significance level of 0.176. Although this is closer to the threshold, it still exceeds 0.05, suggesting no statistically significant differences in communication and collaboration skills among the different levels of the study. Therefore, these skills are uniformly distributed among students at different levels. Problem-solving and critical thinking skills have a Kruskal-Wallis H value of 3.665 with a significance level of 0.300. Since the p-value is greater than 0.05, there are no significant differences in these skills across the different levels. This indicates that problem-solving and critical thinking abilities are consistent among students from Levels 3 to 6.

Moreover, the H value for safety and security is 1.311 with a significance level of 0.727. The high p-value indicates no statistically significant differences among the levels in terms of safety and security skills. This suggests a uniform distribution of safety and security knowledge and practices among students at different study levels.

Overall, the Kruskal-Wallis H test results indicate that there are no statistically significant differences in any of the digital literacy skills (information literacy, technology operation and concepts, communication and collaboration, problem-solving and critical thinking, safety and security) among students at different levels of the B.Ed. (Natural Sciences) program. This uniformity suggests that the curriculum and learning experiences provided are effective in maintaining consistent digital literacy skills across all levels of the study program.

Factors Influencing the Digital Literacy Levels of BEd Students.

The 3rd research question is to explore factors that may influence the digital literacy levels of BEd students. To explore the factors that may influence the digital literacy levels of BEd students, a multiple regression analysis using ordinal logistic regression was performed, examining the relationship between demographic factors (gender, age, and level of study) and digital literacy levels. Table 8, 9, 10, and 11 present the statistical data of multiple regression analysis.

Table 8

Model Fitting Information of the multiple regression analysis.

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	67.504			
Final	58.560	8.944	6	.177

According to the Table 8, the model fitting information indicates how well the model fits the data. The -2 Log Likelihood value for the intercept-only model is 67.504, while the final model has a -2 Log Likelihood value of 58.560. The chi-square value is 8.944 with 6 degrees of freedom and a significance level of 0.177. Since the p-value is greater than 0.05, this suggests that the overall model is not statistically significant, indicating that the included predictors do not collectively explain a significant portion of the variance in digital literacy levels.

Table 9

Goodness-of-Fit of the multiple regression analysis.

	Chi-Square	df	Sig.
Pearson	38.619	33	.231
Deviance	39.675	33	.197

The goodness-of-fit statistics include the Pearson chi-square and the deviance chi-square. The Pearson chi-square value is 38.619 with 33 degrees of freedom and a significance level of 0.231. The deviance chi-square value is 39.675 with 33 degrees of freedom and a significance level of 0.197. Both p-values are greater than 0.05, suggesting that the model fits the data well.

Table 10*Pseudo R-Square of the multiple regression analysis.*

Cox and Snell	.200
Nagelkerke	.214
McFadden	.082

The pseudo R-square values provide an indication of the amount of variance explained by the model:

- Cox and Snell: 0.200
- Nagelkerke: 0.214
- McFadden: 0.082

These values suggest that the model explains a small portion of the variance in digital literacy levels, with Nagelkerke's R-square indicating that approximately 21.4% of the variance is explained by the model.

Table 11*Parameter Estimates of the multiple regression analysis.*

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Threshold	[Reg = 2.00]	-2.284	.752	9.225	1	.002	-3.758	-.810
	[Reg = 3.00]	-1.367	.695	3.869	1	.049	-2.728	-.005
	[Reg = 4.00]	.289	.662	.190	1	.663	-1.010	1.587
Location	[Gender=1.00]	-1.102	.692	2.534	1	.111	-2.458	.255
	[Gender=2.00]	0 ^a	.	.	0	.	.	.
	[Age=2.00]	1.618	1.394	1.347	1	.246	-1.114	4.349
	[Age=3.00]	.073	.907	.006	1	.936	-1.705	1.851
	[Age=4.00]	0 ^a	.	.	0	.	.	.
	[Level=1.00]	-.902	1.122	.647	1	.421	-3.101	1.297
	[Level=2.00]	1.606	1.496	1.153	1	.283	-1.326	4.538
	[Level=3.00]	-1.878	1.074	3.054	1	.081	-3.984	.228
	[Level=4.00]	0 ^a	.	.	0	.	.	.

Referring the Table 11, the parameter estimates provide insights into the effect of each predictor variable on digital literacy levels:

Thresholds: These values represent the cut-off points between the different categories of digital literacy levels. Significant thresholds (e.g., [Reg = 2.00] with $p = 0.002$) indicate clear distinctions between certain levels.

Gender: The estimate for Gender (1.00) is -1.102 with a p-value of 0.111, suggesting that being male is associated with lower digital literacy levels compared to females, but this effect is not statistically significant.

Age: The estimates for Age (2.00 and 3.00) are 1.618 and 0.073 respectively, with p-values of 0.246 and 0.936. These results indicate no significant effect of age on digital literacy levels. Level of Study: The estimates for Level (1.00, 2.00, and 3.00) vary, with Level (3.00) having an estimate of -1.878 and a p-value of 0.081, which is close to the significance threshold, suggesting a potential but not statistically significant lower digital literacy for Level 3 students compared to Level 4 students.

In sum, the ordinal logistic regression analysis suggests that gender, age, and level of study do not have a statistically significant influence on the digital literacy levels of BEd students, given the model's overall lack of significance. Although the goodness-of-fit measures indicate a well-fitting model, the low pseudo R-square values and non-significant parameter estimates highlight that other factors not included in the model may play a more crucial role in determining digital literacy levels among these students. These findings suggest the need for further research to identify additional variables that might better explain the variation in digital literacy levels.

However, qualitative responses suggest that external factors, particularly poor internet connectivity and limited technological knowledge, are more significant barriers. For example, one student noted, “Since I’m not in great touch with technology, I feel I’m yet ignorant about it”, highlighting knowledge gaps. Another emphasized “slow coverage issues”, pointing to infrastructure limitations. These findings suggest that institutional and contextual factors, not captured in the regression model, play a critical role in shaping digital literacy, warranting further exploration.

Conclusions and Recommendations

The study identified that moderate to high digital literacy proficiency was exhibited by the b.ed. (natural sciences) students at a sri lankan odl university. Similarly, the highest competency was in safety and security while the lowest was recognized to be in communication and collaboration. These findings were supported by qualitative responses that emphasised the student’s proactive responses towards security challenges such as the installation of antivirus software and enabling zoom waiting rooms. However, it highlighted a lack of meticulously planned out strategic structures for online collaboration. In addition, the absence of prominent gender-based disparities suggest that educating students on digital literacy can be applied uniformly, while the higher proficiency in safety and security among younger students suggest a strong awareness due to the shift in generational paradigm. The lower mean ranks of the level 5 students across all domains possible reflect a gap in the curriculum or a limited exposure to collaborative endeavours. Qualitative responses such as having “no idea” on communication strategies encourage the execution of well-designed trainings to introduce professional tools. A condition heightened by constant connectivity issues.

Next, “poor connectivity” being cited by over 60% of the students as the major obstacle that hinders them from using technology effectively, the qualitative data revealed prominent contextual challenges. Limitation in a student’s technological knowledge and resources further stand as obstacles for digital literacy development, especially in communication and collaboration. For instance, reliance on whatsapp provides accessibility but limits exposure to more professional choices when it comes to collaborative tools. The study’s sample size (n=40) and the convenience sampling approach limits the sample’s generalizability. However, qualitative data brings out a

more deep and contextual approach as it provides nuanced insights for odl settings. As a result, these findings emphasize the space to incorporate measures that overcome both skill gaps and infrastructure limitations.

The study proposes the following recommendations to enhance the digital literacy among B.Ed. students.

- **Strengthen Communication and Collaboration Training:** Via the introduction of professional collaboration tools (e.g. Microsoft Teams, Google Workspace) into the program's curriculum through project-based learning and virtual group activities, the students' communication and collaboration can be improved. Furthermore, workshops designed to leverage effective online communication along with netiquette and collaborative strategies can act as a remedy to the lack of defined approaches as mentioned in student responses.
- **Address Connectivity Challenges:** Improving internet access can be done in collaboration with institutional stakeholders. For example, making subsidized data plans and offline learning resources available for students can improve their digital learning experience. A temporary solution can be brought forward by offering recorded lectures, minimizing disturbances caused by power outages or signal issues.
- **Enhance Critical Thinking Through Technology:** Guided by student suggestions, quizzes, simulations, and educational games can exacerbate interactions within the class, ultimately improving their critical thinking skills. This can be facilitated more efficiently via faculty training initiatives intended to develop technology-driven assignments.
- **Broaden Cybersecurity Education:** Even though some students appeared to be having adequate knowledge regarding digital safety and security, some demonstrated having a limited exposure to threats. An extensive cyber security training that is inclusive of simulations regarding phishing or malware scenarios, can prepare students for online risks.
- **Develop ODL-Specific Frameworks:** It is recommended that further research is needed to create digital literacy frameworks that are more customized to ODL contexts. These frameworks could contain contextual factors such as connectivity and resource access. In addition, the overtime development of the skills can be tracked via longitudinal studies.
- **Qualitative Exploration:** The utilisation of qualitative methods would further enhance on nuances that are embedded in individual challenges and perceptions. Such discoveries would positively affect targeted interventions regarding communication and collaboration.

The objective behind these recommendations is to fortify students' strengths in safety and security while addressing weaknesses in communication and collaboration. This will ultimately develop them into educators with a solid digital skills and competencies. By focusing on infrastructure barriers and enhancing training, the ODL university can create a fertile ground that encourages the digital literacy development for all students.

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