revista interfaces
Artigos Originais
V. 13, N. 3 (2025) | ISSN 2317-434X

BEYOND DIGITAL LITERACY: EVALUATION OF THE DIGITAL INTELLIGENCE OF STUDENTS AND HEALTHCARE WORKERS

DOI: 10.16891/2317-434X.v13.e3.a2025.id2477 *Recebido em: 12.11.2024 | Aceito em: 31.07.2025*

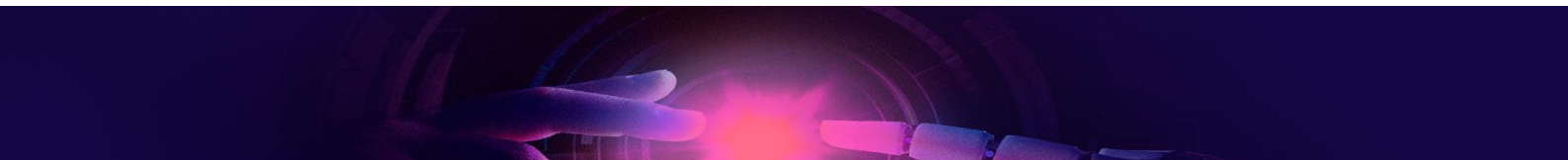
Gilberto Vieira Branco[a]*, Deysianne Costa das Chagas[b], Luciano Rodrigo Lopes[c], Ivan Torres Pisa[c], Angélica Baptista Silva[d]

Rede Nacional de Ensino e Pesquisa – RNP, Rio de Janeiro – RJ, Brasil[a]
Universidade Federal do Maranhão – UFMA, São Luís – MA, Brasil[b]
Universidade Federal de São Paulo– UNIFESP, São Paulo – SP, Brasil[c]
Fundação Oswaldo Cruz– FIOCRUZ, Rio de Janeiro – RJ, Brasil[d]
E-mail: gilberto.branco@rnp.br

ABSTRACT

The concept of Health Digital Intelligence (HDI), which encompasses digital literacy, refers to the set of competencies, knowledge, skills, attitudes, and values that enable individuals to effectively use digital information and communication technologies in their health-related activities. Recognizing the urgency and necessity of HDI, the Ministry of Health's Digital Health Strategy 2020-2028, Brazil, underscores its importance. This article describes the development of a self-assessment test for HDI aimed at students and healthcare workers. This quantitative, cross-sectional, and descriptive study adopted the Common Framework for Digital Literacy, Skills, and Readiness, addressing digital competencies such as identity, use, safety, security, emotional intelligence, communication, literacy, and rights. The development stages included a literature review, test creation, expert evaluation, volunteer application, result analysis, discussion, and adjustments. In the first application, 292 participants responded to 44 statements, while in the second, 79 volunteers responded to 56 statements. An individual digital report was provided with a literacy score, highlighting profiles of digital citizenship, digital creativity, and digital competitiveness, as well as strengths and weaknesses in digital health literacy. Future studies should explore the application of the full HDI model and its relationship to the digital literacy maturity of students, healthcare professionals, patients, and citizens, aiming to significantly enhance the quality of healthcare delivery.

Keywords: Digital health; Computer literacy; Health education.



revista interfaces
Artigos Originais
V. 13, N. 3 (2025) | ISSN 2317-434X

INTRODUCTION

Despite the widespread use of information technologies to enhance public health, significant global disparities persist in access to healthcare services, particularly in low- and middle-income countries and among populations facing economic and clinical challenges. Therefore, increasing access to healthcare and promoting advances in information and communication technologies (ICTs) concerning health services is necessary. In alignment with the Digital Health Strategy for Brazil 2020-2028 (BRASIL, 2020) and the guidelines proposed by the World Health Organization (WHO, 2021), this study aimed to investigate the levels of digital literacy among health workers, including health professionals, managers, service providers, educational and research institutions, health plan operators, and ICT professionals and companies (BRANCO, 2022).

Paul Gilster popularized the concept of digital literacy (POOL, 1997), which refers to the ability to comprehend, evaluate, and integrate digital information. The current study builds on existing research and emphasizes the need to enhance digital skills to improve professional performance in healthcare.

Furthermore, the current study aims to go beyond mere digital literacy by employing a digital self-assessment tool—i.e., the Health Digital Intelligence Test (HDIT)—based on the digital intelligence model developed by the DQ Institute (DQ INSTITUTE, 2019). The HDIT assesses the following dimensions: digital connectivity, citizenship, creativity, and competitiveness. The current study aimed to identify strengths and areas for development among healthcare workers, thereby facilitating the implementation of individualized development plans. This research aimed to contribute to the digital training of health professionals, thus aligning with the scientific objectives of the Saúde 360° research group at the Federal University of São Paulo (UNIFESP), Brazil.

MATERIAL AND METHODS

The current study applied a cross-sectional design and included both descriptive quantitative analyses. A wide range of digital literacy assessment tools were identified based on an integrative literature review of the PubMed, Brazilian Capes Portal, and Education Resources Information Center (ERIC) databases. The literature review used the following search terms: "digital literacy" and "health". Tools were selected based on their relevance in digital literacy and health informatics and based on their degree of alignment with the OECD guidelines (OECD, 2019).

A digital intelligence framework was chosen to develop the new instrument; this framework is based on a 24 competencies matrix and was derived from 25 global digital literacy initiatives from institutions such as British Columbia, Microsoft, Mozilla, the OECD, Open University and UNESCO. The HDIT competencies were organized into eight areas of personal development: digital identity, digital use, digital protection, digital security, digital emotional intelligence, digital communication, digital literacy, and digital rights. According to the digital literacy framework, each competency offers four dimensions of knowledge, skills, and attitudes (KSA) values: digital connectivity, digital citizenship, digital creativity, and digital competitiveness.

The original framework was translated from English into Brazilian Portuguese using Microsoft Translate. Then, the translation was evaluated by a specialist who was fluent in English. Furthermore, a panel of judges, including experts in digital literacy and health informatics, assessed the adequacy of the translations to ensure the quality and relevance of the new instrument. Additionally, the items were adapted for the Brazilian context to ensure cultural relevance, including the public health system's architecture.

Since the original framework does not include direct questions for an assessment test, questions for the IDs test were developed and scored using the Likert scale (LIKERT, 1932). The aim was to create a sustainable digital literacy test that would serve as a self-assessment tool and as an incentive for personal improvement. A website was developed using the automation of the HDIT assessment tool. The website was built using PHP and JavaScript programming languages, MySQL database, and HTML/CSS markup languages. The website was prepared to receive voluntary respondents through spontaneous demand. Additionally, a routine was developed for students of an online Health Informatics Specialization Course (HISC) at UNIFESP to access the HDIT directly from the Moodle virtual learning

revista interfaces
Artigos Originais
V. 13, N. 3 (2025) | ISSN 2317-434X

environment. Furthermore, all respondents were invited to provide information such as the education field, type of healthcare work establishment, use of technologies at work, and strategy used to learn about technology.

Test applications

The first pre-alpha version of the HDIT questionnaire consisted of 30 closed-ended questions, which took approximately 20 minutes to complete. The test addressed topics such as technologies, use of technological resources, strategies, frequency of use, perceived importance, and self-assessment of digital literacy. The test was divided into four sections: general digital literacy; digital literacy in academic studies; digital literacy in professional activities; and digital literacy in personal, social, and entertainment activities. The results are presented as percentages for six leading indicators: general digital literacy, assertiveness, strategies, use of technology, frequency, and perceived importance. Finally, a single predictor for the self-assessment of digital literacy was obtained. This version was administered to the students from HISC/UNIFESP, 5th edition.

The second version of the HDIT questionnaire consisted of affirmative statements and took approximately 40 minutes to complete. It focuses on the respondent's self-reflection and presents as a psychometric test and a competency assessment. This test is not an exam because its responses cannot be judged as right or wrong. The HDIT alpha version includes 44 statements, and the beta version consists of 56 statements. A digital report was created to provide detailed feedback to the respondents, including skills to develop, strengths and weaknesses, and general results. This version was administered to students from the HISC/UNIFESP, 6th and 7th editions.

Response criteria

The items were rated on a Likert-type scale (LIKERT, 1932) with four response options: “totally disagree”; “partially disagree”; “partially agree”; “totally agree”; and “I didn't understand” or “does not apply to me”. This model was chosen for its simplicity and ease of use, thus enabling participants to express their level of agreement or disagreement with each statement in a straightforward manner. It has been widely used in similar assessments and has demonstrated good validity and reliability.

Results analysis

An analysis of the results and suggestions from participants followed the application. The beta version was then adapted for the specificity of the health context, with revised statements and new examples. A committee of digital literacy and health informatics expert judges oversaw this adaptation process. Their role was to ensure the fairness and objectivity of the adaptation process by approving the final version of the test based on their collective expertise and judgement.

The data were extracted from MySQL, entered into spreadsheets and loaded into Excel and Power BI for statistical analysis. Descriptive statistical methods were applied using the BioStat program.

Population and sample

The research included students, professionals, and health managers, excluding patients, authorities, and others who did not work in the health sector. Participants were recruited from specialization courses and via the internet, including 540 specialization students and course staff in the pre-alpha application, 292 specialization students in the alpha application, and 192 workers in the beta application.

Study period and location

We carried out the study between December 2018 and May 2022, with data collection and analysis occurring from July-August 2020, May-July 2021, and May-June 2022. The research was conducted at the Health Informatics Department at UNIFESP, with participants recruited from specialization and acceptance courses under the strictest adherence to approved ethical criteria.

Reliability Analysis

To assess the reliability of the HDIT, statistical measures related to reliability validation methods were applied to calculate Cronbach's Alpha coefficient. The dataset included responses from all participants, with

calculations of mean, standard deviation, and variance for each response, as well as the total variance for each respondent. Cronbach's Alpha was computed using four different approaches: (1) grouping all respondents across all levels, (2) grouping by digital citizenship level, (3) grouping by digital creativity level, and (4) grouping by digital competitiveness level. In all cases, an alpha coefficient above 0.70 was expected, indicating that the instrument demonstrates reliable internal consistency.

Ethical criteria

The UNIFESP Ethics Committee approved this study, opinion 3.316.294/2019, respecting Resolution 466/2012 of the Brazilian National Health Council. Informed consent was obtained from the participants, ensuring the ethical integrity of the research and the protection of the participants' rights.

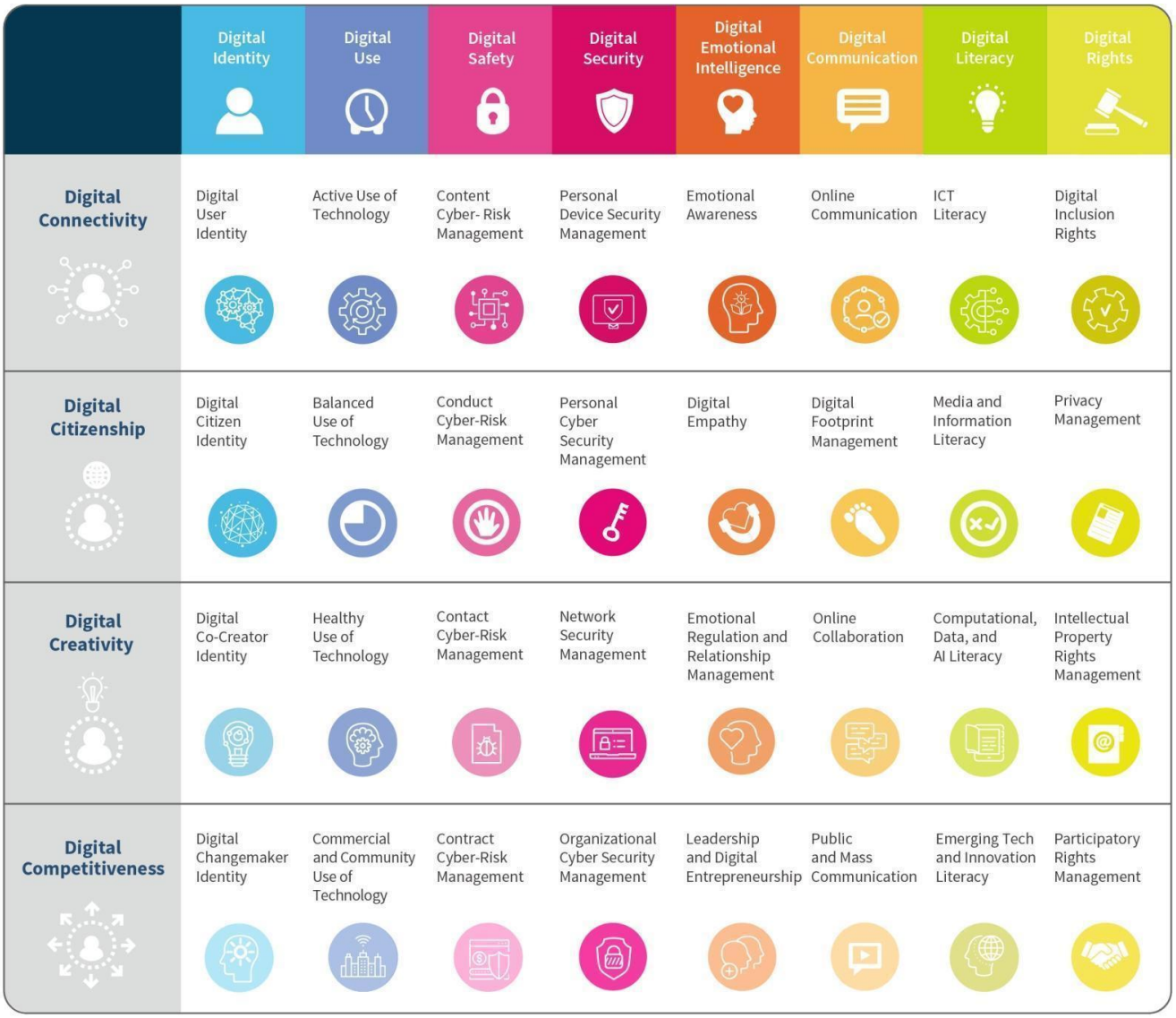
RESULTS

The search identified 16 relevant sources, including articles, books, and reports (BURNETT *et al.*, 2014). Three primary frameworks for digital skills emerged: McKinstry *et al*. (2020), Hübner *et al*. (2018), and the DQ Institute (2019). Among them, the DQ Institute Digital Intelligence Framework stood out, consolidating 25 existing literacy models into a structured matrix. It defines four digital identity profiles—connectivity, citizenship, creativity, and competitiveness—each subdivided into eight areas, totaling 24 key competencies.

After evaluating the three frameworks selected, the digital intelligence framework was found to be robust, as indicated by its competency matrix and its IEEE 3527.1-2020 standardization, which was obtained from the learning technology committee of the Institute of Electrical and Electronics Engineers (IEEE) (Figure 1).

revista interfaces
Artigos Originais
V. 13, N. 3 (2025) | ISSN 2317-434X

Figure 1. Digital intelligence competencies.



Source: © DQ Institute, 2023.

Regarding the HDIT alpha version, analysis revealed a 74.7% average proficiency in digital skills among 292 respondents (mainly UNIFESP students). Following an evaluation, the HDIT was refined into the beta version, increasing the number of questions (from 44 to 56), integrating practical examples, and enhancing data security measures. The beta version was administered to 79 professionals across different fields. A chi-square (χ^2) test assessed the association between response patterns and digital literacy profiles. The most frequent responses were "Completely agree" (53.62%) and "Partially agree" (24.21%), indicating enhanced clarity and precision.

The digital literacy levels varied across professional groups. Among healthcare professionals, averages ranged from 52% (physiotherapists) to 84% (attendants), with nursing (76%) and medicine (75%) representing the largest groups. In non-health sectors, literacy scores spanned from 39% (audit) to 98%

revista interfaces
Artigos Originais
V. 13, N. 3 (2025) | ISSN 2317-434X

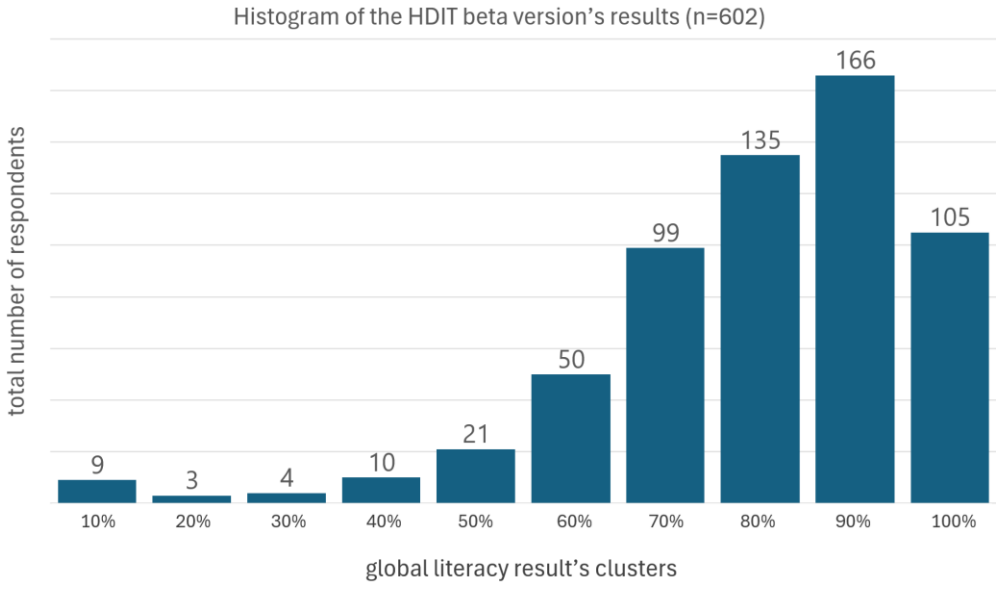
(engineering), with health IT (86%) and administration (67%) forming the largest subgroups. A notable difference in literacy levels between health professionals and students was observed.

The comparison of HDIT versions (Table 1) highlights distinct competency profiles, particularly for healthcare workers and health IT specialists. The beta version demonstrated higher precision and adaptability, validating its role in assessing and enhancing digital literacy across sectors, with an emphasis on digital health. By June 2024, 602 respondents had completed the beta version, as illustrated in the histogram (Figure 2).

Table 1. Global literacy comparison between samples.

HDIT version	N	Respondent profile	Global literacy mean	Global literacy median	Minimum and maximum values
Pre-alpha	522	Specialization students	1.0%	5.1%	3.0-98.0%
Alpha	292	Specialization students	74.7%	6.4%	27.0-100%
Beta	79	Health professionals	74.6%	7.0%	19.0-99.0%

Figure 2. Histogram of the HDIT beta version's results (n=602) as of June 2024, with the X-axis representing the global literacy result's clusters and Y-axis representing the total number of respondents.



Regarding the reliability of the HDIT, the application of Cronbach's Alpha coefficient (CRONBACH 1951) to the beta version data demonstrated values above 0.70 across all levels of knowledge, both individually and collectively, as presented in Table 2. One of the characteristics of this method is that the alpha value tends to increase as the number of evaluated aspects grows. This is particularly evident in the global level, which considers the sum of all responses and aligns with findings in the literature. Thus, the instrument can be considered reliable, indicating adequate internal consistency.

revista interfaces
Artigos Originais
V. 13, N. 3 (2025) | ISSN 2317-434X

Table 2. Comparison of Cronbach's Alpha coefficients by digital intelligence level.

Level	Questions	Cronbach alpha
Digital citizenship	19	0.89
Digital creativity	20	0.82
Digital competitiveness	17	0.83

DISCUSSION

The development of digital literacy supported by skills analysis (DQ INSTITUTE, 2019; HÜBNER *et al*., 2018; KUEK *et al*., 2018) suggested the empowerment of healthcare workers. Mesko and Győrffy (2019) asserted that 21st-century healthcare workers should have skills such as curiosity, teamwork, continuous learning, creativity, partnership with patients, empathy, and digital literacy. The study also explored the potential benefits and barriers to achieving this empowerment. Some studies identified obstacles including a lack of knowledge about digital health technologies, insufficiently trained support staff, concerns about patient data privacy and security, and a work culture that is resistant to innovation.

The decision to investigate digital intelligence and develop the HDIT to measure and analyse the level of digital literacy was a response to numerous reports in the literature. These reports highlighted that the lack of skills in dealing with ICT delays professional career development leads to relationship problems within teams, limits professional performance, and causes a series of other issues stemming from a lack of information or updates related to ICT use (HÜBNER *et al*., 2018; MESKO *et al*., 2019; BURNETT *et al*., 2014; CAMPBELL *et al*., 2011).

The test helped identify literacy levels in three fundamental aspects: citizenship, creativity, and competitiveness. The results provided a broad perspective on the healthcare professional's readiness to operate in the digital environment and make informed decisions.

Citizenship is an essential pillar, and a percentage above 70% indicates a high level of digital awareness and responsibility. This means the professional is well-prepared to engage with health-related information ethically and critically, understanding the social impacts of their decisions.

Creativity, on the other hand, is directly linked to the ability to conduct research, create content, and interpret information from various sources, including potentially misleading content such as fake news. A level below 70% may indicate difficulties in developing reliable materials or in cultivating the critical thinking necessary to validate information before sharing it. To ensure that healthcare professionals can effectively and safely generate and disseminate knowledge, their creative literacy should be above this threshold.

Finally, competitiveness involves the use of data and artificial intelligence in the workplace, as well as ethical considerations regarding technology. Professionals with scores between 50% and 70% have a valuable opportunity to enhance their skills in AI tools, both for content creation and personal use. Scores above 80% suggest strong analytical capabilities, enabling professionals to interpret data strategically and apply it to clinical or administrative decision-making processes.

These indicators reflected not only the professional's technical proficiency but also their aptitude to navigate a dynamic and ever-evolving digital landscape. Investing in the development of these competencies strengthens evidence-based healthcare practice and contributes to a more efficient and trustworthy system.

Furthermore, it is difficult to determine how healthcare workers react after completing the HDIT. This tool was expected to empower healthcare workers, giving them a starring role in their careers. By learning about the new elements that constitute digital literacy, health workers will likely be able to assess their current level of digital intelligence and explore opportunities for expanding their knowledge within digital health.

The reliability analysis of the HDIT, with Cronbach's alpha coefficients above 0.70 across all domains, indicates adequate internal consistency of the instrument. The highest value in digital citizenship (0.89)

revista interfaces
Artigos Originais
V. 13, N. 3 (2025) | ISSN 2317-434X

suggests strong coherence among items related to the ethical and critical use of technologies. The indices obtained for creativity (0.82) and competitiveness (0.83) demonstrate that the HDIT is sensitive to different levels of digital maturity among professionals. These findings reinforce the instrument's validity for identifying training gaps and supporting capacity-building strategies in digital health.

This study aimed to enable respondents to conduct a self-assessment process through our digital reports. These reports described the profiles and relationships of digital literacy competencies, including respective achievement percentages and the elements of the competencies already developed (i.e., strengths) and those not yet developed (i.e., weaknesses). In addition to the self-assessment process, our goal was to verify the possibility of group analysis and use it as a decision-making tool for managers. In fact, after analysing the global results, it was evident that for HDIT to become an effective decision-making support tool, adjustments to the platform will be necessary. For instance, we identified the need to develop a reporting module that allows data segmentation. With the generation of segmented reports, it would be possible to analyse groups and use HDIT as a tool to support decision-making in both health institutions and higher education institutions.

Limitations

Although the study began before the COVID-19 pandemic, the beta version was applied during the height of the pandemic. The pandemic restricted our ability to conduct the study in university hospitals, such as Hospital São Paulo, Brazil, which had shown interest in broader internal dissemination and conducting personal interviews with the institution's healthcare professionals.

Additionally, the decision to focus solely on digital literacy limited the scope for comparing our results with other areas of the digital intelligence framework. However, the findings provide a strong incentive for future studies to apply the test across all areas of digital intelligence, thereby offering healthcare workers a more comprehensive self-assessment of their digital intelligence.

CONCLUSIONS

This study aimed to analyse the digital literacy of students and healthcare workers to identify their respective digital competence profiles and establish a value scale for their measurement. The analysis revealed that the digital citizenship profile was the most developed among respondents, while the creativity and digital competitiveness profiles presented the greatest opportunities for developing skills related to digital literacy. We were able to quantitatively analyse both the global percentages per respondent and the specific percentages per profile, providing a clear measure of the results obtained.

HDIT variables were used to identify profiles with the most significant strengths and to pinpoint aspects of skills that respondents strongly accepted or required further development. Additionally, we could establish groupings by activity, allowing us to infer how the HDIT was applied and identify potential areas for improvement. The application of the digital intelligence model to the digital health sector has been proven to be viable, as indicated by the initial results obtained.

The study highlighted both challenges and opportunities for the evolution of the HDIT. The next steps include expanding the analysis to cover all areas of the digital intelligence model, devoting special attention to primary healthcare workers, creating reports that offer a learning journey related to the test results, and enhancing the HDIT as a decision-making support tool in health institutions. For these efforts, the project was supported by public financial funding through Department of Science and Technology of Secretariat of Science, Technology, Innovation and Health Complex of Ministry of Health of Brazil – MoH with support from the National Council for Scientific and Technological Development – CNPq Call No. 21/2023 - Transdisciplinary Studies in Public Health, project 445310/2023-5, for the period 2024-2026. HDIT must be widely applied as a tool for developing human resources training initiatives in digital health in Brazil.

ACKNOWLEDGEMENTS

The authors thank all the volunteer respondents who contributed to the development of the test; the coordination of the Health Informatics Specialization

Course at UNIFESP; the Saúde 360° research group for their support in the dynamics and evaluations; the Health Informatics Department, UNIFESP, for the academic support; and the financial funding from the Decit/SECTICS/MS (MoH) with support from the CNPq, Brazil, process 445310/2023-5, for the period 2024-2026.

REFERENCES

BRANCO, G. V.; LOPES, P. R. L.; PISA, I. T. Evolução da literacia digital e sua importância para os trabalhadores da área da saúde na era da inteligência digital. **Revista de Saúde Digital e Tecnologias Educacionais**. [online], p. 1-15, 2020. Available from: https://repositorio.ufc.br/bitstream/riufc/56007/1/2020_art_gvbranco.pdf.

BRANCO, G. V. **Análise da literacia digital de estudantes e trabalhadores da área da saúde** [Internet]. São Paulo: UNIFESP; 2022 Sep 27 [cited 2024 May 31]. Dissertação (Mestrado) - Programa de Pós-Graduação em Gestão e Informática em Saúde, Escola Paulista de Medicina, Universidade Federal de São Paulo, 2022. Available from: https://repositorio.unifesp.br/handle/11600/65819.

BRASIL. **Estratégia de Saúde Digital para o Brasil 2020-2028**. Brasília-DF: Ministério da Saúde, Departamento de Informática do SUS; 2020. Available from: http://bvsms.saude.gov.br/bvs/publicacoes/estrategia_saude_digital_Brasil.pdf.

BURNETT, C.; MERCHANT, G.; PAHL, K.; ROWSELL, J. The (im)materiality of literacy: the significance of subjectivity to new literacies research. **Discourse: Studies in the Cultural Politics of Education**. South Yorkshire, v. 35, p. 30-103, 2014. DOI: https://doi.org/10.1080/01596306.2012.739469.

CAMPBELL, C. J.; MCDOWELL, D. E. Computer Literacy of Nurses in a Community Hospital: Where Are We Today? **J Contin Educ Nurs**, v. 42, p. 365-370, 2011. DOI: https://doi.org/10.3928/00220124-20110215-01.

CRONBACH, L. J. Coefficient Alpha and the Internal Structure of Tests. **Psychometrika**, v. 16, p. 297-334, 1951. DOI:

DQ INSTITUTE. **DQ Global Standards Report 2019: Common Framework for Digital Literacy, Skills and Readiness** [Internet]. Singapore: DQ Institute; 2019 [cited 2024 May 31]. Available from: https://www.dqinstitute.org/wpcontent/uploads/2019/11/DQGlobalStandardsReport2019.pdf.

DQ INSTITUTE. **DQ Global Standards Microcredentials (GSM): A Global Interoperable Codification of Digital Skills for AI and Sustainability**. [Internet]. Singapore: DQ Institute; 2023 Nov [cited 2024 May 31]. Available from: https://www.dqinstitute.org/wp-content/uploads/2023/11/DQ-GSMWhitepaper.pdf.

HÜBNER, U. *et al*. Technology Informatics Guiding Education Reform - TIGER. **Methods Inf. Med.** v. 57, p. 30–42, 2018. DOI: https://doi.org/10.3414/ME17-01-0155.

KUEK, A.; HAKKENNES, S. Healthcare staff digital literacy levels and their attitudes towards information systems. **Health Informatics J.**, v. 26, p. 592–612, 2020. DOI: https://doi.org/10.1177/1460458219839613.

LIKERT, R. A technique for the measurement of attitudes. **Archives of Psychology**, v. 22, p. 5-55, 1932.

MCKINSTRY, C.; IACONO, T.; KENNY, A.; HANNON, J.; KNIGHT K. Applying a digital literacy framework and mapping tool to an occupational therapy curriculum. **Aust Occup Ther J.**, v. 67, p. 210–217, 2020. https://doi.org/10.1111/1440-1630.12644.

MESKO, B.; GYŐRFFY, Z. The Rise of the Empowered Physician in the Digital Health Era: Viewpoint. **J. Med. Internet Res.**, v. 21, 2019.

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD). **Skills for 2030: Concept Note** [Internet]. 2019 [cited 2024 May 14].

Available from: https://www.oecd.org/education/2030-project/teaching-andlearning/learning/skills/skills_for_2030_concept_note.pdf.

POOL, C. R. A New Digital Literacy: A Conversation with Paul Gilster. **Educational Leadership**, v. 55, p. 6-11, 1997.

WORLD HEALTH ORGANIZATION (WHO) (2021). **Global strategy on digital health 2020-2025** [Internet]. Available from: https://iris.who.int/handle/10665/344249.