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Construction and validation of an educational video on hand hygiene through artificial intelligence: a methodological study

Construção e validação de vídeo educativo sobre higienização das mãos utilizando inteligência artificial: estudo metodológico

Construcción y validación de un video educativo sobre la higiene de manos utilizando inteligencia artificial: un estudio metodológico

ABSTRACT

Objective: To construct and validate an educational video on hand hygiene using artificial intelligence. **Methods:** This is a methodological study conducted in three stages: video construction, content validation, and analysis of the script's reliability. Twelve expert judges were selected for the validation of the educational video, and six experts for the analysis of the script's reliability. Data analysis was performed using the content validity index, the binomial test, and the intraclass correlation coefficient. **Results:** The content validity index ranged from 0.83 to 1.00, demonstrating consensus among the expert judges, as evidenced by the binomial test. The script's reliability was considered good, with an intraclass correlation coefficient of 0.90 and a p-value < 0.001. **Final remarks:** An educational video on hand hygiene using artificial intelligence was constructed and validated, as the content and script presented satisfactory values.

Descriptors: Hand disinfection; Infection control; Health personnel; Validation studies; Educational film and video.

RESUMO

Objetivo: Construir e validar um vídeo educativo sobre higienização das mãos utilizando inteligência artificial. **Métodos:** Trata-se de um estudo metodológico realizado em três etapas: construção do vídeo, validação de conteúdo e análise da confiabilidade do roteiro. Foram selecionados 12 juízes especialistas para a validação do vídeo educativo e seis expertos para a análise da confiabilidade do roteiro. Para análise de dados, foi utilizado o índice de validade de conteúdo, o teste binomial e o coeficiente de correlação intraclasse. **Resultados:** O índice de validade de conteúdo variou de 0,83 a 1,00, demonstrando consenso entre os juízes especialistas, como evidenciado pelo teste binomial. Quanto à confiabilidade do roteiro, foi considerada boa, com um coeficiente de correlação intraclasse de 0,90 e valor p < 0,001. **Considerações finais:** Foi construído e validado um vídeo educativo sobre higienização das mãos utilizando inteligência artificial, visto que o conteúdo e o roteiro apresentaram valores satisfatórios.

Descritores: Desinfecção das mãos; Controle de infecções; Pessoal de saúde; Estudos de validação; Filme e vídeo educativo.

RESUMEN

Objetivo: Construir y validar un video educativo sobre la higiene de manos utilizando inteligencia artificial. **Métodos:** Se trata de un estudio metodológico realizado en tres etapas: construcción del video, validación de contenido y análisis de la confiabilidad del guion. Se seleccionaron doce jueces expertos para la validación del video educativo y seis expertos para el análisis de la confiabilidad del guion. Para el análisis de datos se utilizó el índice de validez de contenido, la prueba binomial y el coeficiente de correlación intraclase. **Resultados:** El índice de validez de contenido varió de 0,83 a 1,00, demostrando consenso entre los jueces expertos, como lo evidenció la prueba binomial. En cuanto a la confiabilidad del guion, se consideró buena, con un coeficiente de correlación intraclase de 0,90 y un valor p < 0,001. **Consideraciones finales:** Se construyó y validó un video educativo sobre la higiene de manos utilizando inteligencia artificial, ya que el contenido y el guion presentaron valores satisfactorios.

Descriptores: Desinfección de las manos; Control de infecciones; Personal de salud; Estudios de validación; Película y video educativo.

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INTRODUCTION

One of the six international patient safety goals established in 2004 by the World Health Organization (WHO) through the World Alliance for Patient Safety emphasizes hand hygiene (HH) as a fundamental strategy for preventing and controlling healthcare-associated infections (HAIs). Numerous studies have demonstrated a strong association between adherence to HH practices and the reduction of HAI rates, reinforcing the importance of their systematic implementation across healthcare services[1,2].

Healthcare-associated infections (HAIs) constitute a global and multifactorial problem, representing a major challenge to the quality and safety of care delivery. Often caused by multidrug-resistant microorganisms, these infections are linked to increased morbidity and mortality, prolonged hospital stays—particularly in intensive care units (ICUs) - and substantial increases in healthcare costs[1,3]. A key factor contributing to their transmission is the inadequate adherence of professionals, companions, and visitors to HH, especially through direct and indirect contact with contaminated hands[1].

In this context, the development of educational strategies that encourage adherence to proper hand hygiene (HH) practices - aligned with the five moments recommended by the WHO and supported using appropriate techniques and products - is essential. Educational technologies have emerged as promising tools for enhancing knowledge, with educational videos standing out as dynamic and accessible resources that hold significant potential to influence the behavior of healthcare professionals[4-6].

Despite the availability of numerous educational videos on HH in the literature and on digital platforms, many have not undergone systematic validation regarding content, language, and pedagogical adequacy. Moreover, there remains a scarcity of materials that address the five moments of HH in a comprehensive and didactic manner, grounded in updated guidelines and conveyed in language accessible to the target audience[6]. The distinctive methodological feature of the present proposal is the incorporation of artificial intelligence (AI) resources in the video development process, particularly for scriptwriting, textual synthesis, image generation, and automated narration.

Researchers have emphasized the potential of AI as a strategic resource in education, particularly within the health field. Evidence suggests that AI can facilitate personalized learning, streamline pedagogical processes, and enhance the development of instructional materials grounded in updated data and scientific corroboration. Moreover, its use enables the creation of engaging and interactive content that can be tailored to learners' specific needs, thereby fostering greater engagement and improving teaching effectiveness across both formal and informal educational contexts. In the health domain, this includes applications such as supporting the prevention of HAI through HH[7].

In the context of health education, studies have shown that AI can expand access to information, enhance knowledge retention, and strengthen continuing education strategies for health professionals[7,8]. The integration of educational technologies—such as instructional videos—constitutes a significant methodological innovation, as it ensures greater accuracy,

timeliness, and applicability of the content produced. These resources not only facilitate the teaching–learning process but also contribute to the improvement of care practices, thereby underscoring the relevance of the present study[7].

Considering this context, the objective of the present study is to develop and validate an educational video on hand hygiene, incorporating the use of artificial intelligence as a methodological resource.

METHODS

This descriptive and methodological study was carried out in three stages: video production, content validation, and script reliability analysis. The development process followed established recommendations for the creation of educational videos, encompassing the pre-production, production, and post-production phases[9].

In the pre-production stage, the script was developed with the support of artificial intelligence, specifically the Generative Pre-trained Transformer (ChatGPT) language model. The system was instructed to generate an interactive script featuring a nurse character, aimed at training healthcare professionals in the correct HH technique and reinforcing the importance of this preventive measure in healthcare settings. The content was subsequently reviewed by researchers and, when necessary, revised in accordance with the guidelines of the WHO and the Brazilian Health Regulatory Agency (Anvisa)[10,11].

Within the production phase, the storyboard was structured to define both auditory and visual elements of the animation. The character's voice was generated using the ElevenLabs (Generative Voice AI) platform, applying three specific design parameters: gender (female), estimated character age, and accent. The synthesized voice prototype was subsequently exported and integrated into Adobe Express Animate From Audio, which was employed to synchronize vocal output with lip movements, configure the virtual setting, and design the visual representation of the nurse character. Upon completion of the animation sequence, the CapCut® application was utilized for advanced editing, including timeline adjustments, refinement of transitions, and the insertion of synchronized subtitles. In the post-production stage, the final video underwent a systematic verification process to ensure the accuracy and temporal alignment of subtitles, the consistency of illustrative images depicting HH techniques, and the coherence of the character's speech, assigned to the fictional Nurse Silvia.

The development of the video content was guided by Richard Mayer's Multimedia Learning Theory, which outlines 12 core principles for the design of instructional materials using audiovisual resources. Evidence in the literature indicates that adherence to these principles enhances comprehension, knowledge retention, and learner engagement, particularly within the field of health education. By promoting the coordinated and meaningful integration of auditory and visual channels, this approach strengthens the effectiveness of educational interventions and supports more robust learning outcomes[12–14].

Accordingly, the educational video was designed in alignment with Mayer's Multimedia Learning Theory, incorporating both visual and auditory elements to optimize comprehension and knowledge retention. Several of the theory's principles were operationalized during the pro-

duction. Multimedia principles (integration of images with spoken narration), temporal and spatial contiguity (synchronization and spatial proximity between narration and visuals), voice (use of natural, human-like narration), and segmentation (organization of content into short, logically sequenced thematic units) were systematically applied. Furthermore, signaling techniques were employed to emphasize key information and attract the learner's attention[12–14]. To prevent cognitive overload, the principles of coherence (removal of extraneous elements) and redundancy (avoidance of simultaneous presentation of identical text and narration) were observed. The personalization principle was also applied using accessible, conversational language intended to foster engagement. Finally, illustrations and animations were harmoniously integrated and directly aligned with the instructional objectives, thereby facilitating the construction of meaningful mental models and enhancing learning effectiveness[12–14].

For the content validation process, consensus among expert judges was pursued using the Delphi technique[15]. This method was selected due to its recognized capacity to build agreement among specialists through iterative, anonymous rounds of evaluation, thereby minimizing bias and increasing the reliability of the findings. Although the study design anticipated up to four rounds, consensus was reached at the conclusion of the second round, with agreement levels exceeding 0.90. Consequently, it was deemed unnecessary to proceed with the third and fourth rounds. This decision is consistent with the literature, which indicates that the Delphi process may be concluded once response stability and the predetermined threshold of agreement have been attained[16].

The predefined closure criteria for the Delphi process were: (i) a minimum agreement level of 80% for each evaluated item; (ii) the absence of additional relevant suggestions in subsequent rounds; and (iii) the maintenance of response stability between rounds. Although consensus was reached in the second round, the systematization of data adhered strictly to the principles of the Delphi technique, evidencing both the progressive refinement of the instrument and the active participation of the expert judges. This process was fundamental to ensuring that the material developed with AI support underwent rigorous evaluation by experienced professionals, thereby guaranteeing its quality, clarity, and pedagogical suitability.

The selection of expert judges was conducted through the Lattes Platform of the National Council for Scientific and Technological Development (CNPq). The researchers evaluated the participants' résumés based on predefined inclusion criteria: possession of at least a specialization in the field of infection control, a minimum of one year of professional experience in the area, and evidence of scientific production related to hand hygiene, such as articles, book chapters, or contributions as author or editor of books. Although the requirement of at least one year of experience may be considered flexible, it was established in combination with the candidates' academic training and scientific output, aligning with the methodological framework adopted in similar studies.

Out of the 23 specialist judges invited, 12 agreed to participate in the validation of the educational video. Additionally, six experts were designated to assess the reliability of the script, resulting in a total

of 18 evaluators involved in the study. The literature indicates that, although content validation may be conducted with as few as two experts, the prevailing recommendation is to engage at least six to ensure a reliable and robust assessment of the Content Validity Index (CVI). Therefore, the sample size adopted in this study is consistent with methodological standards commonly applied in expert validation research[17].

The first group received a structured instrument previously validated in the literature, comprising 18 variables related to theme validation, behavior change, adequacy of information, text length, contribution to the field, and the ability to engage the target audience. The second group received a form designed to assess overall reliability, which included the following variables, categorized as relevant or irrelevant: concept, idea, dramatic construction, rhythm, character, dramatic potential, dialogue, visual style, target audience, and relevance[18]. These elements were incorporated into the educational video with the support of artificial intelligence, which contributed directly to generating the narrative structure, selecting vocabulary, suggesting rhythm, and organizing didactic sequencing. The technology was applied iteratively to enhance conceptual clarity, dialogue fluidity, and visual coherence with the proposed pedagogical objectives.

For the validation of the educational video, the first structured instrument was developed using Google Forms®. The instrument consisted of items and response scales specifically designed for this study. Each question was rated on a four-point Likert scale, where 1 = not equivalent, 2 = requires major revision, 3 = equivalent, and 4 = absolutely equivalent.

The Content Validity Index (CVI) was calculated at both the item and scale levels to assess agreement among the expert judges. The Item-Level Content Validity Index (I-CVI) was used to determine the proportion of agreement for each item, while the Scale-Level Content Validity Index (S-CVI), derived from the average of the I-CVI values, provided an overall measure of agreement across all items evaluated[17,18]. The calculation followed the formula: number of responses scored as 3 or 4 divided by the total number of responses. A minimum acceptable agreement threshold of 0.78 was adopted, as recommended for studies involving at least nine experts[17]. Furthermore, the exact binomial distribution test was applied, with a 5% significance level, to validate the video. The agreement threshold was considered satisfactory when the proportion reached 80% and statistical significance was observed at $p > 0.05$, assuming the null hypothesis of agreement[19,20].

To assess reliability, the intraclass correlation coefficient (ICC) was applied, considering both the overall reliability of the educational video script and the statistical significance of $p < 0.001$. A two-way random-effects model with mean measures was adopted, as it is suitable for evaluating consistency among multiple evaluators who apply the same criteria at a single point in time. This model aligns with the study design and enables the estimation of variability across judges[21].

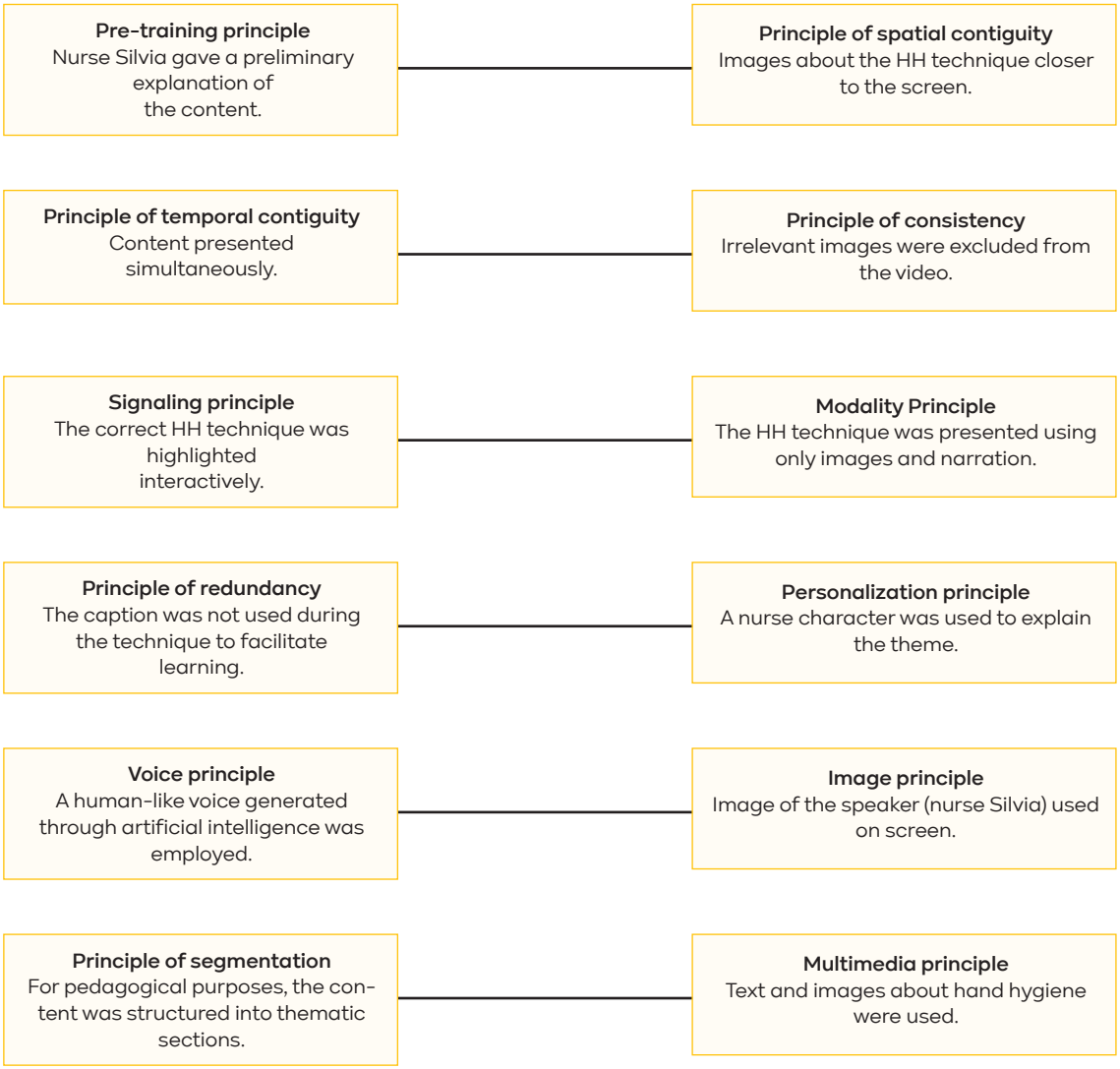
This study followed all ethical principles established in Resolution No. 466/2012 of the National Health Council. The project was approved by the Research Ethics Committee (CEP) of the University Hospital of the Federal University of Juiz de Fora (UFJF), Opinion No. 5,660,025 and CAAE:

62352022.5.0000.5133. All participants read and signed the Free and Informed Consent Form (FICF).

RESULTS

Figure 1 presents the stages of the educational video, structured according to the principles of multimedia learning theory, highlighting the integration of pedagogical foundations to enhance viewers' comprehension and content retention.

Figure 1. Application of multimedia learning theory principles in the educational video on hand hygiene. Juiz de Fora, Minas Gerais, Brazil, 2024.



Source: Prepared by the authors, 2024.

Among the 18 specialist judges who participated in the study, 16 (88.9%) were female. Participants' ages ranged from 34 to 56 years, with a mean age of 41. In terms of academic qualifications, 12 (66.7%) held doctoral degrees, while six (33.3%) had master's degrees. Professional experience in the field of infection control varied

from six to 17 years. Regarding institutional affiliation, eight judges (44.4%) were employed in hospital services, six (33.3%) worked in teaching and research in infection control, and two (11.1%) served as specialist consultants.

In the validation stage of the health education content, the Item-Level Content Validity Index (I-CVI) demonstrated an overall value of 0.81 in the first round of the Delphi technique. In the second round, I-CVI values ranged from 0.83 to 1.00, reflecting increased agreement among the experts. Only one item—related to the assessment of interactive language, defined as the material's capacity to foster active user engagement in the educational process—fell below the recommended threshold, with a value of 0.75 (Table 1).

Table 1. Validation of the educational video by the expert judges included in the study, Juiz de Fora, Minas Gerais, Brazil, 2024

Variables	I-CVI	p-Value*
1. Contemplates the proposed topic	1,00	0,38
2. Suitable for the teaching-learning process	1,00	1,00
3. Clarifies doubts about the topic addressed	0,91	0,00
4. Reflects the topic	0,83	0,27
5. Encourages behavioral change	0,91	0,27
6. Language appropriate for the target audience	0,91	0,27
7. Language appropriate for educational videos	1,00	0,77
8. Interactive language, allowing active involvement in the educational process	0,75	0,00
9. Correct information	1,00	0,39
10. Objective information	1,00	0,15
11. Clear information	1,00	0,39
12. Necessary information	1,00	0,07
13. Logical sequence of ideas	1,00	0,00
14. Current topic	1,00	0,07
15. Appropriate text length	1,00	0,39
16. Stimulates learning	0,83	0,27
17. Contributes to knowledge in the area	1,00	0,15
18. Arouses interest in the topic	0,83	0,00
S-IVC	**0,94**	

Note: *Binomial test; I-CVI = Item-Level Content Validity Index; S-CVI = Scale-level Content Validity Index.
Source: Prepared by the authors based on a previous study, 2024[22].

Regarding the assessment of overall reliability, the intraclass correlation coefficient (ICC) for all evaluated categories was 0.90, indicating good reliability. The 95% confidence interval ranged from 0.73 to 0.98, with a p-value quite below 0.001.

Table 2. Reliability analysis of the educational video script on hand hygiene. Juiz de Fora, Minas Gerais, Brazil, 2024.

Variables	Relevant	Irrelevant	ICC	Min - Máx.	*p*-value
Concept idea	6	-			
Dramatic construction	5	1			
Rhythm	4	2			
Character	5	1			
Dramatic potential	3	3	0,90	0,73 - 0,98	0,00

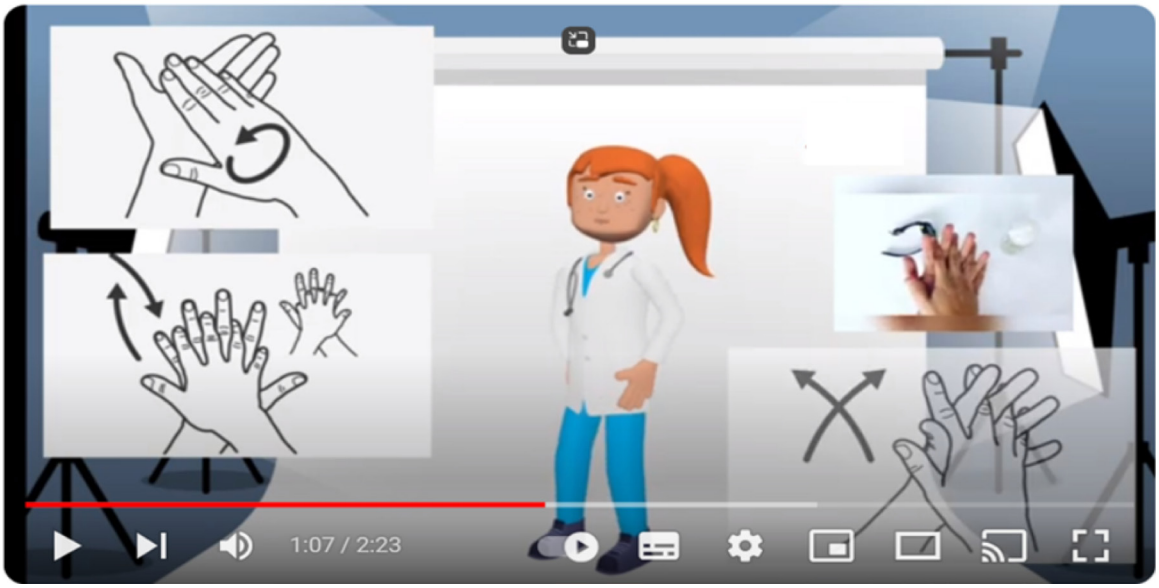
Continua

Variables	Relevant	Irrelevant	ICC	Min - Máx.	*p*-value
Dialogue	5	1			
Visual style	5	1			
Target audience	6	-			
Relevance	6	-			

Note: Min = minimum; Max = maximum; ICC = Intraclass Correlation Coefficient.
Source: Prepared by the authors, 2024.

Figure 2 presents the educational video on hand hygiene, developed with artificial intelligence and designed for healthcare professionals, with a duration of 2 minutes and 23 seconds. The video opens with the introduction of Nurse Silvia, who contextualizes the theme and introduces the five recommended moments for hand hygiene, emphasizing their importance. The technique of handwashing with water and liquid soap is explained in detail, supported by illustrative images and a demonstration segment. The character further highlights that alcohol-based preparation follows the same procedure and concludes by reinforcing its preventive impact in reducing HAIs.

Figure 2. Excerpt from the educational video on hand hygiene, Juiz de Fora, Minas Gerais, Brazil, 2024



Source: Prepared by the authors, 2024.

DISCUSSION

This discussion begins with a summary of the study's main findings. The educational video on HH, developed with the support of artificial intelligence, was validated by expert judges and demonstrated high levels of agreement; the CVI indicated satisfactory reliability. The final version, lasting 2 minutes and 23 seconds, combines digital animation, audio narration, and subtitles, and addresses the five recommended moments for hand hygiene, the technique using soap and water, and

the procedure with alcohol-based hand rub, emphasizing their preventive role in reducing HAIs.

In the context of health education, the use of theoretical frameworks to guide the construction and validation of teaching materials has been widely recognized as a valuable strategy in the teaching–learning process. In developing the video, several principles from Mayer's Multimedia Learning Theory were applied: segmentation, by dividing the content into short, logical sections; coherence, by eliminating unnecessary information that could lead to cognitive overload; personalization, using language that is accessible and relatable to the target audience; and signaling, by incorporating visual elements that highlight key information. Generative artificial intelligence contributed to the initial structuring of the script, suggesting a sequential and didactic organization that was subsequently refined in accordance with these principles[12,13].

Although there is no native programming that directly integrates AI resources with the fundamentals of Mayer's theory, the use of AI can be intentionally guided by these principles. For example, by instructing ChatGPT on the desired elements, such as avoiding excessive text, prioritizing simple language, or highlighting important steps with visual emphasis, it is feasible to align its responses with the theory. However, this integration depends directly on the pedagogical knowledge of the human user, who must guide, supervise, and adapt the AI's suggestions[13,14].

It is also important to reflect on whether, given the current state of technology, videos produced with AI support can fully incorporate the proposed theoretical framework. Although AI facilitated the generation of textual content and the logical organization of the narrative, challenges persist regarding pedagogical sensitivity and the necessity of expert review. Limitations include the absence of automated interactivity grounded in theoretical principles and the difficulty of AI in capturing more subjective aspects, such as rhythm, emotional appeal, and visual adequacy for the target audience[22].

Within this framework, the development of educational technologies has demonstrated promising results in health services, serving as tools for promoting self-care and patient empowerment. For instance, a Brazilian study reported the construction and validation of an educational video for older adults addressing the risk of falls, which was deemed valid by expert judges. Similarly, another Brazilian study validated the script of an audiovisual resource designed for people living with HIV[23,24]. Nonetheless, there remains a scarcity of studies exploring the development of educational videos supported by generative AI, particularly those focusing on the five moments of hand hygiene, underscoring the relevance of the present proposal[6,7].

It is important to emphasize that although AI tools, such as ChatGPT, hold significant potential for supporting the development of educational materials, their use must be grounded in robust theoretical and methodological frameworks. Such foundations are necessary to guide and legitimize every stage of the process, from conception to the final validation of the educational technology. This approach is crucial to ensuring the quality, applicability, and acceptance of these tools in health education practice. AI should therefore be regarded as a resource that provides te-

chnical support to teaching, rather than a replacement for pedagogical intentionality[25–27].

From this perspective, the present study aimed to develop an educational audiovisual tool on HH that delivered relevant content in language appropriate to the target audience, easily understandable, and concise—limited to a maximum of 15 minutes—as recommended in the literature to reduce cognitive fatigue and sustain viewer attention. Evidence shows that educational materials with objective presentations and optimized duration are more effective in promoting learning outcomes[12,20]. In this context, generative artificial intelligence supported the development of the script, streamlining production and assisting in the structuring of educational content. Methodologically, the use of this technology resulted in significant gains in the speed and organization of information; however, the final product still required critical human curation to ensure quality, ethical adequacy, and pedagogical coherence[26,27].

During the content validation process, up to four Delphi technique rounds were planned, but consensus was achieved after only two, with an agreement level exceeding 0.90 among the experts. This outcome highlights both the rigor and complexity of the evaluation process, even when grounded in a structural framework supported by AI. The experts' discussions centered on conceptual clarity, relevance, and the appropriateness of audiovisual language—elements essential to ensuring the educational effectiveness of the material. Furthermore, the reliability analysis of the educational video required a comprehensive assessment of multiple qualitative dimensions, including concept, central idea, dramatic construction, rhythm, characters, dramatic potential, dialogue, visual style, target audience, reference, and overall relevance. These dimensions demanded a critical and refined review from the judges, which ultimately strengthened the scientific robustness of the validated material[15].

The reliability analysis of the script was conducted with data from only nine participants, a limitation that must be acknowledged. Although the results were statistically significant, the small sample size calls for a cautious interpretation of the agreement levels, as emphasized in the specialized literature[21,28]. In this study, the ICC was employed as a widely accepted reliability index to assess consistency across multiple evaluations conducted by different observers or instruments[21,29]. The use of such measures ensures the adequacy of educational content. Specifically, the ICC contributed to evaluating the overall reliability of the script developed for the educational video, thereby enhancing the robustness of the scientific validation process—an approach also supported in previous studies[12].

In addition, the reliability analysis of the educational video encompassed multiple qualitative dimensions—including concept, central idea, dramatic construction, rhythm, characters, dramatic potential, dialogue, visual style, and overall relevance—which required careful analytical judgment and contributed to the development of more consistent audiovisual technologies. Nevertheless, deeper critical reflection is needed regarding the role of AI in this process. To what extent is its use truly essential, and what risks may arise from the automated and uncritical application of AI in health education? Teacher

mediation and pedagogical supervision remain central, particularly in nursing, where ethical, affective, and human dimensions are crucial to the construction of educational content[25,28]. Accordingly, AI should be understood as a supportive tool rather than a replacement for human discernment[26].

It is important to highlight that the validation of educational materials in health is a rigorous process that establishes the methodological foundation necessary for a technology to be reproducible[28]. Accordingly, in the video validation stage, professionals were carefully selected based on specific criteria: specialization in infection control, at least one year of professional experience in the field, and prior publications on hand hygiene in the form of articles, book chapters, or as book organizers/authors. The growing popularity of audiovisual educational tools reflects their attractiveness, dynamism, and capacity to facilitate the teaching–learning process through the integration of sound and image. These features capture the audience's attention, stimulate interaction, and enhance engagement with the proposed content[12,23].

Within this context, the educational video on HH demonstrates significant potential for use in health education initiatives by nurses and other members of the multidisciplinary team, as it facilitates access to knowledge through an accessible and user-friendly technology[30,31]. Moreover, its development and validation contribute to scientific advancement in the health field by fostering innovation and supporting new approaches to health promotion.

The study presents some limitations, including restrictions imposed by the development platforms, such as the limited availability of options for customizing clothing or settings, as well as the need for manual evaluation of the final video elements, which may introduce errors and inconsistencies. Another limitation concerns the script generated by ChatGPT, which was not subjected to expert validation and may therefore compromise the accuracy of the information presented. Finally, the passive and non-interactive format of the video can reduce user engagement and hinder the collection of feedback necessary to identify areas for improvement.

Finally, it is essential to restate the objective of this study: to develop and validate an educational video on HH with the support of generative artificial intelligence. By positioning AI as a central element of technological innovation, grounded in theoretical and methodological rigor, this work contributes to advancing health education in a manner that integrates scientific evidence, ethical responsibility, and creative approaches.

FINAL CONSIDERATIONS

This study developed and validated an educational video on HH, produced with the support of AI. The result is a health education tool that is efficient, inclusive, dynamic, attractive, and easily accessible to healthcare professionals, who play a central role in providing care across different contexts. In this way, the study successfully achieved its objective of creating and validating an educational video on hand hygiene through the collaborative integration of AI and human expertise.

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