



Analysis of Digital Health Literacy Regarding Healthy Hydration Habits in University Students

Alejandro De la Hoz Serrano

Department of Mathematics and Sciences Education, Faculty of Education and Psychology, University of Extremadura, Spain, alexdlhoz@unex.es

Given the low levels of Digital Health Literacy and limited Scientific Knowledge concerning well-being, this study analyzed Healthy Hydration Habits and assessed the effect of an educational intervention, using active and collaborative methods, on the Digital Health Literacy and Scientific Knowledge in a small convenience sample of Primary Education Degree students (n=29). A exploratory quasi-experimental quantitative with qualitative interpretative categorization of score levels was conducted, with pre-post intervention without a control group. Standardized questionnaires was employed, including eHEALS for Digital Health Literacy and a custom questionnaire for Healthy Hydration Habits based on international recommendations, alongside scientific databases and an educational website. Findings indicated that male students exhibited more positive water consumption habits, while female students demonstrated insufficient intake. Following the intervention, Digital Health Literacy improved from a Problematic to a Sufficient level, and Scientific Knowledge related to hydration reached an Excellent level. These findings suggest that active, collaborative educational interventions supported by validated digital tools are associated with improvements in the digital professional competencies of future teachers. Expanding initial teacher-training programs focused on health and well-being promotion is therefore recommended.

Keywords: digital health technology, drinking behavior, health education, health literacy, teacher training, water

INTRODUCTION

In recent decades, diseases and health issues resulting from unhealthy lifestyles have increased alarmingly, particularly among children and adolescents. Within this context, overweight and obesity affect approximately one-third of the population aged 3 to 24 years, with a higher prevalence observed in males compared to females (Pérez-Rodrigo et al., 2022). One of the most significant risk factors is the excessive consumption of sugar-sweetened beverages as a substitute for water, which undermines healthy hydration habits and contributes to an imbalanced nutritional profile (Salas-Salvadó et al., 2020). Furthermore, the COVID-19 pandemic has exacerbated this trend by

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promoting more sedentary lifestyles and disorganized eating and hydration patterns, especially among young people (De la Hoz et al., 2021a).

Water, recognized as an essential nutrient by the European Food Safety Authority (EFSA), is indispensable for physiological functions such as thermoregulation, nutrient transport, and cognitive performance (EFSA, 2010). Despite its central role in human health, studies indicate that a large proportion of the population fails to meet daily hydration recommendations (Aphamis et al., 2021; García-García, 2022), and their scientific knowledge regarding the benefits of adequate hydration remains limited (Aranceta et al., 2016; Nissensohn et al., 2015; Perales-García et al., 2018). This gap reveals a disconnect between scientific evidence and everyday practices, which can be reversed through educational interventions promoting healthy behaviors and fostering competencies for informed decision-making (Chen et al., 2017; De la Hoz et al., 2020).

Despite growing concern about adopting healthy habits among young populations, there is a notable scarcity of updated epidemiological studies that thoroughly analyze hydration status in adolescent and university populations, particularly within the European context (Nissensohn et al., 2017). Specifically, in Spain, available data point to insufficient hydration patterns. The Hydration and Health Observatory reported that 85% of adults consumed fluid volumes below recommended levels, while other studies (Lombán et al., 2015; Ojeda, 2015) confirmed this trend among university students, many of whom reported drinking fluids only when experiencing thirst, with consumption heavily concentrated during main meals. This reactive approach to hydration reflects not only a lack of conscious habit but also limited education on the preventive role of healthy hydration (Ojeda, 2015).

In this context, the educational system represents a privileged space for promoting healthy lifestyles from an early age. Teachers play a decisive role not only as transmitters of knowledge but also as behavioral models capable of influencing students' long-term health practices. However, research consistently highlights the limited presence of structured Health Education and Digital Health Literacy content in teacher training programs, especially outside health-related disciplines. Strengthening these competencies in pre-service teachers is essential to ensure that future educators can guide their students toward healthier, evidence-informed behaviors Charro-Huerta & Charro, 2017; Franco-Reynolds et al., 2022).

Despite increasing research on hydration behaviors and Digital Health Literacy separately, few intervention-based studies have examined their combined development within pre-service teacher populations, a group that plays a key role in future school-based health promotion. This gap highlights the need for pilot educational interventions addressing both domains simultaneously.

Accordingly, the present study focuses on analyzing Healthy Hydration Habits, the level of Scientific Knowledge about these habits, and the degree of Digital Health Literacy among pre-service Primary Education teachers. By providing empirical evidence, this research aims to support the integration of Health Education and Digital Competencies as fundamental pillars of initial teacher training, promoting a pedagogical

approach that is reflective, current, and socially committed to individual and collective well-being.

CONTEXT AND REVIEW OF LITERATURE

Previous research analyzing beverage intake patterns among university populations reveal that, although water remains the most frequently consumed drink, daily volumes often fall short of the minimum values established by international organizations (Ojeda, 2015; Ruiz-Moreno et al., 2014). Furthermore, these studies have revealed a concerning incorporation of sugar-sweetened soft drinks as a habitual component of the liquid diet, which not only reduces hydration quality but also introduces metabolic risk factors. The ALADINO study (López-Sobaler et al., 2014), conducted in school-aged populations, already warned of this trend at early stages, with 36.8% of children consuming soft drinks between one and three times per week, and 9.6% at higher frequencies, suggesting continuity of this pattern into youth and university life. Similarly, the latest report from this study in 2023 continues to describe worrying obesity rates among children and adolescents (Recuero et al., 2024).

Moreover, comparative analyses of national databases from France, Italy, and Spain revealed that only French women met the recommended reference values for fluid intake (Nissensohn et al., 2017). This disparity among European countries with relatively similar cultural contexts highlights the urgent need to strengthen awareness campaigns, training, and scientific evaluation of healthy hydration, especially in educational settings where health education remains marginal in most non-health-related university programs (Kiss et al., 2024)

In this scenario, schools emerge as privileged environments for health promotion from early ages. Teachers play a crucial role as educators and behavioral models in the acquisition of healthy habits. However, several studies have pointed to significant deficiencies in initial teacher training on health topics, often limited to superficial content about the human body, hygiene, or nutrition (Charro-Huerga & Charro, 2017; Franco-Reynolds et al., 2022). This educational gap hinders the implementation of robust and updated educational proposals, reinforcing the need to develop programs that strengthen scientific knowledge applied to the school context (Franco-Reynolds et al., 2022; Nguyen et al., 2023).

Adding to this challenge is the issue of Digital Health Literacy (eHealth Literacy). In a deeply digitalized society, access to health information via the internet has become widespread, but not always yielding positive outcomes (Gavidia et al., 2019). Although university students frequently use digital media to seek health information, many lack critical skills to discern reliable sources from erroneous or decontextualized content (Acevedo et al., 2003; Hernández-Rabanal et al., 2018; Juvinyà-Canal et al., 2018). This phenomenon has led to the concept of Digital Health Literacy (eHealth Literacy), understood as the ability to seek, find, understand, evaluate, and apply health information obtained from electronic sources (Norman & Skinner, 2006; Nutbeam, 2000, 2009; Rojas-Gualdrón & Useche-Aldana, 2013).

Multiple studies have confirmed that university students, despite constant exposure to digital environments, do not always exhibit adequate levels of Digital Health Literacy (Kim & Xie, 2017; Llorent-Bedmar & Cobano-Delgado, 2019). A recent study in Portugal showed that nearly one-third of students assessed demonstrated *Inadequate* or *Problematic* competency levels, with many feeling unconfident to make health decisions based on information sourced online (Almeida et al., 2024). Although students knew how to search for resources, their ability to evaluate quality and apply the information was limited. Those with higher levels of Digital Health Literacy accessed official media and professional websites more frequently, while students relying on social media or general search engines performed worse. Furthermore, time dedicated to informed searching and academic discipline (health-related studies) were positively associated with higher Digital Health Literacy (eHealth Literacy) levels (Almeida et al., 2024).

These findings align with another systematic review showing that even health science students display low levels of Health Literacy, especially in its critical dimension, which involves the ability to assess risks and make informed decisions (Kühn et al., 2022). Additionally, factors such as age, semester enrolled, parents' educational level, and socioeconomic status also influence this competence (Kühn et al., 2022; Park, 2019).

Particularly relevant to education is a recent study conducted in Turkey involving non-health university students, including those enrolled in Education Degrees. This research found that general Digital Literacy was the primary predictor of Digital Health Literacy (eHealth Literacy) levels, followed by media and television literacy, and lastly, traditional Health Literacy (Dolu & Durmuş, 2023). Screen time, conversely, was not significantly associated with higher health literacy, contradicting the assumption that mere technological exposure equates to critical competence. Accordingly, the authors explicitly recommend incorporating specific courses on Digital Health Literacy into university curricula for degrees such as Education to equip future teachers with practical tools to combat health misinformation and educate their students based on sound scientific and digital criteria.

Given this dual necessity, to enhance scientific knowledge regarding healthy hydration habits and to strengthen Digital Health Literacy skills, implementing targeted training interventions within the university context is paramount. Previous studies have demonstrated that well-designed educational programs can yield significant improvements in both areas. Interventions focused on university populations have increased scientific understanding of hydration and positively modified consumption habits, especially among young people (De la Hoz et al., 2023). These results support advancing integrated educational strategies, particularly in Primary Education Degrees, where initial teacher training presents a key opportunity for intervention. These students not only need to adopt healthy behaviors but also develop scientific and digital competencies that enable them to become effective health promoters within school environments

Within this framework, the present study aims to analyze Healthy Hydration Habits, the level of Scientific Knowledge regarding these habits, and the level of Digital Health Literacy among pre-service teachers Primary Education. The research seeks to provide empirical evidence supporting the integration of Health Education and Digital Competencies as fundamental pillars of initial teacher training, thus fostering a more critical, updated, and socially committed pedagogical practice oriented toward individual and collective well-being.

METHOD

Study Design and Sample

This study employed a quasi-experimental pre–post intervention design without a control group, integrating descriptive and inferential quantitative analyses to examine changes in Healthy Hydration Habits, Digital Health Literacy (eHealth Literacy), and Scientific Knowledge following an educational intervention, and qualitative interpretative categorization of score literacy levels and scientific knowledge analysis (Creswell, 2021). A convenience sampling strategy was used, yielding a total of 29 participants, including 20 female and 9 male undergraduate students enrolled in the Primary Education Degree program. Due to the convenience sampling strategy, small sample size, and absence of a control group, the findings should be interpreted as exploratory and limited to similar educational contexts.

The sample reported a mean Body Mass Index (BMI) of 24.03, with higher values observed in male participants (25.30) compared to female participants (23.51). The intervention was conducted in full compliance with the ethical standards set forth in the Declaration of Helsinki (World Medical Association, 2022) and was approved by the institutional Bioethics and Biosafety Committee.

Intervention

In order to assess progress in both Digital Health Literacy (eHealth Literacy) levels and the acquisition of scientific knowledge, a collaborative active-learning intervention was implemented (Cruz & Béjar, 2014; Jaramillo et al., 2016). The intervention consisted of three hours of instructional training, organized into structured phases.

In the first phase involved instruction on the identification and use of various high-quality digital resources, search engines, and online bibliographic databases recognized for their scientific credibility. Participants were introduced to reputable professional validation platforms such as *INTEF*, *Educarex*, *CSIC* and *FECYT*. Subsequently, specific academic and research-oriented databases, including *Dialnet*, *PubMed*, *Google Scholar* and *ERIC*, were explored, along with specialized digital health resources such as the *WHO*, *Familia y Salud*, *Healthfinder* and *Health on the Net*. Additionally, a custom-designed educational website, published on the *Procomún* platform (https://procomun.intef.es/ode/view/es_2023060712_9123916), was presented as a tool for guiding students in Digital Health Literacy (De la Hoz et al., 2021b). It is important to note that all websites employed in the intervention were required to hold the *Health on the Net Foundation* (HON), ensuring their scientific and healthcare accuracy. This

criterion aims to equip students with reliable digital resources to enhance their Digital Health Literacy (eHealth Literacy) skills.

The educational intervention was carried out through collaborative group work, with students organized into teams of three to four members, following the methodology used in prior studies (Cruz & Béjar, 2014; Cubero et al., 2018). This group-based format allowed students to comprehensively engage with a wide range of validated sources while fostering peer collaboration and communication skills.

Data collection and analysis

To assess the level of Digital Health Literacy (eHealth Literacy), the Spanish version of the eHealth Literacy Scale (eHEALS) was employed (Paramio Pérez et al., 2015). The instrument was administered both before and after the intervention. The questionnaire comprises eight closed-ended items, each rated on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." For the classification of Digital Health Literacy (eHealth Literacy) levels, a qualitative categorization system previously validated in university populations was applied (Mávita-Corral, 2018).

In turn, to assess Scientific Knowledge regarding Healthy Hydration Habits, as well as the frequency of consumption of different types of beverages, a questionnaire (Appendix 1) was used. Hydration intake estimates were based on self-reported beverage consumption and did not include water obtained from food sources. Therefore, comparisons with EFSA recommendations should be interpreted cautiously, as total water intake may be underestimated. Scientific Knowledge was evaluated using four closed-ended items addressing fundamental hydration concepts, including recommended daily water intake, minimum daily water consumption, primary physiological functions of water, and the proportion of water intake obtained through food sources. Each item was scored using an objective rubric: correct responses received 1 point (e.g. "Approximately 2–2.5 liters per day in healthy adults."), partially correct responses 0.5 points (e.g. "Around 1.5 liters per day," reflecting incomplete alignment with guideline ranges or addressing only recommendations for children") and incorrect responses 0 points (e.g. "Water intake depends only on thirst; there is no recommended amount"), yielding a total possible score ranging from 0 to 4.

This instrument was derived from previously standardized studies and was based on the most relevant content that students are expected to master in order to achieve adequate learning about Healthy Hydration Habits, in accordance with recommendations from international organizations (Aranceta et al., 2016; EFSA, 2010; Martínez & Iglesias, 2006). To determine the level of Scientific Knowledge, a rating scale previously developed in studies of a similar nature was applied (De la Hoz et al., 2021a). Table 1 presents the categories and scales used to classify the different levels of scientific knowledge and eHealth literacy.

Table 1
Qualitative Categories of eHealth Literacy and Scientific Knowledge Levels

Category	eHEALS Score Range	Scientific Knowledge Scale
Inadequate	0-19	0-25%
Problematic	20-24	26-50%
Sufficient	25-31	51-75%
Excellent	32-40	76-100%

To validate internal consistency of the questionnaire, Cronbach's alpha coefficient was calculated, yielding a final value of 0.93 (excellent) for the eHEALS questionnaire and 0.70 (acceptable) for the scientific knowledge questionnaire (Taber, 2018). Data analysis was conducted using Microsoft Office Excel 365[®] for descriptive statistics, including means (M), percentages (%), Frequencies (F) and standard deviations (SD). Effect size estimates (EE) were calculated to assess the magnitude of observed differences and interpreted following conventional non-parametric benchmarks. Following the application of the Kolmogorov–Smirnov test ($p < 0.05$), which indicated that the data did not follow a normal distribution, non-parametric inferential statistical tests were used. The Mann–Whitney U test was applied to determine significant differences between independent student samples, while the Wilcoxon signed-rank test was used to analyze changes in eHEALS scores over time. These statistical analyses were performed using the ‘R-Commander’ interface within the ‘R’ software (Ocaña, 2019).

FINDINGS

The following section presents the results of the study. First, the findings related to students’ beverage intake frequencies, reflecting their Healthy Hydration Habits, are reported (Table 2). The data includes Frequencies (F) and Percentages (%) for the consumption of various types of beverages

Table 2
Descriptive Results of Daily Water Intake Frequency

Gender	< 6 Glasses		6 Glasses		> 6 Glasses	
	F	%	F	%	F	%
Male	0	0.0%	1	11.11%	8	88.89%
Female	8	40%	9	45%	3	15%
Total	8	27.59%	10	34.48%	11	37.93%

As observed, most male participants (88.89%) reported consuming more than 6 glasses of water daily, whereas only 15% of female participants reached this level of intake. Conversely, 40% of female students consumed less than 6 glasses of water per day, a pattern not observed among any of the male participants. Regarding the remaining beverages, Table 3 displays the corresponding frequencies and percentages for each category.

Table 3
Descriptive Results of the Frequency of Consumption of Various Beverages

Beverage	More than once a day		Once a day		Once a week		More than once a week		A few times a month		Never	
	F	%	F	%	F	%	F	%	F	%	F	%
Milk	1	11.11%	4	44.44%	1	11.11%	2	22.22%	1	11.11%	0	0%
Male	1	11.11%	4	44.44%	1	11.11%	2	22.22%	1	11.11%	0	0%
Female	4	22.22%	8	44.44%	2	11.11%	3	16.67%	1	5.55%	0	0%
Total	5	18.52%	12	44.44%	3	11.11%	5	18.52%	2	7.41%	0	0%
Natural Juices												
Male	0	0%	0	0%	3	33.33%	0	0%	5	55.55%	1	11.11%
Female	0	0%	2	10%	3	15%	1	5%	10	50%	4	20%
Total	0	0%	2	6.90%	6	20.69%	1	3.45%	15	51.72%	5	17.24%
Packaged juices												
Male	0	0%	1	11.11%	2	22.22%	3	33.33%	1	11.11%	2	22.22%
Female	0	0%	1	5%	4	20%	2	10%	8	40%	5	25%
Total	0	0%	2	6.90%	6	20.69%	5	17.24%	9	31.03%	7	24.14%
Milkshakes												
Male	0	0%	0	0%	0	0%	2	22.22%	2	22.22%	5	55.55%
Female	0	0%	1	5%	0	0%	1	5%	6	30%	12	60%
Total	0	0%	1	3.45%	0	0%	3	11.11%	8	27.59%	17	58.62%
Soft Drinks												
Male	0	0%	2	22.22%	1	11.11%	4	44.44%	2	22.22%	0	0%
Female	1	5%	1	5%	4	20%	9	45%	5	25%	0	0%
Total	1	3.45%	3	11.11%	5	17.24%	13	44.83%	7	24.14%	0	0%

Among all the beverages analyzed, Milk is the most frequently consumed by participants, with a total daily intake of 62.96% (44.44% once a day + 18.52% more than once a day). Following Milk, Soft drinks show the second highest daily consumption at 14.56% (11.11% once a day + 3.45% more than once a day), with the highest consumption category being more than once per week. Regarding Juices (both natural and packaged), most participants reported consuming them a few times per month. In contrast, Milkshakes represent the beverage with the lowest consumption, with 58.62% of participants reporting that they never consume them.

With respect to the inferential analysis (Table 4) comparing beverage consumption by gender, statistically significant differences ($p < 0.05$) were found only for water intake, which was higher among male participants. Effect size estimates (EE) were calculated to assess the magnitude of observed differences and interpreted following conventional non-parametric benchmarks.

Table 4
Inferential results on beverage consumption frequencies according to the gender of the study sample

Beverages	U de Mann-Whitney		
	E	p	EE
Water	19.5	<0.01*	0.78
Milk	84.5	0.81	0.06
Natural juices	83.5	0.80	0.07
Packaged juices	70.5	0.36	0.22
Milkshakes	83.0	0.73	0.08
Soft drinks	84.0	0.78	0.07

*Statistically significant differences ($p < 0.05$)

The following section describes the descriptive results of the eHealth Literacy Scale (eHEALS) questionnaire, followed by the inferential statistical outcomes. Subsequently, the results obtained from the Scientific Knowledge questionnaires on health-related content are presented. Table 5 displays the descriptive results of the eHealth Literacy Scale (eHEALS) questionnaire prior to the intervention, both by gender and for the total sample.

Table 5
Descriptive Results of the Pretest eHealth Literacy Scale (eHEALS) Questionnaire.

Item	Pretest		Female		Total	
	Male		X	SD	X	SD
	X	SD				
1	3.44	1.33	2.05	0.89	2.48	1.21
2	3.11	1.27	2.10	0.85	2.41	1.09
3	3.00	1.32	2.45	0.89	2.62	1.05
4	3.33	1.19	2.70	1.13	2.90	1.15
5	3.11	0.93	2.48	1.10	2.66	1.08
6	3.11	0.78	2.35	1.09	2.59	1.05
7	3.22	0.83	2.75	1.16	2.90	1.08
8	3.00	1.00	2.45	1.05	2.62	1.05
Total	25.33	6.48	19.30	6.84	21.17	7.20

*Statistically significant differences ($p < 0.05$)

As can be observed, the results indicate that male students obtained higher scores than female students. In this case, the level of Digital Health Literacy is classified as *Problematic* for males and *Inadequate* for females. Regarding the overall sample, the level is categorized as *Problematic*. Concerning the post-intervention results (Table 6), male students again scored higher than female students. Here, the Digital Health Literacy level is *Excellent* for males and *Sufficient* for females. For the total sample, the level is classified as *Sufficient*.

Table 6
Descriptive Results of the Posttest eHealth Literacy Scale (eHEALS) Questionnaire.

Item	Pretest		Female		Total	
	Male		X	SD	X	SD
	X	SD				
1	3.89	0.33	3.75	0.91	3.79	0.77
2	4.22	0.44	4.20	0.62	4.21	0.60
3	4.33	0.50	4.05	0.67	4.14	0.64
4	4.22	0.67	3.95	0.69	4.03	0.68
5	4.11	0.61	3.85	0.49	3.93	0.53
6	3.89	0.61	3.55	0.61	3.66	0.61
7	3.56	0.53	3.70	0.73	3.66	0.67
8	3.78	0.67	3.60	0.75	3.66	0.72
Total	32.00	2.87	30.65	3.81	31.07	3.56

*Statistically significant differences ($p < 0.05$)

Based on the inferential results, Table 7 presents the statistical outcomes of the Mann-Whitney U test according to the participants' s gender.

Table 7
Statistical results of the Mann-Whitney U test for the eHealth Literacy (eHEALS) questionnaire.

Item	U de Mann-Whitney					
	Pretest			Posttest		
	S	<i>p</i>	EE	S	<i>p</i>	EE
1	35.0	0.01*	0.61	88.0	0.93	0.02
2	47.0	0.00*	0.48	90.0	1.00	0.00
3	63.0	0.19	0.30	70.5	0.31	0.22
4	63.0	0.19	0.30	71.0	0.33	0.21
5	58.0	0.13	0.36	70.0	0.24	0.22
6	53.0	0.07	0.41	63.5	0.17	0.29
7	70.5	0.35	0.22	83.0	0.74	0.08
8	64.5	0.22	0.28	78.5	0.57	0.13
Total	45.0	0.04*	0.50	69.5	0.34	0.23

*Statistically significant differences ($p < 0.05$)

As observed, statistically significant differences ($p < 0.05$) were found in items 1 and 2, as well as in the total pretest scores. Additionally, there is a trend towards significance in item 6 ($p = 0.07$). Regarding the posttest, no statistically significant differences ($p > 0.05$) were found based on the gender of the students. Concerning the comparisons between pre- and post-intervention questionnaire results, Table 8 presents the statistical outcomes of the Wilcoxon test.

Table 8
Statistical results of the Mann-Whitney U test for the eHealth Literacy (eHEALS) questionnaire.

Item	Wilcoxon								
	Male			Female			Total		
	S	<i>p</i>	EE	S	<i>p</i>	EE	S	<i>p</i>	EE
1	9.0	0.43	0.36	4.5	<0.001*	0.95	28.0	<0.001*	0.84
2	3.0	0.04*	0.83	0.0	<0.001*	1.00	5.50	<0.001*	0.94
3	2.5	0.03*	0.86	0.0	<0.001*	1.00	6.50	<0.001*	0.97
4	0.0	0.09	1.00	0.0	<0.001*	1.00	0.00	<0.001*	0.95
5	0.0	0.02*	1.00	0.0	<0.001*	1.00	0.00	<0.001*	0.96
6	0.0	0.05	1.00	11.0	0.00*	0.86	14.0	<0.001*	0.86
7	8.0	0.30	0.43	10.0	0.00*	0.83	34.0	0.02*	0.71
8	0.0	0.05	1.00	9.0	0.00*	0.87	12.0	<0.001*	0.76
Total	1.0	0.02*	0.94	1.0	<0.001*	0.99	3.0	<0.001*	0.94

*Statistically significant differences ($p < 0.05$)

The results indicate that statistically significant differences ($p < 0.05$) were found in items 2, 3, and 5, as well as in the total scores for male participants. Furthermore, there is a trend towards significance ($p \approx 0.05$) in items 6 and 8 ($p = 0.05$). In the case of female participants, all items showed statistically significant differences ($p < 0.05$), as did the overall results of the statistical test. Below are the results related to Scientific Knowledge on the Habit of Healthy Hydration (Table 9), showing the average score, percentage of correct answers, and Scientific Knowledge Level (SKL) for each question and the overall total.

Table 9

Descriptive results on Scientific Knowledge of Habit of Healthy Hydration.

Item	Questionnaire			SKL
	X	SD	%	
1	0.97	0.19	97%	E
2	0.59	0.50	59%	S
3	0.62	0.49	62%	S
4	1.00	0.00	100%	E
Total	3.17	0.76	79.25%	E

Note. I = *Inadequate*; P = *Problematic*; S = *Sufficient*; E = *Excellent*.

The results indicate that the question with the highest accuracy was question 4, with a 100% correct response rate, followed by question 1, with 97% accuracy. Both questions, as well as the overall questionnaire score (79.25% accuracy), fall within the *Excellent* Scientific Knowledge Level (SKL). The remaining two questions were classified as *Sufficient*, with question 2 having the lowest average accuracy (59%), and question 3 achieving 62%. Regarding participants' gender (Table 10), the findings show that both male and female students achieved an *Excellent* SKL in the overall questionnaire. Similarly, Items 1 and 4 received an *Excellent* level for both genders. Items 2 and 3, meanwhile, were rated as *Sufficient* for both male and female participants

Table 10

Descriptive results on Scientific Knowledge of Habit of Healthy Hydration.

Item	Gender	Questionnaire			SKL	U de Mann-Whitney		
		X	SD	%		S	p	EE
1	Male	1.00	0.00	100%	E	85.5	0.55	0.05
	Female	0.95	0.22	95%	E			
2	Male	0.56	0.57	56%	S	86.0	0.85	0.04
	Female	0.60	0.50	60%	S			
3	Male	0.67	0.50	67%	S	84.0	0.76	0.07
	Female	0.60	0.50	60%	S			
4	Male	1.00	0.00	100%	E	0.00	1.00	0.00
	Female	1.00	0.00	100%	E			
Total	Male	3.22	0.83	80.5%	E	84.0	0.80	0.06
	Female	3.15	0.75	78.75%	E			

Note. I = *Inadequate*; P = *Problematic*; S = *Sufficient*; E = *Excellent*. *Statistically significant differences ($p < 0.05$)

Regarding the differences in results, no statistically significant differences were found ($p > 0.05$) in any of the individual questions or in the overall score of the questionnaire.

DISCUSSION

The results related to daily water intake indicate a generally favorable pattern, particularly among male students, who reported significantly higher consumption frequencies than female students. When compared with international hydration recommendations, these findings suggest that a proportion of participants, especially female students, may still fall below recommended intake levels (EFSA, 2010; Recuero et al., 2024). Similar gender differences in water consumption have been documented in previous studies, which attribute these variations partly to physiological factors such as body mass and hydration requirements, as well as to differences in perception of thirst

and hydration needs (Rosinger & Herrick, 2016). These results reinforce the importance of educational interventions aimed at promoting consistent hydration behaviors, particularly among populations with lower intake levels.

However, the persistence of soft drink consumption remains a relevant public health concern, as frequent intake of sugar-sweetened beverages is widely recognized as a metabolic risk factor and may indirectly hinder the consolidation of healthy hydration habits (López-Sobaler et al., 2014). Evidence from longitudinal national studies (ALADINO, 2023; Recuero et al., 2024) indicates that these consumption patterns begin early in life and often continue into university stages, which may explain the behaviors observed in this sample. Consequently, health education strategies should not only emphasize increased water intake but also address the reduction of sugar-sweetened beverage consumption, integrating both objectives within comprehensive hydration promotion programs supported by Digital Health Literacy training.

Although water remains the most consumed beverage in both genders, total liquid intake does not always meet the recommendations set by organizations such as EFSA (2010). This hydration intake deficit aligns with the general scenario described in Spain, where challenges persist in promoting healthy habits and health education (Ministerio de Sanidad, 2023). Although this trend reflects relatively positive hydration behaviors within the sample, it should be interpreted cautiously given that the intake estimation was based on self-reported beverage consumption and did not include water obtained from food sources. This highlights the need to integrate educational interventions that not only promote adequate water intake but also improve Digital Health Literacy to facilitate access to reliable and useful information.

Regarding Digital Health Literacy levels, pre-intervention results show a *Problematic* level, consistent with previous research documenting deficiencies in this competence among university populations (Budhathoki et al., 2019; Cubero et al., 2018; De la Hoz et al., 2021a; Hernández-Rabanal et al., 2018; Mavita-Corral, 2018). In contrast, other studies (Masilamani et al., 2020) report higher average levels, especially among students in health-related degrees, where this competence is more systematically integrated into curricula. This contrast could reflect structural deficiencies in the Spanish educational system regarding the incorporation of eHealth and digital literacy into teacher training programs, as highlighted by various international reports (Montero-Pau et al., 2018; Sanz et al., 2020).

After the educational intervention, students reached a *Sufficient* level, demonstrating that the intervention was associated with improvements in Digital Health Literacy scores in university training through interventions based on an active collaborative methodology, indicate that the intervention may contribute to strengthening information searching and use of digital resources related to health sciences knowledge. This result is consistent with other studies implementing similar methodologies (Hernández-Rabanal et al., 2018), although the scores obtained remain somewhat lower than those recorded in populations with more robust prior training in digital health (De la Hoz et al., 2021a). A particularly notable aspect is the improvement in students' confidence in using digital health information, a dimension identified by studies such as Almeida et

al. (2024) and Bíró et al. (2023) as one of the most frequent weaknesses among university students. Although young people are accustomed to intensive use of digital technologies, this does not necessarily imply critical competence. Results show that after the intervention, participants not only better identify reliable sources but also feel more capable of evaluating and applying that information to real contexts, as also observed in previous studies (Cubero et al., 2018; De la Hoz et al., 2021a; Jiménez-Pernett et al., 2010).

According to gender differences observed, statistically significant differences were detected before the intervention, with the male group showing higher scores. Similarly, previous studies (Rivadeneira et al., 2023; Rosário et al., 2020; Sarhan et al., 2020; Shiferaw et al., 2020) report these same differences in university populations, although others (Svendsen et al., 2020) find better results in females. Previous research has argued that female students face more difficulties evaluating and trusting digital information (Rivadeneira et al., 2023), which may negatively affect their initial performance. Nonetheless, after the intervention, gender differences disappeared, consistent with findings from other studies (De la Hoz et al., 2021a; Hernández-Rabanal et al., 2018; Mavita-Corral, 2018), highlighting the potential of active interventions to act as equalizing mechanisms that reduce gender-based educational gaps.

With respect to Scientific Knowledge acquired, results show notable progress after the intervention. Students reached an *Excellent* level in the general questionnaire, with especially high accuracy in questions such as the percentage of water obtained through food (100%) and the daily recommended water intake (97%). This improvement pattern has also been documented in previous works (Cubero et al., 2019; Steven et al., 2019; Franco-Reynolds et al., 2022), where active and digitally mediated interventions favored greater retention and conceptual understanding of scientific content. However, it is important to note that the questions with the lowest accuracy, such as the minimum number of daily glasses of water or the main function of water in the body, were also those most directly associated with specific biosanitary knowledge, which coincides with research (Almeida et al., 2024; Aranceta et al., 2016; Nissensohn et al., 2017) warning about the limited presence of these contents in teacher training curricula. Nevertheless, these questions reached a *Sufficient* level, indicating significant formative progress, especially considering the starting level. The study by Kiss et al. (2024) shows that adequate interventions improve scientific learning of contents related to water intake, although it warns of difficulties in achieving a deeper understanding of certain concepts due to lack of basic knowledge.

Finally, no significant gender differences were found in Scientific Knowledge after the intervention, consistent with observations by De la Hoz et al. (2021), reinforcing the idea that Digital Health Literacy not only improves understanding of health information but also contributes to greater educational equity regardless of student gender. These findings support the proposal that collaborative methodologies focused on developing Digital Health Literacy (eHealth Literacy) may be an effective pedagogical resource in both schools and universities. In line with the Ministry of Health report (2023), these innovative and evidence-based educational interventions are key to preparing future teachers and students to face the challenges of health education in an increasingly

digitalized society, promoting critical and autonomous citizenship regarding health information. In conclusion, there is a need to continue developing innovative, sustainable, and evidence-based training programs that prepare 21st-century teachers to respond critically and competently to the challenges of health education in a digital society.

CONCLUSIONS

The results indicate that, although water remains the predominant beverage, frequent consumption of soft drinks persists as a metabolic risk factor among university students, and total fluid intake remains below international recommendations, especially among women. This highlights the need to strengthen education on healthy hydration habits by integrating strategies that address existing cultural and physiological barriers.

Regarding digital health literacy, the identification of *Problematic* initial levels among students underscores the existing gap in essential skills for critical and effective navigation of digital health information. The significant improvement achieved after the educational intervention, based on active and collaborative methodologies, demonstrates the effectiveness of innovative pedagogical approaches that enhance not only access to reliable sources but also the critical evaluation and practical application of digital health knowledge. The reduction of gender gaps in digital literacy post-intervention emphasizes the equalizing role of well-designed educational strategies that can mitigate historical inequalities in access to and trust in digital health information.

Concerning scientific knowledge, the substantial improvement observed confirms that digitally mediated active methodologies facilitate deep understanding and retention of scientific content. However, the persistence of lower performance in more specialized bioscientific concepts indicates the need to strengthen the integration of foundational scientific content within teacher training curricula, ensuring that healthy behavioral practices are supported by robust conceptual understanding. In summary, these results provide a solid foundation for designing policies and educational programs aimed at addressing contemporary challenges in health education within digitalized societies, promoting innovative, sustainable, and evidence-based interventions that contribute to forming a healthy, informed, and empowered citizenry.

Due to the convenience sampling strategy, small sample size, and absence of a control group, the findings should be interpreted cautiously and are primarily applicable to educational contexts similar to those examined in this study. Future research should evaluate scalable adaptations of this intervention model across larger teacher-training cohorts and multi-institutional settings to examine its broader applicability.

STUDY LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study presents several limitations that should be considered. First, the absence of a control group limits the ability to compare the results with those obtained using other methodologies. Additionally, the sample size and the disparity between genders suggest that future studies should aim to increase this variable, as well as extend the duration of the interventions conducted. Furthermore, it is recommended that future research examine whether the increase in Digital Health Literacy and scientific knowledge

regarding healthy hydration habits translates into the promotion of the habit itself in the short and long term. Also, the estimation of hydration intake was based on self-reported beverage consumption and did not include water derived from food sources. Therefore, comparisons with EFSA recommendations should be interpreted cautiously, as total water intake may be underestimated. Likewise, it would be advisable to analyze this pattern with different scientific contents, and even with interdisciplinary content combining scientific and mathematical topics.

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