

Leveraging Educational Technology to Enhance Health Literacy: Insights from 21st Century Case Studies

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Abstract

Health literacy is essential for enabling individuals to access, understand, and utilize health information to promote better health outcomes. This study aims to explore the role of educational technology in improving health literacy, particularly in 21st-century health education.

A systematic review was conducted using 16 international journals from 2008 to 2024, selected from Google Scholar and Scopus. The focus was on analyzing interventions employing technologies such as virtual reality (VR), multimedia platforms, and interactive tools to enhance health literacy across diverse populations.

The results indicate that VR-based interventions improved knowledge retention, skill acquisition, and behavioral changes, including smoking cessation. Multimedia applications tailored for specific groups showed positive impacts on knowledge enhancement and engagement. However, accessibility challenges and technological literacy gaps remain barriers. Studies highlight the importance of immersive, culturally relevant, and targeted educational approaches to achieve better outcomes.

Educational technology presents significant potential for advancing health literacy, especially among vulnerable populations. Tailored interventions leveraging innovative technologies can support meaningful learning experiences and foster positive health behaviors.

keywords: Health literacy, Media, Health education.

Introduction

Health literacy is an effort to raise children's awareness and prevent them from various health disorders and diseases that may require examination, treatment, and care. If the community has adequate health literacy, they will be able to seek, understand, and even evaluate the health information they obtain, which can later be disseminated to improve the health quality of certain communities [10].

The origin of the Health Literacy (HL) concept began in 1974, when S.K. Simonds linked it to another closely related concept, Health Education (HE). Both concepts were defined within the field of school education, and it wasn't until 1998 that the World Health Organization (WHO) adopted HL as a concept within the field of public health, defining it as "the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand, and use information in ways that promote and maintain good health" [5].

Low health literacy has been linked to poorer health status. Although there is evidence showing that low levels of health literacy are associated with poor health outcomes, increased hospitalization rates, and non-adherence to treatment for various diseases, relatively few effective interventions have been developed to address low literacy, and even fewer have been developed to target ethnic minority populations who tend to have lower levels of health literacy. However, existing interventions primarily rely on communication and education alone and mostly fail to achieve substantial and sustained behavioral change [15]. The use of VR training in medical education has been shown to be less effective compared to traditional learning methods, according to a meta-analysis of existing literature on the effects of VR-based health education on changes in knowledge, attitudes, skills, and behavior [6].

At the regional, national, and international levels, there has been a growing interest in media literacy

in policy discussions. Literacy skills are essential for accessing various types of information, especially in the field of health. The Education Development Center (EDC) states that literacy is more than just reading and writing skills. With the understanding that literacy includes the ability to "read the word and read the world," literacy is broadly defined as language skills, including listening, speaking, reading, writing, and thinking—elements inherent in literacy itself. Health literacy is one of the determinants of health and reflects how well a person can understand, assimilate, and critically evaluate health and disease information. Health literacy encompasses various levels within it. Efforts to operationalize the concept of health literacy have varied in terms of methodological and conceptual approaches. Commonly used health literacy assessment tools, such as the Rapid Assessment of Literacy in Medicine and the Test of Functional Health Literacy in Adults, have been criticized for focusing on reading ability and not assessing other important aspects of health literacy, such as understanding and the ability to evaluate and use information.

Health literacy not only requires the ability to read but also the skills of listening, analyzing, and decision-making, as well as the ability to apply these skills in a health context. Therefore, health literacy is the result of both individual and social processes, including cultural and societal influences, the healthcare system, and the education system. Enhancing health literacy is relevant across the entire spectrum of healthcare services, from healthcare services, disease prevention and control, to health promotion. However, from the existing literature, it is evident that most health literacy interventions focus on the healthcare system and the provision of health information to service users [15].

Health literacy has become a public health agenda. The goal of "improving public health literacy" was included as an objective in the Healthy People 2010 and 2020 initiatives. In 2004, the Institute of Medicine released *Health Literacy: A Prescription to End Confusion*, which recommended that "the Department of Health and Human Services and other government and private funders should support research leading to the development of causal models that explain the relationships between health literacy, the education system, the healthcare system, and relevant social and cultural systems." The 2010 National Action Plan from the U.S. Department of Health and Human Services to Improve Health Literacy emphasizes the need for conceptual advancements in this area by calling for the development and implementation of literacy interventions based on theories and models drawn from related disciplines such as communication, education, cognitive science, and medical sociology. The lack of a common definition and understanding of health literacy may have hindered progress in the field in developing metrics and conducting robust methodological research. Various models and frameworks describe the factors associated with health literacy skills. A comprehensive theory or framework of health literacy could encourage more professional discussions to help lay the groundwork for a new era of theory-based research [16].

Research Method

This research is a systematic review conducted from August 26, 2024, to August 31, 2024. The sample consists of 16 international journals, including 4 international journals and 12 verified Scopus journals. The variables used in this study are the application of educational technology in improving health literacy, with a case study in 21st-century health education. This article is organized as a systematic review based on findings from the Google Scholar and Scopus databases. Articles were selected based on the criterion of publication from 2008 to 2024. The focus of this research is to gain insights and understanding regarding the application of educational technology in enhancing health literacy in the context of 21st-century health education. Based on data collection to uncover understanding and details about the data being studied, the authors have gathered various relevant research studies for in-depth analysis through a systematic review approach. The goal of this approach is to understand the application of educational technology in improving health literacy by identifying existing research works with relevant titles regarding "the application of educational technology in enhancing health literacy: a case study in 21st-century health education," based on previously published journals.

Results

The acceptance and use of technology: Doctors believe that the expected performance of the system is related to several factors, such as the relevance of the content to patients, providing specific health narratives to conceptualize the content, and considering potential contraindications to its use. It is suggested that the main drivers of this system's performance lie in its ability to deliver health information in an immersive experience. The efforts required to use VR are considered worthwhile, and the ability to successfully operate

the technology may stem from individual technological competencies. Acceptance of technology is categorized in relation to expected effort. Challenges related to the setup and use of devices are seen as hurdles to their use, but it is believed that these can be managed through routine usage. Ensuring that VR is suitable for addressing patients' abilities to access and obtain health-related information is thought to depend on several factors, including the timing of the intervention (in the course of the patient's treatment) and how technology influences therapeutic outcomes. Out of 35 citations (28.9%), a portion relates to health literacy in connection with access to and acquisition of information. Doctors emphasize concerns about the accessibility of headsets in healthcare and community settings and note that having competencies related to seeking healthcare services is a prerequisite for accessing these interventions [2].

VR technology consists of various devices and platforms. Some technologies are developed by faculty members/researchers, while others are commercially available. Fourteen studies (56.5%) investigated VR simulations (VRS) as supplementary learning tools for skill acquisition, such as (IV placement, suctioning, decontamination, blood withdrawal processes, medication administration, and Foley catheter skills). Fifteen studies (65%) out of twenty-three found that VRS can enhance student learning or their knowledge. In the cognitive context, six studies indicated that VRS improves knowledge acquisition and retention. Furthermore, VRS enhances the development, acquisition, and application of knowledge. In the affective domain, seven studies found that realistic VRS experiences provide knowledge about care, interaction, and allow for feedback on accessible engagement, enjoyable gaming, and student attention, while other research showed no difference in knowledge after five months. Seven studies indicated no differences when using VRS compared to face-to-face/manikin simulation in terms of knowledge acquisition, application, and learning, with knowledge improvement seen in both groups where VRS was considered an additional tool alongside face-to-face/manikin simulation [3].

PowerPoint presentations can be converted into Flash-based films. This multimedia e-learning module (designed to improve colorectal cancer literacy) can be delivered in various formats, including interactive CD-ROMs, DVDs, enhanced booklets, podcast/iPod films, or via the Internet. Other interventions have utilized computer-mediated interventions with CD-ROM content that do not require Internet access to influence positive dietary behavior changes among economically disadvantaged African American adolescents who may not have easy access to the Internet. Tailoring the type of delivery modality for different patient groups and subgroups is considered more beneficial than a one-size-fits-all approach. Educational computer multimedia applications for diabetes provided in urban clinical settings found that the intervention group showed increased susceptibility to diabetes complications, particularly among subjects with low health literacy levels. In the intervention group, subjects with higher health literacy spent more time in front of the computer. However, there were no significant differences in changes in A1C levels, weight, blood pressure, knowledge, self-efficacy, or self-reported medical care between the intervention and control groups. Participants in the intervention, with outcomes measured in terms of diet, stress, and physical activity, reported significantly higher ratings for web-based program materials compared to print programs across all health topics and overall evaluations. Nevertheless, electronic interventions were not more effective in reducing stress or increasing physical activity compared to the control intervention [4].

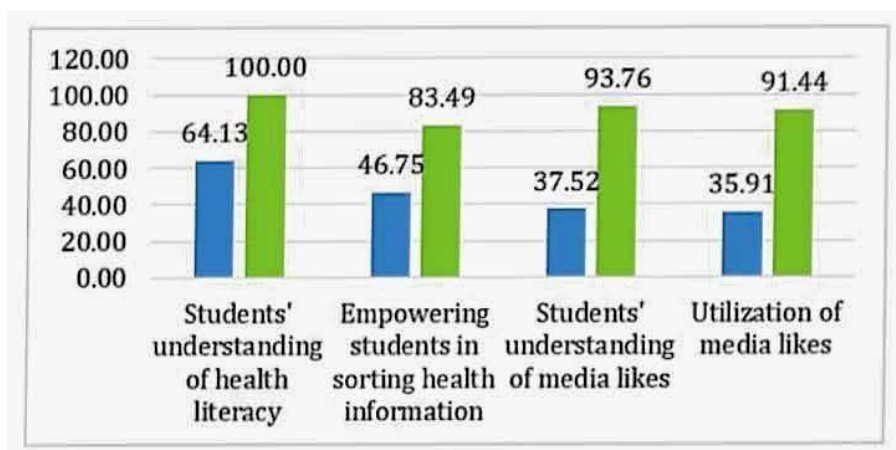
Four studies compared the outcomes of the VR exposure intervention group with other treatment groups or conventional methods (such as two-dimensional video, role-playing, or online counseling). In one study, the teaching outcomes of VR were compared with outcomes from a non-treatment group. Another study compared the results of a combined VR and conventional intervention with the conventional intervention alone. Studies on behavior change were analyzed according to follow-up periods, and data were analyzed considering each obtained outcome as a separate study. One study reported behavioral changes (quitting smoking) in the VR exposure group. The estimated effect indicated an increase in abstinence rates in the intervention group (OR=2.36; 95% CI 1.03 to 5.41; $P < .05$) [6].

In the U.S., the Health Activity Literacy Scale (HALS) is increasingly approaching a more comprehensive testing form by incorporating various health-related competencies across five domains: health promotion, health protection, disease prevention, health care and maintenance, and system navigation (Educational Testing Service, 2006; Rudd, 2007). Baker (2006) states that this test is new, its properties are unknown, and long-term testing can take up to one hour to complete. For it to be used more widely, it needs to be made more accessible to researchers, and a shorter version should be developed alongside its ongoing use as a benchmark measure. Even the HALS still reflects the view that measuring health literacy is a derivative of measuring literacy, rather than a standalone concept. If we accept the idea that health literacy is

an independent concept reflecting the skills and capacities that enable communities to exert greater control over their health, then this has important implications for measurement. In this conceptualization of health literacy, much work remains to develop more comprehensive measures that assess individual health literacy in relation to a person's ability to access, understand, and use health information in ways that promote and maintain good health. It is likely that different measurement tools will be needed for various ages and life stages—even if the conceptual structure remains constant. This would consider the different social contexts in which health literacy is relevant, as explicitly recognized in the definition by the Institute of Medicine and implicitly in the WHO definition [7].

Computerized health interventions have now been developed and specifically evaluated for individuals with low health literacy levels, such as multimedia touchscreen computers that manage standard diagnostic questionnaires and health education systems designed to accommodate varying levels of health, computer, and reading literacy. These systems typically provide information using audio, video, or graphics alongside text to minimize the literacy level required from users, often employing touchscreen input so that users do not need mouse and keyboard skills. For example, the Diabetes Multimedia Education Program uses images, 2D animations, and spoken audio (narrator) along with text. In a study involving 190 patients (21% with low health literacy), it was found that all patients experienced significant increases in diabetes knowledge after interacting with the program, although the program did not fully compensate for their low health literacy levels. Interactive voice response systems (or telephone-based systems) represent another modality that may be well-suited for delivering interventions to individuals with low literacy, as these systems (a) provide information in spoken form rather than text, and (b) utilize the widely available telephone communication channel, eliminating the need for computer literacy or computer access for participants [8].

The results from the three activities conducted show an increase in the participants' understanding. This improvement is evident in the percentage of understanding before and after the community service activities, as illustrated in Figure 1 [10].



Picture 1. Improving Students Understanding of Health Literacy

Based on Picture 1, the participants in the activity experienced an average increase in health literacy understanding of 92.17%. This includes an increase of 35.87% in students' understanding of health literacy (from 64.13% to 100%), a 36.74% increase in students' empowerment to sift through health information (from 46.75% to 83.49%), a 56.24% increase in students' understanding of media (from 37.52% to 93.76%), and a 55.53% increase in media usage (from 35.91% to 91.44%). Therefore, the results of this health literacy training can be considered successful, with an excellent category. [10]

Six relevant reviews published between 2000 and 2011 used narrative synthesis of evidence identified through searches. A variety of intervention approaches to improve health literacy were evaluated in this study, including: the use of easy-to-read materials (such as simplified language or the use of visual information), audio cassettes, videos, computer-based information and interactive platforms, personal contact with individual or group instruction, literacy education, health education, health management interventions, and internet education classes..

The Use of Audio Cassettes to Improve Health Literacy. The results were inconclusive regarding

the benefits of audio cassettes in reducing patient anxiety and enhancing patients' knowledge and recall. Although most studies reviewed reported an increase in knowledge and recall of the information presented, two studies reported no change, and one study reported a decrease in knowledge. Four studies showed positive results for behavior change and self-care outcomes, with only one study contradicting this trend.

Interventions aimed at improving consumer health information online included skills for searching, evaluating, and using online health information. Two studies included, both conducted in the United States, examined the effects of adult education classes on consumer online health literacy. A randomized controlled trial comparing Internet classes with patient education classes for participants with HIV reported positive effects on primary outcomes, including self-efficacy for health information, skills for evaluating health information, and the frequency of discussions about online information with healthcare providers. These interventions demonstrated significant effects on participants' readiness to adopt the Internet as a tool for prevention and health information, with no reported side effects. The authors of the review concluded that there is low-quality evidence that online interventions can improve health literacy in specific populations and called for more rigorously controlled trials in this area. [15]

Discussion

Several research areas have emerged regarding the effectiveness of didactic strategies to enhance health literacy skills. In each educational intervention, improvements were observed in the assessed outcomes. Analysis of health literacy skill levels showed an increase over time; however, students exhibited varying levels of health literacy skills, ranging from adequate to low. Each combined research area is crucial in identifying best practices to enable students to achieve high-level health literacy skills. Interestingly, some studies yielded controversial results; some researchers claimed that students demonstrated adequate or sufficient skills in health literacy. [1]

The use of technology in education for patients shows that the primary benefits of using educational technology to enhance health literacy include providing patients with immersive and experiential learning, which is considered unique to this technology. Doctors reported that facilitating patients' understanding of pain through immersive and experiential elements appeared to be superior to conventional methods, even though clinical outcomes were not formally assessed. [2]

Based on the conducted research, there was an increase in student satisfaction through enhanced knowledge, learning objectives, and outcomes, along with a feeling that their preparation was comfortable and very good, facilitated by the use of educational technology. This can contribute to motivation, improvement in clinical skills, and a reduction in time spent on education by promoting self-reflective activities. Interventions provided through technology should deliver health information that is culturally relevant and support decision-making for consumers with low literacy levels. [4]

Adolescents appear to be one of the groups most affected by mental health issues in the context of the pandemic, indicating that mental health literacy can be very useful as a strategy to navigate current and future challenges in this area [5]. Overall, VR-based health interventions are considered a good strategy, given their advantages of presence, immersion, and repetition [6]. In the conceptualization of health literacy, there is still much work to be done to develop more comprehensive measures that will assess individuals' health literacy in relation to their ability to access, understand, and use health information in ways that enhance and maintain good health [7]. IT systems can be utilized to significantly improve the social support network for individuals with low health literacy levels [8].

Our research results indicate a somewhat functionalist and individualistic perspective on media literacy among adolescents, where media literacy is seen as an essential awareness needed to function in a contemporary media-mediated society [9]. Health education through media publications, which should already be considered literacy, ought to be packaged in alignment with the processes of personal change—transitioning from childhood to adolescence, and then from adolescence to adulthood—linked to achieving individual and community health goals. Individual health literacy will enable communities to make positive choices to enhance their health [10].

Creating a learning culture that produces graduates with the capacity and desire for lifelong learning in a rapidly changing, complex environment filled with information requires significant changes in educational paradigms and resources [13]. Nurses need to move away from passive user roles and take on active roles in developing and applying technology. Therefore, educational institutions must integrate technology literacy and information literacy into nursing curricula, ensuring that students and future nurses

possess up-to-date skills at a higher level of complexity [11]. Programs addressing scientific health literacy are even rarer, despite their potential to develop a crucial understanding of science that is essential for health education and effective communication with healthcare services [12].

Health literacy must be an integral part of the service delivery system and quality analysis, and it should be included in studies on preventive services. Health literacy occurs when the skills and abilities of those needing health information and services align with the demand and complexity of that information and services [14]. Studies on online health literacy also encompass outcome measures such as health information evaluation skills, Internet usage, and information-seeking support [15]. The source of the message or the messenger also plays a significant role in influencing an individual's ability to process health information [16].

Conclusion

Understanding and measuring patient health literacy in relation to behavioral risk factors is a key objective in the prevention, detection, and management of chronic diseases. The concern lies in the fact that overall health literacy levels remain poor, and even worse for individuals from low socioeconomic backgrounds and/or minority ethnic groups. The implementation of eHealth and health IT is seen as an effective alternative to address current concerns regarding health status and the quality and safety of healthcare service consumers in the U.S. Therefore, it is crucial to ensure best practices for providing health literacy interventions using accessible and cost-effective IT solutions. There is also a risk that eHealth and the use of new technologies in healthcare could widen health disparities. This review indicates that eHealth interventions specifically designed to enhance health literacy skills for individuals with varying health conditions and risk factors can be effective [4].

This is the first research study to conduct a comprehensive bibliometric analysis of Health Literacy (HL) and Health Education (HE) at the international level. As indicated by the increasing number of publications over the past two decades, HL and HE have become increasingly important and relevant in the field of public health publishing. The research also shows that health education using VR is effective for adolescents. Specifically, pro-VR programs can be beneficial in enhancing health promotion related to knowledge, skills, and behavior change. Therefore, health interventions using VR can be utilized as educational opportunities and strategies to prevent risky behaviors among adolescents.

The majority of the included studies focus on measurement, with few addressing acquisition, and only one focusing on knowledge, skills, and technological competencies in nursing. The term technological literacy appears to be relatively underused in the field of nursing education. This is critically important not only for Australia but also for all countries. For instance, Taiwan held its first national conference on information literacy in 1999. Studies evaluating the relative effectiveness of various intervention approaches to improve health literacy are greatly needed, including traditional and innovative community, media, and participatory approaches. Developing the nature and scope of health literacy measurement and intervention strategies is essential for advancing health literacy research beyond what is covered in this review. Strategic actions at the European level are necessary to address the identified research gaps and to embed health literacy interventions as an integral component of population health promotion and health inequality reduction.

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