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Implementation of the Digital Health Approach to Support Learning for Health Students Based on Bloom's Taxonomy: A Systematic Review

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Objectives: Health students' ability to utilize technology effectively is vital for improving the quality of future healthcare services. Relevant digital health education must be comprehensively integrated into training programs, continuing professional development activities, and school curricula to keep them current. This study investigated the most effective digital health approaches to enhance health students' cognitive, affective, and psychomotor skills, thereby preparing them for the workforce. **Methods:** A literature review was conducted by searching for articles from 2013 to 2023 in PubMed, Science Direct, ERIC, and Scopus. The search used the PICO model, focusing on experimental studies and digital learning. **Results:** The review identified 26 studies, categorizing digital education methods into platform-based (46.2%), tools-based (30.7%), and training-based approaches (23.1%). Participants included health students (57.7%), healthcare professionals (34.6%), and a combination of both (7.7%). The content materials primarily targeted curriculum objectives (65.4%) and clinical applications (34.6%). The outcomes, classified according to Bloom's taxonomy, were divided into cognitive (84.6%), affective (76.9%), and psychomotor (46.1%) domains. **Conclusions:** Digital health education benefits from a variety of approaches. A platform-based approach is recommended for delivering theoretical and methodological materials, a tools-based approach for simulations, and a training-based approach for practical skills to enhance the cognitive domain. Both platform-based and training-based approaches are advised to improve the affective and psychomotor dimensions of learning. This study underscores the importance of an integrated digital learning system in health educational institutions to prepare students for evolving health systems and to improve learning outcomes and skill transfer.

Keywords: Digital Health, Health Literacy, Health Education, Electronic Health Records, Health Information Management

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I. Introduction

Education in health information management is vital for addressing the future quality requirements of healthcare. This field plays a key role in the efficient operation of healthcare processes, including reimbursement systems, technology development, research, and improving the quality of patient care. Health information management professionals are tasked with managing patient data, coding medical records, maintaining information systems, and ensuring adherence to regulatory and legal standards concerning health information [1]. Education in health information management provides the academic and professional training necessary for careers in this. Specifically, it equips students with the skills and knowledge required to manage healthcare information systems effectively, understand medical terminology, safeguard data security and privacy, and comply with healthcare laws and regulations [2].

Education in health information management must equip students with skills in data management, statistical analysis, medical terminology, disease management, clinical pathway knowledge, information technology, and strong leadership abilities to carry out their future roles effectively [1]. Students enhance their practical skills through internship programs conducted at healthcare facilities. These programs not only provide practical experience but also play a crucial role in shaping undergraduates into competent healthcare professionals. The success of these internships hinges on comprehensive supervision, clearly defined roles, and a supportive environment that encourages active participation from students [2]. Recognizing the importance of these programs, it is vital to develop strategies that improve the work environment, thereby increasing student satisfaction and reducing anxiety levels [3].

These strategies can be developed by considering interactive digital technologies in education, such as multimedia platforms and games, which have seen increased usage over the past few decades. To make digital health education effective for health students, it is crucial to continuously update and comprehensively integrate it into internship programs, professional development activities, and campus curricula to ensure relevance and widespread adoption [3,4]. This approach could potentially be applied to health information management education as well.

The creation of learning materials based on interactive digital technology can utilize Bloom's taxonomy. This taxonomy, widely used for evaluating learning outcomes and objectives, addresses the cognitive, affective, and psychomotor dimensions of students' development. Originally developed by Benjamin Bloom, the framework divides learning into three domains: cognitive knowledge (mental abilities), affective attitudes (emotions), and psychomotor skills (physical skills). Bloom's taxonomy facilitates deeper learning and the application of knowledge and skills across different tasks and contexts [5].

The cognitive domain refers to knowledge associated with the retention of specific and distinct information, such as facts, definitions, or methodologies. This type of knowledge can be evaluated using straightforward methods like multiple-choice or short-answer questions [4,5]. The affective domain encompasses emotions, feelings, perceptions, acceptance, and personal development. It is measured through various indicators including attitudes, collective interests, perceptions, satisfaction, self-assertiveness, self-confidence, self-efficacy, self-leadership, difficulties, and stress. The psychomotor domain involves physical skills and human development, assessed through metrics such as skills, critical thinking, self-confidence, clinical competence, and practice performance [5].

Therefore, this taxonomy is considered appropriate to be used as a basis for discussing the choice of material in a literature review. The present study conducted a literature review with a focus on the use of the digital health approach to enhance cognitive, affective, and psychomotor skills applicable to health information management students.

II. Methods

This systematic review used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement, which is an up-to-date guideline for reporting systematic reviews.

1. Search Strategy

The study utilized Medical Subject Headings (MeSH) keywords to identify relevant studies [6]. The study conducted an extensive literature search across PubMed, Science Direct, ERIC, and Scopus using the search terms "digital AND (health OR medical) AND (education OR health professional OR training)." Inclusion criteria comprised publications between 2013 and 2023, open full-text availability, and English language. Exclusion criteria excluded studies unrelated to medicine, nursing, or the health professions, as well as non-journal article types such as reviews, books, conference papers, and letters.

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2. Eligibility Criteria

The study utilized the PICO model to select experimental studies (Table 1). The PICO process is a method used in evidence-based practice to formulate and answer a clinical question that pertains to a specific patient problem and is relevant to the evidence found in the literature [7].

Descriptive studies that focused on digital approaches and method development were also evaluated and selected. Initially, this study was aimed at students and health practitioners engaged in health services. However, to widen the scope of the search, the criteria for participants were broadened to include collaborators of healthcare professionals, covering studies involving health-related students, healthcare professionals, and individuals employed in health-related fields.

3. Study Collection

Collected studies were organized by converting references into RIS format using the Zotero reference management tool, which helped eliminate duplicates. The initial search results were subjected to title and abstract screening, independently conducted by two authors (A.R.S. and K.P.). Subsequently, full texts of potentially eligible studies were downloaded and further screened according to the study's eligibility criteria. In instances of uncertainty or disagreement between two authors (A.R.S. and K.P.), the author S.C.B. provided consensus guidance. The use of Zotero facilitated efficient data management for the citation writing process.

4. Quality Appraisal of the Studies

The methodologies of the selected articles were critically assessed for quality by two independent reviewers (K.P. and A.R.S.) using the Joanna Briggs Institute's critical appraisal tool. Any disagreements were addressed and resolved with the assistance of a third reviewer (S.C.B.). Details of the critical appraisal are available in Supplementary Table S1.

5. Data Extraction and Analysis

Data extraction utilized a table that listed the author (year), study design, country, subjects/participants, intervention, sample size, and outcome. The researchers recorded all topics related to digital health education or healthcare workers found in the papers. Qualitative content analysis was performed using the Atlas Ti 8th version qualitative analysis tool. Data analysis adhered to the guidelines outlined in the *Cochrane Collaboration Handbook for Systematic Reviews* to minimize researcher bias in systematic reviews [8].

The initial search across four databases yielded 259,930 articles. Of these, 253,810 were excluded based on the inclusion and exclusion criteria applied by each database's filter tool, as illustrated in Figure 1. After removing 65 duplicates, 6,055 articles were manually screened using their titles and abstracts according to the eligibility criteria. Subsequently, the researchers conducted a complete screening of all articles that met these requirements. A total of 140 articles were subjected to full-paper reading to evaluate their methodological quality and eligibility. Ultimately, 26 studies were selected for data extraction and synthesis.

III. Results

1. General Characteristics (Characteristics of Sources of Evidence)

The largest number of studies (12; representing 46,2%) originated from Europe. Most of these studies (nine papers) were published in 2022. Table 2 provides an overview of the types of studies included in the research [2-4,9-31]. The majority were quasi-experimental (13 papers), followed by qualitative studies (five papers), randomized control trials (five papers),

Table 1. Application of the PICO framework in this study

Acronym	Definition	Description
P	Population	Health-related students: medical, nursing, pharmacy, psychology, midwifery, and health information management. Healthcare professionals include doctors (general practitioners, interns, residents, and specialists), nurses, pharmacists, psychologists, midwives, and community health workers.
I	Intervention	Digital approaches: online or digital platforms, e-learning tools, and training/workshops/courses that can be online or face-to-face as long as the topic delivered is related to digital competency improvement.
C	Control or comparison	Conventional approach
O	Outcome	Knowledge, skill, self-efficacy, and confidence of participants' digital competency or their health-related performance.

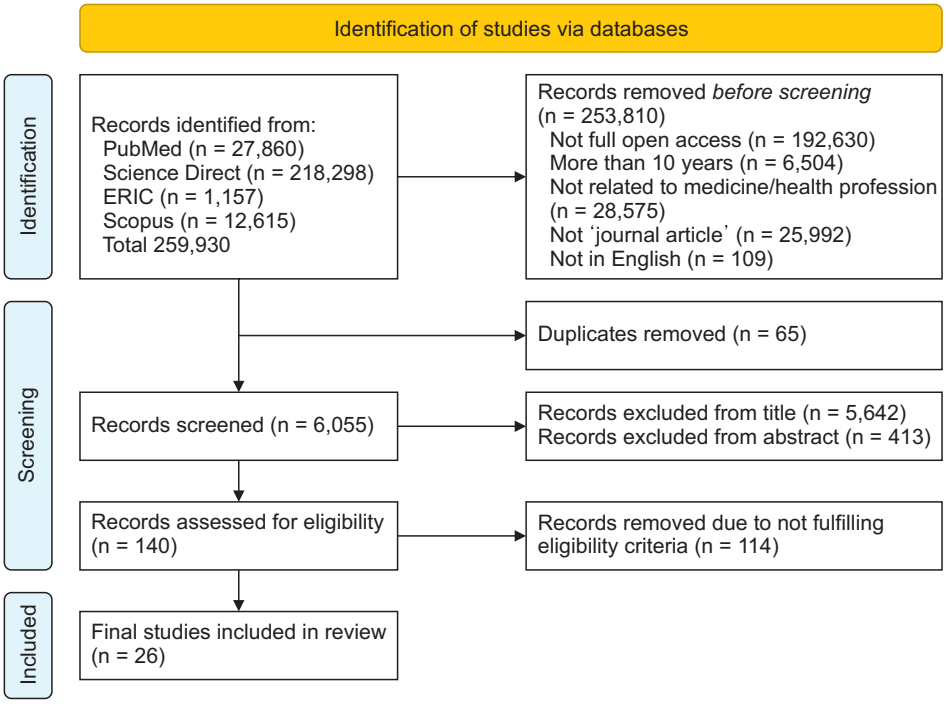

Figure 1. Preferred Reporting Items in Systematic Reviews and Meta-Analyses flow diagram of study selection.

and cross-sectional studies (two papers).

Table 2 summarizes studies conducted in various countries involving medical students, nurses, and other health professions. The search results from this article indicate that a variety of learning media are utilized in the educational process, including e-learning platforms, digital education programs, virtual simulations, digital games, workshops, and web-based platforms. These findings are considered in the development of learning media for health information management education, aimed at improving students' understanding of the material before they engage in practical fieldwork.

2. Study Participants

As shown in Table 1, the target training groups can be divided into three categories: (1) students in health professions, (2) healthcare professionals, and (3) both students and healthcare professionals. The majority of the studies (n = 15; 57.7%) targeted student groups. Nine studies (34.6%) involved healthcare professionals. Two studies (7.7%) included both students and healthcare professionals.

3. Digital Education Methods

In our analysis of the studies, we categorized the digital education approaches into three types: platform-based, tools-based, and training-based (Table 3). The majority of the studies employed a platform-based system (n = 12; 46.2%), followed by eight studies (30.7%) that adopted a tools-based approach, and six studies (23.1%) that implemented a training-based approach.

Research employing a platform-based approach typically focused on cognitive (knowledge and perception), affective (attitude, satisfaction, and motivation), and psychomotor (performance and self-confidence) aspects. In contrast, education adopts a training-based approach, targeting cognitive (practical knowledge and skills), affective (attitudes and satisfaction), and psychomotor (practical skills and interests) aspects. According to the analysis of articles presented in Table 3, education that utilizes a tool-based approach generally explores cognitive (knowledge and understanding), affective (attitude, motivation, and perception), and psychomotor (confidence in study performance, experience, and usability) aspects. It is essential for health information management students to acquire the necessary knowledge to meet cognitive, affective, and psychomotor competencies.

4. Content and Material

The studies varied in their content and material, leading us to categorize them based on their objectives and target audiences: curriculum-targeted and clinical-targeted. Seventeen studies (65.4%) were curriculum-targeted, focusing on educational materials (No. 1,4,6,7,9,10,13,15–17,20,22–26 in Table 3). Conversely, clinical-targeted studies, comprising 34.6%, were designed to enhance the skills of healthcare workers in their daily practice (No. 2,3,8,11,12,14,18,19,21 in Table 3).

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Table 2. Characteristics of the included studies

Study, year	Study design	Country	Subject	Methods	Sample size
Mesko et al. [10], 2015	Quasi-experimental	Hungary	Medical and dentistry students	Online course and e-learning platform "The Social MEDia" course	932 student
Benwell et al. [11], 2017	Quasi-experimental	Australia	First-year doctors	E-learning package for digital medical records (BOSSnet) use	20 doctors
Manning et al. [4] 2017	Quasi-experimental	UK	Nurses	Digital educational programme	98 nurse
Jauregui et al. [24], 2018	Qualitative	USA	Medical students	Peer-assisted learning (PAL) through case-based simulations	135 students
David et al. [26], 2018	Cross-sectional	Mozambique	Faculty members, residents, medical students, and informatic technicians	E-learning modules	Four professionals and 126 students
Ngan et al. [25], 2018	Cross-sectional	Hong Kong	Pharmacy students	Electronic professional study (ePS) courseware	53 students
Zwart et al. [14], 2020	Quasi-experimental	Netherlands	Nursing students	Digital learning materials (DLMs)	39 students
Roberts et al. [27] 2020	Quasi-experimental	USA	Internal medicine residents	Nephrology immersion classroom	39 doctors
Zaragoza-Garcia et al. [9], 2021	Quasi-experimental	Spain	Nursing students	Web-based virtual simulation: vSim for Nursing platform	112 students
Sefein et al. [23], 2021	Quasi-experimental	Malaysia	Medical students	Coding Workshop with Arduino Nano (teaching tool)	29 students
van Houwelingen et al. [19], 2021	Quasi-experimental	Netherlands	Nurses	Tailored training in nursing telehealth activities	37 nurses
McDermid et al. [31], 2022	RCT	UK	Nurses and people with dementia	The Optimized WHELD Digital Learning Program (eWHELD)	45 nurses and 130 people with dementia
Fernandes et al. [15] 2022	Qualitative	Portugal	Nursing students	Digital game "Game2FamilyNursing"	102 students

Continued on the next page.

Table 2. Continued

Study, year	Study design	Country	Subject	Methods	Sample size
Knapp et al. [16] 2022	Quasi-experimental	USA	Dermatology and pathology residents	Novel diagnostic educational resource (NDER): a web-based adaptive learning module	26 doctors
Liu et al. [22], 2022	Cross-sectional	China	Medical student	A workshop on the introduction of medical big data	274 students
Schnieders et al. [30], 2022	RCT	Zambia	Medical student	Asynchronous e-learning	50 students
Taramarcaz et al. [2], 2022	RCT	Switzerland	Medical and dental students	Digital module basic life support for cardiac arrest	529 student
Eumbunnapong et al. [12], 2022	Quasi-experimental	Thailand	Computer engineer and medical technology expert	Intelligent digital learning platform	Five computer engineers and five medical technology expert
Nyberg et al. [13], 2022	RCT	Sweden	Healthcare professionals (nurses, physical therapists, occupational therapists, and dieticians)	Web-based platform for digital COPD education	88 healthcare professionals
Seok et al. [28], 2022	Qualitative	South Korea	Nurse students, professional nurses, and app developer	Cancer survivorship app	Ten professionals and 20 students
Moretti et al. [20], 2023	Quasi-experimental	Italy	Medical student	Digital Course included a specific focus on the Dottoremaeveroche (DMEVC) website	341 students
Wu et al. [29], 2023	Quasi-experimental	Taiwan	Internship nursing students	Multimedia e-book	32 students
Seemann et al. [17], 2023	Quasi-experimental	Germany	Medical students	Digital health module	34 students
Tsopra et al. [21], 2023	Qualitative	France	Medical students	Artificial intelligence for clinical decision support system (AI-CDSS)	15 students
Mastellos et al. [3], 2018	RCT	Malawi	Health surveillance assistants (HSAs) and senior HSAs	Classroom-based course about introduction to information and communication technology and eHealth	40 HSA's
Djibril et al. [18], 2023	Qualitative	Turkey	Health-services student	Mobile augmented reality anatomy application (MAGAU)	200 students

RCT: randomized controlled trial, COPD: clinical decision support system.

Table 3. Final studies analyzed

No.	Approach	Study, year	Outcome	Bloom taxonomy domains		
				Cognitive	Affective	Psychomotor
1	Platform-based	Mesko et al. [10], 2015	Knowledge, perception	√	√	
2		Benwell et al. [11], 2017	Performance, teaching other staff, efficiency, and accuracy	√		√
3		Manning et al. [4], 2017	Attitude, knowledge, self-efficacy, confidence, and clinical behavioral intention	√	√	√
4		Jauregui et al. [24], 2018	Satisfaction, clinical simulation		√	√
5		David et al. [26], 2018	Satisfaction, motivation, and performance		√	
6		Ngan et al. [25], 2018	Attitude		√	
7		Zwart et al. [14], 2020	Knowledge, self-efficacy, appreciation	√	√	
8		Roberts et al. [27], 2020	Knowledge, clinical skill, experience	√	√	√
9		Zaragoza-Garcia et al. [9], 2021	Knowledge, performance, self-confidence and satisfaction	√	√	√
10		Taramarcaz et al. [2], 2022	Performance confidence, knowledge, motivation	√	√	√
11		Eumbunnapong et al. [12], 2022	Digital literacy and performance	√		√
12		Nyberg et al. [13], 2022	Satisfaction, knowledge, working procedure	√	√	√
13	Training-based	Sefein et al. [23], 2021	Digital literacy, creating projects, satisfaction	√	√	√
14		van Houwelingen et al. [19], 2021	Satisfaction in digital literacy, creating projects, self-efficacy, knowledge	√	√	
15		Liu et al. [22], 2022	Knowledge, attitude, professionalism	√	√	
16		Moretti et al. [20], 2023	Digital literacy, practical confidence	√		√
17		Tsopra et al. [21], 2023	Knowledge, confidence in clinical and technology performance, enthusiasm	√	√	√
18		Mastellos et al. [3], 2018	Knowledge, attitude, satisfaction	√	√	
19	Tools-based	McDermid et al. [31], 2022	Attitude, hope, knowledge	√	√	
20		Fernandes et al. [15] 2022	Perception/motivation, knowledge	√	√	
21		Knapp et al. [16], 2022	Knowledge	√		
22		Schnieders et al. [30], 2022	Satisfaction, usability, knowledge	√	√	
23		Seok et al. [28], 2022	Experience, practicum, interest		√	√
24		Wu et al. [29], 2023	Health communication and literacy	√		
25		Seemann et al. [17], 2023	Attitude, knowledge	√	√	
26		Djibril et al. [18], 2023	Understanding, confidence in study performance	√		

5. Study Outcomes

All study outcomes were categorized according to Bloom's taxonomy domains as cognitive, affective, and psychomotor. Out of the 26 studies sampled, 22 (84.6%) pertained to the cognitive domain, 20 (76.9%) addressed the affective domain, and 12 (46.1%) involved the psychomotor domain.

IV. Discussion

Research articles on health education were reviewed with the ultimate goal of developing educational media for health information management, given the scarcity of literature in this area.

1. Cognitive

Undergraduate health information programs equip students to deliver systematic healthcare services through the analysis of needs, system design, and plan implementation [9,10]. A platform-based approach is advised to strengthen skills in theory and methodology. This recommendation is supported by studies that demonstrated enhanced understanding following virtual simulations and digital modules [2].

The platform-based approach also had several positive impacts, including enhanced computer proficiency and better preparation of doctors for clinical roles [11]. Additionally, it has improved digital literacy [12] and significantly increased the knowledge of health workers [13]. These findings demonstrate the relevance of this approach in enhancing student knowledge and skills in health information management.

Implementing a platform-based approach for health information management students requires addressing complex subjects such as medical terminology, data security, procedure development, and programming logic. This necessitates the use of systematic and flexible learning tools. Online education presents additional challenges in promoting independent communication and establishing precise conditions for interaction [14]. Furthermore, the stages of the cognitive domain in Bloom's taxonomy—comprehension, application, synthesis, and analysis—are difficult to achieve [5].

Simultaneously, simulations and quizzes should be employed to enhance health digital literacy. Clinical simulations enhance knowledge, enabling students to apply what they have learned and evaluate their competence [15]. Learning modules increase skill accuracy and lead to improved test outcomes, demonstrating effective knowledge transfer [16,17]. An app has been found to act as an additional resource, augmenting understanding [15]. Digital courses and training have a positive effect on students' academic performance and learning experiences [18].

The findings of this study suggest that tool-based approaches can enhance the cognition of health information management students. These approaches include clinical case simulations, role-play, anatomy, pathology, disease coding, software coding, and health financing simulations [1]. Apps should be interactive and user-friendly, incorporating question-and-answer content, games, quizzes, and opportunities for discussion. Proper dissemination of information and education on how to use the app is essential for addressing technical and personal issues, thereby enhancing the e-learning experience for health information management students [1].

All of the studies that employed a training approach consistently showed a positive correlation with increased knowledge among both health workers and students. Training in information and communication technology (ICT) and eHealth significantly improved self-rated and ICT knowledge among health surveillance assistants (HSAs) and senior HSAs. Telehealth training also boosted nurses' learning and self-efficacy [19]. In addition, exercises such as using medical information and web resources can improve students' skills in finding quality internet resources, answering health questions, and utilizing health information, thereby improving their health literacy scores [20]. This training equipped medical students with practical skills and a deeper understanding of technologies applicable to clinical practice, including the use of artificial intelligence (AI) in clinical decision systems [21]. Workshops like NUWA (National Union of Real-World Gynecologic Oncology Research & Patient Management) expanded medical students' knowledge of extensive data and professionalism [22]. Furthermore, a coding workshop that utilized Arduino Nano as a teaching tool significantly improved student literacy in health-related technology [23].

Several health information management courses, including clinical case practicum, health administration, and health statistics, require ongoing support [1]. It is recommended that digital training be implemented to enhance the quality of cognitive aspects in students.

2. Affective

Implementing a platform-based approach seems to correlate positively with the affective domain. In studies focused on curriculum, students expressed high satisfaction with peer-assisted learning through tablet-based case simulations [24] and virtual case simulations [9]. They also showed appreciation for digital learning methods, positively received

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anatomy courseware [25], and valued interactive digital microscopy for pathology education [26]. Furthermore, their confidence in their skills notably increased after completing the course [2]. In studies focusing on clinical practice, healthcare professionals reported increased confidence in patient care [4] and expressed satisfaction with digital education programs, which they found supportive in their work [13]. They also enjoyed the classroom experience and recommended it [27]. Despite the differences in content, all platform-based approaches showed a positive correlation with affective domains across both curriculum-based and clinical settings.

Studies showed a robust correlation between training methodologies and increased knowledge among health workers and students [23]. Students reported high levels of satisfaction with the learning environment and positive attitudes towards big data platforms following coding workshops [22]. They also showed enthusiasm for AI-CDSS programs and increased confidence in using technology [21]. Additionally, the training approach improved healthcare professionals' telehealth and ICT skills, thereby boosting their self-efficacy and satisfaction [19].

The tools-based approach with curriculum-targeted content positively impacted student engagement and interest [18]. Nursing students, in particular, found the cancer survivor application highly beneficial [28]. Students expressed satisfaction and a positive attitude following their use of multimedia e-books [29] and a game application [15]. However, some studies encountered implementation challenges, and the impact on the curriculum was limited, showing no significant differences in student satisfaction with e-learning modules [30]. Students perceived digital health modules as inadequate [17]. In contrast, content specifically targeted at clinical applications markedly improved well-being, hope, and personhood. Among eight studies employing this approach, four reported positive outcomes on the curriculum, two showed insignificant results, and one study on a clinical target demonstrated a positive impact.

Studies have shown that platform-based training substantially improves the affective aspect, particularly for health students preparing for fieldwork or internships [30]. To further enhance this affective impact, it is crucial to address and reduce technical and personal issues through a tool-based approach.

3. Psychomotor

Twelve studies were conducted, of which only eight utilized a platform-based approach relevant to the psychomotor domain. An e-learning package resulted in improvements in both efficiency, as measured by task completion time, and accuracy, indicated by a reduced number of incorrect clicks [11]. Digital education focusing on self-harm in children and young people led to more positive attitudes towards its effectiveness and increased confidence across various practice areas [4]. The intelligent digital learning platform enabled learners to take control of their learning process and build a knowledge base [12]. Greater access to classrooms has been associated with a heightened interest in education [27].

The platform-based approach had a positive impact on the psychomotor aspects of students. Peer-assisted learning provided appropriate simulation content, fostering a safe learning environment for medical students and improving the retention of new concepts [25]. It also boosted students' willingness to register as first responders [2]. While repetition of simulations led to improved scores, the effect was somewhat less pronounced for nursing students [9]. The clinical simulation stage strengthened the psychomotor domain, aiding participants in understanding and practicing essential skills [5].

In eight studies that employed a tools-based approach, only one addressed the psychomotor domain, demonstrating that students benefited from using apps to prepare for clinical practicum courses [28]. Among six studies that adopted a training-based approach, three focused on the curriculum and targeted student psychomotor outcomes. These included completing mini-projects in coding workshops [24] and acquiring practical clinical skills through programs such as AI-CDSS [21]. However, after completing a course on web tool usage, students still expressed uncertainties regarding the practical application of the health information they learned [20].

Articles on health education methods have been reviewed to inform health information management education. The limited availability of articles specifically focused on health information education constrains this research. Health information management benefits from methods that are platform-based, tool-based, and training-based, which positively affect cognitive and affective domains. However, the impact on the psychomotor domain still requires thorough evaluation. Platform-based methods are recommended to improve cognitive function through various learning activities such as questions and answers, games, discussions, virtual simulations, and quizzes related to health information management. Both platform-based approaches and training are advised for improving affective and psychomotor skills in students. The development of integrated digital learning

systems is crucial for preparing students for advancements in the health system. This approach aligns with Bloom's taxonomy, aiming to enhance learning outcomes and facilitate the transfer of skills.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Supplementary Materials

Supplementary materials can be found via https://doi.org/10.4258/hir.2024.30.4.387.

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