ORIGINAL ARTICLE

Assessing the Digital Health Literacy and Teleradiology Adaptability of Radiologic Technology Students in Decentralized Clinical Deployments

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ABSTRACT

Background: Digital imaging, PACS, and teleradiology require future radiologic technologists to evaluate digital health information, protect patient data, and function safely in remote imaging workflows. Evidence on these competencies among Philippine radiologic technology students is limited. *Objective*: To assess digital health literacy and teleradiology adaptability across year levels and test whether digital health literacy predicts adaptability after adjustment for curricular level. *Methods*: A cross-sectional census included all 80 BS Radiologic Technology students at Iligan Medical Center College from September 2024 to March 2025. Students completed a 15-item Digital Health Literacy Instrument and a 17-item radiology-context adaptation of the Telehealth Competency Questionnaire-Provider. Descriptive statistics, one-way analysis of variance with Tukey tests, Pearson correlation, and multiple regression were used. *Results*: Mean digital health literacy was 2.54 (SD 0.65) on a 1 to 4 scale, and mean teleradiology adaptability was 3.12 (SD 0.85) on a 1 to 5 scale. Year-level differences were significant for digital health literacy, $F(3, 76) = 10.40$, $p < .001$, eta squared = .29, and adaptability, $F(3, 76) = 15.92$, $p < .001$, eta squared = .39. Digital health literacy correlated with adaptability, $r = .60$, $p < .001$. Digital health literacy and year level jointly explained 49.1% of adaptability variance. *Conclusion*: Readiness increased across the curriculum, but troubleshooting remained the weakest adaptability domain. Integrating information appraisal, privacy, PACS concepts, remote-workflow simulation, and supervised teleradiology exposure across the program may strengthen practice readiness.

I. INTRODUCTION

Digital transformation has moved from the periphery of health care to the infrastructure through which many clinical decisions, communications, and records now pass. The World Health Organization identifies digital health as a system-level priority that depends not only on hardware and software but also on a workforce capable of using digital resources safely, ethically, and effectively (World Health Organization, 2021). This workforce requirement has particular force in diagnostic imaging because image acquisition, post-processing, archiving, transmission, retrieval, and multidisciplinary communication are already mediated by interconnected digital systems. The contemporary radiologic technologist therefore needs more than equipment operation skills. Practice also demands the ability to locate and evaluate digital health information, understand data governance expectations, protect patient confidentiality, recognize workflow risks, and respond appropriately when technical problems affect image transfer or access.

Radiology is one of the clinical domains in which digital infrastructure has altered the organization of work most visibly. Picture archiving and communication systems, radiology information systems, interoperable image formats, remote workstations, and networked reporting have allowed images to move rapidly between acquisition sites and interpreting physicians. Reponen and Niinimäki (2021) describe this progression as a long-term convergence of teleradiology, PACS, and imaging informatics. Professional guidance now treats electronic image practice as a quality and safety process rather than a simple act of file transmission. The ACR-AAPM-SIIM technical standard assigns responsibilities across physicians, medical physicists, radiologic technologists, and imaging informatics personnel, while teleradiology guidance emphasizes secure communication, dependable image quality, documentation, privacy, availability, and responsibility for failures in the remote workflow (American College of Radiology et al., 2022; Özmen et al., 2021). Morales Santos et al. (2023) similarly frame teleradiology as an extension of radiology services that should meet quality and safety expectations comparable with on-site care.

These expectations create an educational problem. Students may be comfortable with smartphones, social media, web search, or general-purpose applications yet still lack the more specific literacy required to assess clinical information and use digital systems within professional boundaries. Digital health literacy describes the capability to seek, appraise, interpret, generate, and protect health-related information in digital environments. The Digital Health Literacy Instrument developed by van der Vaart and Drossaert (2017) expanded earlier measures by distinguishing several skills, including information search, appraisal of reliability, judgment of relevance, creation of content, and privacy protection. Subsequent work with university populations showed that access to the internet does not guarantee consistent critical appraisal. Dadaczynski et al. (2021), for example, found substantial difficulty among university students when they evaluated the reliability of web-based health information. In a large multicountry study that included Philippine university students, Htay et al. (2022) likewise identified variation across digital health literacy domains and reinforced the importance of trustworthy information sources.

Evidence from health professions education points to a similar gap between confidence with technology and readiness for clinical digital practice. Nazeer et al. (2022) found limited familiarity with digital health concepts among a notable proportion of undergraduate medical students. Baumgartner et al. (2022) reported low self-assessed digital health knowledge despite strong student interest in curricular preparation. Ghaedi et al. (2024) further demonstrated that perceived eHealth literacy and performed skills do not align perfectly, especially for appraisal and application. These studies suggest that higher education cannot infer professional digital competence from routine technology use. Digital competence needs explicit curricular outcomes, repeated assessment, and opportunities to transfer knowledge into clinical decisions.

A comparable concern exists for telehealth. Reviews across health professions have repeatedly identified uneven curriculum integration and limited evidence of standardized competence assessment. Chike-Harris et al. (2021) found considerable variation in telehealth content across provider education programs, while Budakoğlu et al. (2021) concluded that undergraduate telemedicine curricula lacked a well-established, evidence-based structure. In allied health, Hui et al. (2021) reported that curricular adoption had not kept pace with the expansion of telehealth services. More recent student data show that favorable attitudes toward telehealth can coexist with limited knowledge, technical skill, and direct experience. Rettinger et al. (2024), in a multidisciplinary allied health and nursing sample, found broad support for telehealth education but insufficient preparation for implementation. The issue therefore concerns not only willingness to use remote care but adaptability: whether learners can apply professional judgment, preserve rapport and communication, and manage technical barriers when care is mediated by distance and digital systems.

Teleradiology places this adaptability within a highly technical imaging chain. A radiologic technologist may need to confirm that image data are complete, ensure that identifiers and examination metadata are correct, recognize transmission or access failures, protect credentials, communicate limitations to the appropriate personnel, and maintain patient-centered conduct when remote interpretation changes local workflow. Professional guidance also makes clear that remote imaging does not reduce the obligation to protect confidentiality or verify technical quality (American College of Radiology et al., 2022; Özmen et al., 2021). These responsibilities are especially relevant to decentralized clinical education, where students rotate or learn across more than one clinical environment and may encounter different PACS configurations, network conditions, local procedures, and levels of informatics support. Adaptability in this setting is not synonymous with expertise in one software package. It is the capacity to transfer safe practices across sites while responding to workflow and technical variation.

The Philippine BS Radiologic Technology curriculum provides a pertinent context for this question. The Commission on Higher Education recognizes rapid technological development as a defining feature of radiologic technology education and requires a four-year program that culminates in clinical education in affiliated training hospitals (Commission on Higher Education, 2018). This curricular structure creates progressive exposure: early-year students develop scientific and professional foundations, while advanced students encounter more complex imaging systems and clinical responsibilities. In principle, year level should therefore correspond with greater opportunity to integrate information literacy, imaging informatics, privacy, communication, and troubleshooting. In practice, however, students may receive these competencies indirectly through separate courses or site-specific experiences rather than through a vertically mapped digital health and teleradiology curriculum.

The distinction matters because digital health literacy may be a foundational capability for teleradiology adaptability. A student who can identify credible digital information, judge relevance, recognize privacy risk, and contribute information appropriately may be better positioned to understand remote imaging protocols and respond to unfamiliar system conditions. Systematic reviews of digital health competence support a multidimensional view that combines information and data literacy with communication, ethical practice, technology use, and problem solving (Longhini et al., 2022). Khurana et al. (2022) similarly identified a broad set of digital health knowledge, skills, and attitudes that should enter health professions curricula rather than remain optional or informal. The evidence map by Tudor Car et al. (2022) also highlights the need for research that links learners, educational design, infrastructure, and context, with particular need for evidence from low- and middle-income countries.

Despite these developments, empirical work has concentrated mainly on medical, nursing, and mixed allied health populations. Radiologic technology students remain underrepresented even though their future practice is deeply dependent on digital images and networked information systems. Evidence is particularly limited on whether digital health literacy is associated with readiness to adapt to teleradiology workflows after accounting for progression through the curriculum. Such evidence can help educators distinguish general digital literacy deficits from competencies that may develop through curricular and clinical exposure, and it can identify domains that require earlier or more deliberate instruction.

This study assessed the digital health literacy and teleradiology adaptability of first- to fourth-year BS Radiologic Technology students at Iligan Medical Center College during the 2024 to 2025 academic year. It had four objectives: to describe digital health literacy and its domains; to describe teleradiology adaptability across evaluation and workflow, professional rapport, and troubleshooting; to compare both constructs across year levels; and to determine the association between digital health literacy and teleradiology adaptability after adjustment for year level. It was hypothesized that higher year level would be associated with higher scores on both constructs and that digital health literacy would show a positive independent association with teleradiology adaptability.

II. METHODS

Design and Setting

A quantitative cross-sectional, descriptive-correlational design was used. The study was conducted at Iligan Medical Center College in Iligan City, Philippines, from September 2024 through March 2025. The setting was selected because the institution offers the BS Radiologic Technology program and uses affiliated clinical environments for the development of practice competencies. The term decentralized clinical deployment was used to describe the program context in which clinical preparation and placement occur across affiliate practice environments rather than within one centralized training department. Direct clinical exposure is greatest in the advanced phase of the curriculum, but students across year levels receive progressively more contact with digital imaging concepts, laboratory simulations, professional communication expectations, and clinical workflow. Year level was therefore treated as an ordinal indicator of accumulated curricular exposure, not as a direct count of teleradiology cases completed.

The study period covered one continuous academic cycle to avoid combining students from different cohorts. Survey administration occurred after students had received the relevant coursework or clinical exposure scheduled for their year level during the study period. The design was selected to provide a complete institutional profile and to test relationships among variables without manipulating curricular exposure. Because all measurements were obtained within one observation period, the study was intended to estimate association and group differences rather than causal effects.

Participants and Census Recruitment

The target population consisted of all students officially enrolled in the first through fourth years of the BS Radiologic Technology program during the study period. A census approach was used because the eligible population was small and accessible. The enrollment roster contained 80 eligible students: 26 first-year students, 14 second-year students, 20 third-year students, and 20 fourth-year students. Inclusion criteria were current enrollment in the BS Radiologic Technology program, active academic status during data collection, and willingness to provide informed consent. Students on formal leave of absence or those no longer enrolled at the time of data collection were excluded. No eligible student met an exclusion criterion, and all 80 students submitted complete questionnaires, which yielded a 100% institutional response rate for the defined population.

Recruitment procedures were designed to reduce perceived academic pressure. A research assistant who had no role in course grading distributed the invitation and consent information. Faculty members who evaluated students did not receive individual participation lists or item-level responses. Participation was voluntary, withdrawal was permitted before questionnaire submission, and nonparticipation had no effect on grades, clinical assignment, standing, or access to school services. Data were collected using anonymous study codes rather than student names or identification numbers.

Measures

The questionnaire contained a year-level item and two principal measures. Digital health literacy was assessed with a 15-item form derived from the Digital Health Literacy Instrument developed by van der Vaart and Drossaert (2017) and used in university-student research by Dadaczynski et al. (2021) and Htay et al. (2022). The 15 items represented five domains with three items each: information searching, adding self-generated content, evaluating reliability, determining relevance, and protecting privacy. For the first four domains, students rated the perceived difficulty of health-related digital tasks on a four-point response scale, with higher values indicating greater ease. Privacy items assessed protective behavior and were coded in the direction of safer practice so that higher values consistently represented stronger digital health literacy. Domain scores were computed as the arithmetic mean of the three corresponding items, and the total score was the mean of all 15 items. The possible total score therefore ranged from 1.00 to 4.00. No categorical cut point was imposed because the instrument was designed to retain the continuous information in the scale and published studies have used domain and total means rather than a universal diagnostic threshold.

Teleradiology adaptability was assessed through a contextual adaptation of the Telehealth Competency Questionnaire-Provider developed and validated by Taylor and Little (2024). The original TCQ-P contains 17 self-report items and supports a three-factor structure consisting of evaluation, rapport, and troubleshooting. Its validation included large exploratory and confirmatory samples and reported strong model fit, which made it preferable to an entirely investigator-created measure. For this study, the 17-item structure was retained, but clinical wording was adjusted to the radiologic technology context. References to general telehealth encounters were reframed around remote imaging workflow, electronic image exchange, coordination with remote professionals, appropriate communication, and response to technical problems. The adaptation did not add new competency domains or alter the underlying response construct.

Each teleradiology item used a five-point agreement scale from 1, strongly disagree, to 5, strongly agree. Higher scores indicated greater perceived adaptability. Consistent with the three-factor foundation of the TCQ-P, contextualized subscale scores were labeled evaluation and workflow, professional rapport, and troubleshooting. Evaluation and workflow reflected the student's confidence in applying professional judgment and completing appropriate remote-care processes. Professional rapport reflected respectful communication, role clarity, and maintenance of professional interaction despite physical separation. Troubleshooting reflected perceived capacity to identify common technical barriers, initiate appropriate first-line responses, and escalate problems without compromising safety or privacy. The total adaptability score was the mean across all 17 items and ranged from 1.00 to 5.00.

Context Adaptation, Content Validity and Reliability

Instrument adaptation followed a staged content review. The English wording of the digital health literacy items was retained except for minimal contextual clarification that directed respondents to health and medical-imaging information. The teleradiology measure received more explicit contextual revision because the source instrument addressed telehealth providers broadly. A five-member expert panel independently reviewed the adapted questionnaire. The panel comprised two registered radiologic technologists with academic experience, one radiologist familiar with teleradiology practice, one imaging informatics professional, and one health professions education researcher with expertise in instrument development. Reviewers rated relevance and clarity on a four-point content-validity scale and assessed whether each adaptation preserved the intent of its source domain.

Item-level content validity indices for the contextualized questionnaire ranged from .80 to 1.00, and the scale-level average content validity index was .94. Panel comments led to replacement of ambiguous software-specific terms with technology-neutral language, clarification of escalation procedures, and separation of technical troubleshooting from independent system administration. The final wording was reviewed for plain English and professional appropriateness. A pilot test was then completed by 20 recent BS Radiologic Technology graduates who were not eligible for the main study. Pilot participants reported no major comprehension problems. Internal consistency in the pilot was alpha = .89 for the 15-item digital health literacy measure and alpha = .92 for the 17-item teleradiology adaptability measure. Pilot data were used only to confirm questionnaire function and were not included in the study analysis.

Reliability was reassessed in the 80-student study sample because internal consistency is sample dependent. Cronbach alpha was calculated for each principal scale and its domains. An alpha of .70 or higher was considered acceptable for group-level research, but coefficient size was interpreted together with construct breadth and item count rather than as a standalone validity test. No item was removed after data collection because the planned scoring retained the source structures and all observed domain coefficients met the prespecified criterion.

Data Collection Procedure

After administrative and ethics permissions were secured, eligible students received a standardized participant information sheet that described the study purpose, voluntary nature of participation, confidentiality safeguards, approximate completion time, and contact details for questions. Consent was obtained before access to the questionnaire. Survey completion occurred in a quiet period outside graded examinations and clinical evaluation activities. Students were instructed to answer based on their current capability rather than the performance they expected from a licensed radiologic technologist. The questionnaire required approximately 12 to 15 minutes to complete.

The electronic form used field validation so scale items could not be accidentally submitted blank. Students could review and change responses before final submission. The form did not collect names, student numbers, personal email addresses, device identifiers, or precise location information. After closure of data collection, responses were exported to a password-protected data file, checked for duplicate study codes and out-of-range values, and stored on an access-controlled institutional device. The audit found 80 unique records, no missing scale responses, and no out-of-range values. A codebook specified variable names, response direction, reverse coding where applicable, and computed scale formulas before inferential analysis.

Statistical Analysis

Statistical analysis was conducted using IBM SPSS Statistics version 29.0. Year-level distribution was summarized with frequencies and percentages. Continuous scale scores were summarized with means, standard deviations, observed ranges, and 95% confidence intervals where appropriate. Cronbach alpha quantified internal consistency. Because the analytic plan focused on differences across the four curricular levels, separate one-way analyses of variance were used for the digital health literacy total and teleradiology adaptability total. Homogeneity of variance was assessed with Levene tests. Tukey honestly significant difference comparisons were prespecified for significant omnibus tests. Eta squared was reported as the omnibus effect-size estimate.

Pearson product-moment correlation was used to quantify the bivariate association between digital health literacy and teleradiology adaptability. Correlations were also computed between the five digital health literacy domains and the adaptability total to describe which literacy dimensions covaried with adaptability. Two-tailed alpha was set at .05. Exact p values were reported when they were .001 or greater, and $p < .001$ was used for smaller values. Ninety-five percent confidence intervals for correlation coefficients were estimated through Fisher z transformation.

A multiple linear regression model then estimated the independent association of digital health literacy with teleradiology adaptability after adjustment for year level. Teleradiology adaptability total score was the dependent variable. Digital health literacy total score was entered as a continuous predictor, and year level was coded from 1 to 4 to represent ordered curricular progression. The model reported unstandardized coefficients, standard errors, standardized beta coefficients, 95% confidence intervals, R squared, adjusted R squared, and the omnibus F test. Residual plots, normality statistics, variance patterns, and influence diagnostics were reviewed before final interpretation. No transformation was required. The residual normality tests were nonsignificant, the Durbin-Watson statistic was 2.12, and no case met conventional criteria for undue influence. Because the study used a census of the defined institutional population, inferential statistics were applied to quantify uncertainty and relationships and to support cautious comparison beyond this cohort, not to compensate for sampling nonresponse.

Ethical Safeguards

The study procedures followed the ethical principles of voluntary participation, informed consent, confidentiality, minimization of risk, and restricted data access. The questionnaire asked no clinical patient information and no student identifier needed for academic administration. The primary foreseeable risk was mild discomfort from self-evaluation, which was addressed by allowing participants to skip participation entirely and by separating research participation from faculty assessment. Data were reported only in aggregate, and small subgroup results were presented at the year level rather than through identifiable combinations of characteristics. Ethics approval details and the institutional protocol reference are provided in the Ethics Approval and Informed Consent statement and must correspond exactly with the final institutional record used for submission.

III. RESULTS

All 80 eligible students completed the survey. First-year students represented 32.5% of the sample, second-year students 17.5%, third-year students 25.0%, and fourth-year students 25.0%. Table 1 presents the year-level distribution with the total scores for both principal measures. The digital health literacy total increased from M = 2.08 (SD = 0.51) in the first year to M = 2.87 (SD = 0.69) in the fourth year. Teleradiology adaptability increased from M = 2.49 (SD = 0.64) in the first year to M = 3.85 (SD = 0.72) in the fourth year.

Table 1
Participant Distribution and Principal Scale Scores by Year Level

Year level	n	%	Digital health literacy M (SD)	Teleradiology adaptability M (SD)
First year	26	32.5	2.08 (0.51)	2.49 (0.64)
Second year	14	17.5	2.48 (0.59)	2.96 (0.74)
Third year	20	25.0	2.86 (0.43)	3.33 (0.65)
Fourth year	20	25.0	2.87 (0.69)	3.85 (0.72)
Total	80	100.0	2.54 (0.65)	3.12 (0.85)

Note. Digital health literacy scores could range from 1 to 4. Teleradiology adaptability scores could range from 1 to 5. M = mean; SD = standard deviation.

Internal consistency was alpha = .95 for the digital health literacy total and alpha = .96 for the teleradiology adaptability total. Digital health literacy domain coefficients ranged from .80 to .84. Teleradiology adaptability domain coefficients ranged from .87 to .88. The overall digital health literacy mean was 2.54 (SD = 0.65, 95% CI [2.40, 2.69]), with an observed total-score range from 1.00 to 4.00. The overall teleradiology adaptability mean was 3.12 (SD = 0.85, 95% CI [2.93, 3.31]), with an observed range from 1.58 to 4.93.

Table 2
Reliability and Descriptive Statistics for Study Measures

Construct or domain	Cronbach alpha	M	SD	95% CI for M
Digital health literacy total	.95	2.54	0.65	[2.40, 2.69]
Information searching	.80	2.69	0.68	[2.54, 2.84]
Self-generated content	.84	2.37	0.73	[2.20, 2.53]
Evaluating reliability	.80	2.43	0.78	[2.26, 2.61]
Determining relevance	.80	2.59	0.69	[2.44, 2.75]
Privacy protection	.80	2.64	0.66	[2.49, 2.79]
Teleradiology adaptability total	.96	3.12	0.85	[2.93, 3.31]
Evaluation and workflow	.88	3.10	0.87	[2.90, 3.29]
Professional rapport	.87	3.36	0.86	[3.17, 3.56]
Troubleshooting	.88	2.91	0.91	[2.70, 3.11]

Note. N = 80. CI = confidence interval; M = mean; SD = standard deviation.

Among digital health literacy domains, information searching had M = 2.69 (SD = 0.68), privacy protection M = 2.64 (SD = 0.66), determining relevance M = 2.59 (SD = 0.69), evaluating reliability M = 2.43 (SD = 0.78), and self-generated content M = 2.37 (SD = 0.73). For teleradiology adaptability, professional rapport had M = 3.36 (SD = 0.86), evaluation and workflow M = 3.10 (SD = 0.87), and troubleshooting M = 2.91 (SD = 0.91). Table 2 provides the descriptive and reliability estimates.

Levene tests were nonsignificant for digital health literacy, p = .285, and teleradiology adaptability, p = .708. The one-way analysis of variance for digital health literacy was significant, F(3, 76) = 10.40, p < .001, eta squared = .29. The corresponding analysis for teleradiology adaptability was also significant, F(3, 76) = 15.92, p < .001, eta squared = .39. Table 3 reports the omnibus tests.

Table 3
One-Way Analysis of Variance by Year Level

Outcome	df between	df within	F	p	Eta squared
Digital health literacy	3	76	10.40	< .001	.29
Teleradiology adaptability	3	76	15.92	< .001	.39

Note. N = 80. Eta squared is reported as the omnibus effect-size estimate.

Tukey comparisons for digital health literacy showed first-year scores below third-year scores, mean difference = -0.78, p < .001, and below fourth-year scores, mean difference = -0.78, p < .001. The first-year versus second-year difference was not significant, p = .156; second-year versus third-year, p = .199; second-year versus fourth-year, p = .193; and third-year versus fourth-year, p = 1.000. For teleradiology adaptability, first-year scores were below third-year scores, mean difference = -0.83, p < .001, and below fourth-year scores, mean difference = -1.36, p < .001. Second-year scores were below fourth-year scores, mean difference = -0.89, p = .002. The first-year versus second-year comparison was not significant, p = .169; second-year versus third-year, p = .421; and third-year versus fourth-year, p = .079. Table 4 presents all planned pairwise comparisons.

Table 4
Tukey Pairwise Comparisons Across Year Levels

Outcome	Comparison	Mean difference	p
Digital health literacy	First vs second	-0.39	.156
	First vs third	-0.78	< .001
	First vs fourth	-0.78	< .001
	Second vs third	-0.39	.199
	Second vs fourth	-0.39	.193
	Third vs fourth	-0.00	1.000
Teleradiology adaptability	First vs second	-0.47	.169
	First vs third	-0.83	< .001
	First vs fourth	-1.36	< .001
	Second vs third	-0.36	.421
	Second vs fourth	-0.89	.002
	Third vs fourth	-0.52	.079

Note. Mean differences are calculated as the first named group minus the second named group.

Digital health literacy total score correlated positively with teleradiology adaptability total score, r(78) = .60, 95% CI [.44, .72], p < .001. Each digital health literacy domain was also positively correlated with adaptability. Coefficients ranged from r = .50 for evaluating reliability to r = .60 for self-generated content and privacy protection. All domain correlations had p < .001. Table 5 reports the coefficients and confidence intervals.

Table 5
Pearson Correlations With Teleradiology Adaptability

Digital health literacy variable	r with adaptability	95% CI	p
Total score	.60	[.44, .72]	< .001
Information searching	.50	[.32, .65]	< .001
Self-generated content	.60	[.43, .72]	< .001
Evaluating reliability	.50	[.31, .65]	< .001
Determining relevance	.54	[.36, .68]	< .001
Privacy protection	.60	[.43, .72]	< .001

Note. N = 80. CI = confidence interval.

The multiple regression model was significant, F(2, 77) = 37.11, p < .001, R squared = .491, adjusted R squared = .478. Digital health literacy had B = 0.50 (SE = 0.12), beta = .38, t = 4.01, p < .001, 95% CI [0.25, 0.75]. Year level had B = 0.30 (SE = 0.07), beta = .43, t = 4.49, p < .001, 95% CI [0.17, 0.44]. The intercept was B = 1.12 (SE = 0.28), t = 3.99, p < .001, 95% CI [0.56, 1.67]. Table 6 provides the full coefficient set.

Table 6
Multiple Linear Regression Predicting Teleradiology Adaptability

Predictor	B	SE	Beta	t	p	95% CI for B
Intercept	1.12	0.28	-	3.99	< .001	[0.56, 1.67]
Digital health literacy	0.50	0.12	.38	4.01	< .001	[0.25, 0.75]
Year level	0.30	0.07	.43	4.49	< .001	[0.17, 0.44]

Note. N = 80. R squared = .491; adjusted R squared = .478; F(2, 77) = 37.11, p < .001. Year level was coded 1 through 4. B = unstandardized coefficient; SE = standard error; Beta = standardized coefficient; CI = confidence interval.

IV. DISCUSSION

This study indicates that digital readiness in radiologic technology is developmental rather than automatic. Students showed an intermediate level of digital health literacy overall, with greater strength in information search and privacy-related behavior than in the production of digital content and appraisal of reliability. This pattern is important because the modern imaging environment rewards speed of access but also requires disciplined judgment about information quality, data provenance, and appropriateness of use. The original DHLI was designed precisely to separate these competencies rather than equate internet use with literacy (van der Vaart & Drossaert, 2017). The present domain profile therefore suggests that students may acquire basic access habits earlier than the more complex evaluative processes needed for professional digital practice.

The result aligns with university-student evidence showing persistent difficulty with critical appraisal. Dadaczynski et al. (2021) reported that reliability assessment was one of the most problematic digital health literacy tasks in a large German university sample. Htay et al. (2022), whose East and Southeast Asian study included students from the Philippines, likewise demonstrated that digital health literacy varies by task and information source. The overall mean in the present cohort was lower than the approximately high-moderate levels reported in that multicountry pandemic-era sample, although direct numerical comparison should be cautious because the context, period, student mix, and survey focus differed. The more instructive similarity is domain structure: students who search readily do not necessarily evaluate credibility with equal ease.

Health professions research provides a second explanation for this gap. Nazeer et al. (2022) found that undergraduate medical students could hold positive views toward digital health despite incomplete knowledge of digital health concepts. Baumgartner et al. (2022) similarly found that medical students expressed substantial curricular interest while reporting limited digital health knowledge. These findings challenge the assumption that learners described as digital natives arrive with transferable clinical digital competence. Ghaedi et al. (2024) adds an important caution because perceived ability and performed eHealth literacy are related but not equivalent. For radiologic technology education, this means that self-reported comfort should not replace assessment of whether students can appraise evidence, detect privacy risks, verify image-related information, and act correctly under workflow constraints.

Year-level differences in digital health literacy were pronounced between the first year and the two advanced years. Third- and fourth-year students had substantially higher scores than first-year students, while the third- and fourth-year means were nearly identical. The early-to-advanced increase is compatible with cumulative exposure to professional coursework, medical information, imaging systems, and clinical expectations. Khurana et al. (2022) argue that digital health education should integrate knowledge, skills, and attitudes across medical training rather than depend on informal exposure. Longhini et al. (2022) similarly identify digital competence as multidimensional, with information literacy, technology use, communication, data responsibilities, and problem solving appearing across health professional frameworks. The current year-level pattern suggests that curricular progression can coincide with stronger literacy, but the plateau between the final two years also indicates that exposure alone may not continually deepen critical digital capability.

That plateau is educationally relevant. The fourth year in Philippine BS Radiologic Technology education concentrates clinical education in affiliated training environments under the CHED framework (Commission on Higher Education, 2018). Greater time in clinical settings may improve familiarity with systems and professional routines, but familiarity does not necessarily produce additional gains in appraisal if tasks focus mainly on service completion. A curriculum that expects further development of digital health literacy during clinical education may therefore need explicit activities that require verification of evidence, critique of digital sources, privacy reasoning, incident analysis, and documentation of digital decisions. The broader evidence map of Tudor Car et al. (2022) supports this shift from access to educational design by showing that digital health professions education depends on interactions among learners, infrastructure, pedagogy, and context.

The teleradiology results show a parallel but more distinctly clinical progression. Professional rapport was the strongest adaptability domain, evaluation and workflow occupied the middle position, and troubleshooting had the lowest mean. This order is plausible for students who receive sustained instruction in professional conduct and patient communication before they acquire repeated experience with network, software, image-transfer, and access failures. Telehealth education studies have repeatedly identified a gap between positive attitudes and practical readiness. Rettinger et al. (2024) found that allied health and nursing students valued telehealth education yet reported limited preparation and experience. Hui et al. (2021) also concluded that allied health curricula had been slow to incorporate telehealth despite its expansion in practice. The present results extend this concern to imaging education and identify technical troubleshooting as a specific vulnerability rather than a generalized negative attitude toward remote practice.

Troubleshooting deserves particular attention in radiology because remote imaging is a chain of dependent technical and professional events. Image quality, patient and examination identifiers, transmission completeness, workstation performance, network availability, system access, storage, privacy, and communication can each affect whether a remote interpretation is safe and useful. Özmen et al. (2021) place security, privacy, reliability, archiving, documentation, quality control, and responsibility within the core governance of teleradiology. Morales Santos et al. (2023) likewise argue that teleradiology should meet quality and safety standards comparable with local radiology services. The ACR-AAPM-SIIM technical standard also recognizes distinct responsibilities for radiologic technologists and imaging informatics personnel in electronic imaging practice (American College of Radiology et al., 2022). Students therefore do not need to become network engineers, but they do need enough systems knowledge to recognize failure, protect the patient and data, take an appropriate first action, and escalate the problem to the correct professional.

The strong year-level gradient in teleradiology adaptability supports the value of accumulated curricular and clinical exposure. Fourth-year students had the highest adaptability mean and differed significantly from first- and second-year students. Third-year students also exceeded first-year students. Unlike digital health literacy, which showed little difference between the third and fourth years, adaptability continued to rise numerically into the final year. This pattern is consistent with the applied character of telehealth competence. Reviews of telemedicine education show that experiential methods, simulations, patient encounters, and explicit telehealth curricula can strengthen learner confidence and skill, although the evidence base remains heterogeneous (Budakoğlu et al., 2021; Chike-Harris et al., 2021). Clinical placement may therefore add something that classroom digital literacy alone cannot provide: repeated contact with the consequences of system workflow, role coordination, time pressure, and technical dependency.

The positive correlation between digital health literacy and teleradiology adaptability is one of the study's central findings. Students with stronger literacy reported greater adaptability across the remote imaging context, and all five literacy domains correlated with the adaptability total. This relationship supports a layered model of readiness. Digital health literacy supplies foundational capacities to search, judge, create, and protect information; teleradiology adaptability requires those capacities to operate within a specialized clinical workflow. The relationship is conceptually consistent with the broad digital competence domains summarized by Longhini et al. (2022) and with the curriculum priorities identified through the scoping review and Delphi work of Khurana et al. (2022). It also accords with the World Health Organization's emphasis on digital literacy, data protection, interoperability, and safe use as linked conditions of digital transformation (World Health Organization, 2021).

The regression analysis strengthens this interpretation because digital health literacy remained associated with adaptability after year level was included in the model. The result indicates that being further along in the program does not fully account for individual differences in perceived readiness for teleradiology. At the same time, year level retained an independent association, which means adaptability appears to reflect both a general digital-information capability and accumulated curricular exposure. This dual contribution has practical implications. A curriculum that teaches only software procedures may leave students without transferable judgment, while a curriculum that teaches only general digital literacy may leave students unprepared for the operational demands of remote imaging. Both layers should develop in a coordinated sequence.

A vertically integrated curriculum offers one response. In the first year, students can receive explicit instruction in credible health information, source verification, basic data privacy, digital professionalism, and the ethical use of patient information. In the second year, these foundations can be connected to imaging informatics, PACS, DICOM concepts, access control, image metadata, and the consequences of incorrect digital records. The third year can add structured teleradiology simulation, remote communication exercises, workflow mapping, quality assurance, and guided response to common transmission or access failures. The fourth year can require supervised application in clinical placements, with case-based debriefing, incident reflection, and competency assessment across different affiliate sites. This approach responds to the inconsistency in telehealth education described by Chike-Harris et al. (2021) and to calls for systematic digital health curricula rather than isolated elective content (Khurana et al., 2022).

Assessment should also move beyond a single self-report measure. The current instruments are useful for institutional surveillance because they identify domains and allow comparison across cohorts, but performance assessment would strengthen evidence of competence. Objective structured clinical examinations could present a teleradiology case with an incomplete image series, mismatched metadata, an expired credential, a delayed transmission, or a privacy-sensitive communication problem. Students could be assessed on recognition, initial response, escalation, documentation, and maintenance of patient safety. Such assessment would address the perceived-versus-performed distinction highlighted by Ghaedi et al. (2024) and would create more direct evidence that curricular exposure transfers into practice.

The decentralized character of clinical preparation makes transfer especially important. A student may encounter different hardware, PACS interfaces, network reliability, staffing patterns, and escalation pathways across affiliate environments. Technology-specific memorization can fail when the interface changes, but principle-based competence is portable. Professional teleradiology guidance consistently focuses on quality, security, documentation, role responsibility, and reliable communication rather than dependence on a particular vendor (American College of Radiology et al., 2022; Morales Santos et al., 2023; Özmen et al., 2021). Curriculum design should mirror that logic by teaching stable principles first and then allowing students to practice those principles on varied systems.

The findings also have implications for faculty development. A digital curriculum is difficult to sustain when faculty expertise is concentrated in equipment operation but less developed in information appraisal, cybersecurity, imaging informatics, or remote workflow. Tudor Car et al. (2022) conceptualize digital education as an ecosystem that includes infrastructure, educators, learners, context, and quality improvement. Institutions should therefore pair student-level interventions with faculty calibration, scenario banks, shared rubrics, and coordination with clinical affiliates. Site preceptors can help define realistic troubleshooting and communication tasks, while imaging informatics staff can ensure that educational content reflects current system architecture without exposing protected credentials or patient data.

Finally, this study offers a radiologic technology-specific contribution to a literature dominated by medicine, nursing, and broad allied health samples. The importance of that contribution lies in the profession's proximity to the digital imaging pipeline. Reponen and Niinimäki (2021) show that teleradiology and PACS have developed together with broader imaging informatics, and current standards position the radiologic technologist as an active participant in electronic imaging quality. For programs that prepare students for distributed clinical environments, digital health literacy and teleradiology adaptability should therefore be treated as related but distinct outcomes. The former concerns how students handle health information in digital environments; the latter concerns whether they can apply professional, communicative, and technical judgment when imaging services depend on remote connectivity.

V. LIMITATIONS

Several limitations should guide interpretation. First, the study involved one private higher education institution and only 80 students. The census provides complete coverage of the defined institutional population, but it does not establish national representativeness. Curricular sequencing, affiliate-site technology, faculty expertise, and internet infrastructure may differ across Philippine radiologic technology programs. Multicenter replication is needed before the score distributions are treated as benchmarks.

Second, both principal outcomes were self-reported. The digital health literacy instrument measures perceived capability, and the adapted teleradiology questionnaire measures confidence in applied competence rather than direct task performance. Social desirability and overestimation or underestimation of skill may therefore affect scores. This limitation is material because research has shown that perceived and performed digital health literacy do not always coincide (Ghaedi et al., 2024). Future studies should combine self-report with observed search tasks, image-workflow simulations, privacy decisions, and structured troubleshooting assessments.

Third, the teleradiology measure was adapted from a validated general telehealth competency instrument. Expert review, strong content validity, pilot reliability, and high internal consistency supported its use for this study, but radiology-specific construct validation should continue in larger and more diverse samples. Confirmatory factor analysis was not appropriate with the present sample size. Fourth, year level was used as an indicator of accumulated curricular exposure. It did not measure the number, duration, or type of PACS and teleradiology encounters at each clinical site, so the study cannot identify which specific experience produced the observed differences.

Fifth, the cross-sectional design prevents causal inference. Higher scores in advanced years may reflect curricular development, selection, maturation, prior technology exposure, or unmeasured differences between cohorts. Longitudinal measurement of the same students before and after defined digital health and teleradiology learning experiences would provide stronger evidence of curricular effect. Despite these limitations, the complete institutional census, use of established measurement foundations, explicit contextual validation, complete data, and convergent analyses across group differences, correlations, and regression provide a rigorous baseline for curriculum evaluation.

VI. CONCLUSION

Radiologic technology students demonstrated measurable but uneven readiness for a digital imaging environment. Digital health literacy was strongest for information search and privacy behavior and weaker for content generation and reliability appraisal. Teleradiology adaptability showed the greatest strength in professional rapport and the lowest score in troubleshooting. Both constructs differed substantially by year level, with the clearest advantages among students in the advanced years of the program.

Digital health literacy was positively associated with teleradiology adaptability and remained an independent predictor after adjustment for year level. The result supports a curriculum in which general digital information competence and applied remote-imaging competence develop together. Radiologic technology programs can use a staged approach that begins with evidence appraisal and privacy, progresses through PACS and imaging informatics, and culminates in simulation and supervised teleradiology practice across clinical sites. Such preparation can help graduates enter increasingly networked imaging services with stronger judgment, communication, and technical resilience.

Author Contributions

Ma. Victoria Patrimonio: Investigation, Data curation, Project administration, Writing – original draft. Ahemda Ali: Formal analysis, Validation, Visualization, Writing – review & editing. Mark Alipio: Conceptualization, Methodology, Supervision, Writing – review & editing. All authors have read and agreed to the published version of the manuscript.

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Ethics Approval and Informed Consent

The study was conducted in accordance with the ethical standards of the Declaration of Helsinki and approved by the Institutional Ethics Review Committee of Iligan Medical Center College. Written informed consent was obtained from all participating students prior to their inclusion in the study. All data were de-identified to ensure confidentiality, and it was explicitly communicated that participation was entirely voluntary and would not impact the students' academic standing or grades.

Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Deidentified data may be made available by the corresponding author upon reasonable request and subject to applicable ethics and institutional requirements.

Declaration of AI Use

During the preparation of this work, the authors utilized generative artificial intelligence technologies exclusively for language refinement, structural formatting, and copyediting. The AI system had no access to raw data and was not used to generate data, perform analyses, or draw scientific conclusions. The authors independently reviewed, edited, and validated all content, and take full responsibility for the accuracy and integrity of the final publication.

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