Revista Española de Educación Médica

UNIVERSIDAD DE MURCIA

Video infographic on the metastatic cascade in the subject of Pathological Anatomy for Stomatology students.

Videoinfografía sobre la cascada metastásica en la asignatura Anatomía Patológica para estudiantes de Estomatología.

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Received: 4/6/26; Accepted: 16/7/26; Published: 18/7/26

Summary.

Teaching the metastatic cascade in dentistry is challenging due to its dynamic and sequential nature. Static resources limit an integrated understanding of the process. The objective was to design an audiovisual educational resource, specifically a video infographic, about the metastatic cascade for second-year dentistry students. A technological-educational development research project, based on the ADDIE model, was conducted, culminating in the development of a prototype. Thirty-eight students (diagnostic survey) and three professors (semi-structured interview) participated. The initial assessment revealed that 89.5% of the students reported difficulty visualizing the process as an integrated whole, and 100% considered a specific resource useful. Therefore, a video infographic was designed. (short animated video that integrates visual elements, text and audio to explain complex information) of 4 minutes and 29 seconds, subtitled, validated by experts using a rubric in four dimensions (scientific accuracy, instructional clarity, technical quality, suitability to the target audience). The video infographic received a "very adequate" rating in all dimensions from the experts (competence coefficient K=0.89). The designed video infographic reduces cognitive load by visually modeling the metastatic sequence. The subtitles ensure accessibility and reinforce retention through dual encoding. The 4.5-minute format is optimal for maintaining attention during sequential processes. The designed video infographic constitutes a pedagogical tool based on multimedia principles, facilitating the understanding of a complex process and applicable to teaching strategies in the health sciences.

Keywords: Teaching Materials; Neoplasm Metastasis; Neoplasms.

Resumen.

La enseñanza de la cascada metastásica en Estomatología es un desafío por su naturaleza dinámica y secuencial. Los recursos estáticos limitan la comprensión integrada del proceso. El objetivo fue diseñar un recurso educativo audiovisual del tipo videoinfografía sobre la cascada metastásica para estudiantes de segundo año de Estomatología. Se realizó una investigación de desarrollo tecnológico-educativo, basada en el modelo ADDIE, hasta el desarrollo del prototipo. Participaron 38 estudiantes (encuesta diagnóstica) y 3 profesores (entrevista semiestructurada). El diagnóstico inicial reveló que 89,5 % de los estudiantes reportaron dificultades para visualizar el proceso como un todo integrado y el 100 % consideró útil un recurso específico. En este sentido, se diseñó una videoinfografía (video animado de corta duración que integra elementos visuales, texto y audio para explicar información compleja) de 4 minutos con 29 segundos, subtitulada, validada por expertos mediante rúbrica en cuatro dimensiones (exactitud científica, claridad instruccional, calidad técnica, adecuación al público objetivo). La videoinfografía obtuvo una valoración “muy

adecuada" en todas las dimensiones por parte de los expertos (coeficiente de competencia K=0,89). La videoinfografía diseñada reduce la carga cognitiva al modelizar visualmente la secuencia metastásica. Los subtítulos garantizan accesibilidad y refuerzan la retención por codificación dual. El formato de 4,5 minutos resulta óptimo para mantener la atención en procesos secuenciales. La videoinfografía diseñada constituye una herramienta pedagógica fundamentada en principios multimedia, que facilita la comprensión de un proceso complejo y es aplicable a estrategias docentes en ciencias de la salud.

Palabras clave: Materiales de Enseñanza; Metástasis de la Neoplasia; Neoplasias.

1. Introduction

The teaching of Pathological Anatomy in the Dentistry program is essential for understanding the etiology, pathogenesis, and manifestations of diseases, particularly oncological processes. Within the complex field of neoplasms, the metastatic cascade represents the set of pathophysiological events by which tumor cells spread from the primary site to distant organs, and is responsible for the vast majority of cancer deaths (1). Mastery of this cascade is indispensable for future clinical practice, as it influences the prognosis, treatment planning, and follow-up strategies for cancer patients.

However, the dynamic, sequential, and multifactorial nature of this process makes it a pedagogical challenge. Traditional teaching, based on lectures, descriptive texts, and static micrographs, may be insufficient for students to construct an integrated and fluid mental representation of the invasion-intravasation-transport-extravasation-colonization sequence. Several studies (2-3) in medical education indicate that concepts involving movement, sequencing, and spatiotemporal relationships are internalized more effectively when dynamic visual resources that model these processes are used.

In the national context, although there is a policy of computerizing society and a push towards the creation of teaching materials, a gap is evident in the availability of high-quality, interactive digital educational resources specifically designed to address complex content in the basic biomedical sciences. This limitation is particularly pronounced in topics such as metastasis, where the literature reports persistent learning difficulties. Recent research (4-5) demonstrates the significant impact of educational videos and animations on the acquisition of knowledge and skills in health sciences, highlighting their potential to simplify complex topics.

Therefore, the research problem is posed as follows: How can we contribute to improving the teaching and learning process of the metastatic cascade for second-year Dentistry students? The hypothesis posits that the design of an audiovisual educational resource (OER), based on multimedia and instructional design principles, can offer an effective pedagogical representation of the metastatic cascade, thus facilitating its comprehensive understanding. The overall objective of this research is to design an audiovisual educational resource on the metastatic cascade for the Pathological Anatomy course, aimed at second-year Dentistry students at the University of Medical Sciences of Santiago de Cuba.

2. Methods

A technological-educational development research project was conducted at the University of Medical Sciences of Santiago de Cuba, Faculty of Dentistry, from September 2024 to July 2025, for the design of a video infographic on the metastatic cascade. The methodology for the design, development, and implementation of educational resources was employed, following the phases of the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), up to the design of the prototype. This model has been used by various authors in recent studies (6-8) to guide the creation of quality educational materials in the health field, and is distinguished by its

systematic and structured nature (9). The study population consisted of all second-year Dentistry students (n=38) who had taken the course on neoplasms in the Pathological Anatomy subject, as well as 3 professors from the Diagnostic Methods discipline with more than 5 years of teaching experience. A non-probability convenience sampling method was used, as all available students who met the inclusion criteria were included. For the professors, the three instructors of the discipline were intentionally selected. Randomization and sample size calculation were not applied, as this was a developmental study with a needs assessment of the entire group. Inclusion criteria were: enrollment in the second year of the Dentistry program, attendance at at least 80% of the classes on the topic of neoplasms, and voluntary consent to participate. Students who did not complete the survey were excluded.

Study variables

The following variables were defined, collected through surveys and interviews:

- Difficulty visualizing the dynamic process of the metastatic cascade. Dichotomous nominal qualitative variable. Scale: yes/no
- Primary source of study (book or class notes). Dichotomous nominal qualitative variable. Scale: yes/no
- Uses of internet videos as a supplement. Dichotomous nominal qualitative variable. Scale: yes/no
- Perceived usefulness of a specific audiovisual resource. Dichotomous nominal qualitative variable. Scale: yes/no
- Critical points of the process. Nominal polytomous qualitative variable. Scale: open
- Scientific accuracy of the REA. Ordinal qualitative variable. Likert-type scale (Inadequate, Somewhat adequate, Adequate, Very adequate)
- Instructional clarity of the OER. Ordinal qualitative variable. Likert-type scale (Inadequate, Somewhat adequate, Adequate, Very adequate)
- Technical quality of the OER. Ordinal qualitative variable. Likert-type scale (Inadequate, somewhat adequate, adequate, very adequate)
- Suitability for the target audience. Ordinal qualitative variable. Likert-type scale (Unsuitable, Somewhat suitable, Suitable, Very suitable)

Data collection and techniques used

The collection was carried out in five stages:

1. Initial Diagnosis (ADDIE Model Analysis Phase): An anonymous survey was administered to 38 students. It included closed-ended dichotomous (yes/no) questions about specific difficulties with the metastatic cascade and study habits, as well as an open-ended question to identify the stage of the metastatic cascade that presented the greatest learning challenge. Individual semi-structured interviews were conducted with the three professors, with prior informed consent. These interviews explored perceptions regarding the abstraction of the content, limitations of current resources, and critical points in teaching metastasis.
2. OER design (ADDIE model design phase): specific learning objectives derived from the topic of neoplasia were defined, then a pedagogical script structured in four sequential modules was developed:

- Module 1. Introduction and concept (review of malignancy characteristics and definition of metastasis).
- Module 2. Local invasion (loss of cell adhesion due to decreased E-cadherin, epithelial-mesenchymal transition, degradation of metalloproteinases).
- Module 3. Vascular dissemination and lodging (migration to vessels, intravasation, formation of tumor emboli, transport, extravasation, survival in the microenvironment of the target organ and angiogenesis).

- Module 4. Conclusions and clinical relevance for the dentist (prevention and early diagnosis).

The script was organized in a logical sequence that narrates the biological progression, based on the updated description of the metastatic cascade (11-12). The video infographic format was selected with a planned duration of 4 to 5 minutes.

3. Development of OER (development phase of the ADDIE model): For the production of the video infographic, a sequential workflow was established in four stages: *(a)* graphic design, *(b)* animation, *(c)* narration and audio, *and (d)* post-production, which are described below:

- Graphic design: The visual elements were designed. A figure from the *National Cancer Institute* (13) (available in the public domain at cancer.gov) illustrating metastatic spread was used, and figures from the book Robbins and Cotran, "Structural and Functional Pathology" (12) were used as a histopathological reference.
- Animation: The sequences were animated using Wondershare Filmora 14. This software allowed the description of cell movement during invasion, intravasation, and extravasation.
- Narration and audio: The narration was recorded in neutral Spanish by one of the authors. A slow pace was used, with emphasis on key concepts. Soft music and minimal sound effects were added.
- Post-production: The final video was edited. Audio and image were synchronized. Yellow subtitles with black outlines were added. The duration was controlled: 4 minutes and 29 seconds. It was divided into four modules with suggested pauses. The final format was MP4 (1920×1080p). The final credits for the resource were declared. The OER is available in open access, (14) and its technical and pedagogical specifications are summarized in Table 1.

Table 1. Technical and pedagogical characteristics of the designed OER.

Feature	Description
Format	Animated video infographic (mp4, 1920x1080p)
Duration	4 minutes and 29 seconds (segmented into 4 modules with suggested breaks to promote assimilation).
Visual style	2D animation with recognizable anatomical representation of epithelial cells, endothelial cells, and platelets, as well as tissues (primary, blood vessel, target organ).
Narration	Professional audio in neutral Spanish, with a slow pace and variations in intonation to emphasize key concepts.
Texts on screen	Keywords, molecule names (E-cadherin), legible font (Arial), appropriate size.
Subtitling	Arial font in yellow, with a black outline that ensures visibility on any background.
Elements of development	Use of arrows, text boxes, illustrations (enzymes degrading matrix).
Music and effects	Soft and discreet ambient music; minimal sound effects for transitions.
Pedagogical structure	Introduction-Development-Final Integrative Summary. (4 modules)

4. Evaluation of the OER by experts: The evaluation of the OER by experts was carried out through an expert judgment process with the following steps: (a) intentional selection of 3 experts from the same institution with a doctoral degree in medical sciences, more than 10 years of teaching experience and a high level of competence (K≥0.8); (b) a validation rubric was applied that assessed 4 dimensions (scientific accuracy, instructional clarity, technical quality, suitability to the target audience) using a Likert scale, after viewing the OER.

5. Data Analysis: Given the technological-educational development nature of the study and the small sample size (n=38 students, n=3 teachers), the analysis of the surveys and interviews

focused on qualitative-descriptive validation, supplemented by basic descriptive statistics (frequencies and percentages). This approach allowed for the characterization of pedagogical needs and perceptions without aiming for statistical generalization, consistent with the analysis and design phase of the ADDIE model. The quantitative data from the survey and rubric were processed using frequencies and percentages (%). The qualitative analyses of the interviews and open-ended questions were performed using thematic content analysis.

DeepSeek (15) was used as a writing assistant during the manuscript's preparation to perform grammatical, spelling, and stylistic corrections. The authors critically reviewed each suggestion, accepting only those that did not alter the scientific meaning. The authors assume full responsibility for the final content.

3. Results

To characterize students' learning difficulties and didactic needs in relation to the metastatic cascade, an anonymous survey was administered to the entire sample. Table 2 presents the diagnosis of teaching needs regarding the metastatic cascade, summarizing the most relevant findings. As can be seen, 89.5% of students acknowledge their inability to visualize the process as an integrated whole. This data, along with the unanimous acceptance (100.0%) of a specific resource, reveals a pedagogical gap that justifies the relevance of the resource's design. It is important to note that these results reflect self-reported perceptions and needs, not demonstrated learning outcomes.

Table 2. Needs assessment on teaching the metastatic cascade.

Aspect evaluated	Students (%)* n=38	Teachers' perception
Difficulty in visualizing the process as a dynamic whole.	89.5% (34)	They agree on the abstraction of the content.
Main source of study: textbook and class notes.	97.4% (37)	Limitation of dynamic means of support.
Use of internet videos as a supplement (YouTube, among others).	81.5% (31)	They acknowledge its usefulness, but point out a lack of scientific rigor or specific focus.
They would find a specific explanatory audiovisual educational resource useful.	100.0% (38)	Total agreement on the need and potential benefit.
Major difficulty: understanding the sequence of steps and the cell-microenvironment interaction.	86.8% (33)	They point to the epithelial-mesenchymal transition and intravasation as critical points.

*, calculated based on the total (n) of students

For their part, the interviews with the professors showed unanimous consensus regarding the teaching needs of the metastatic cascade. First, the professors agreed that the metastatic cascade is an abstract concept that is difficult to convey using standard static methods. Second, they identified two critical points that pose the greatest difficulties: the epithelial-mesenchymal transition and the intravasation process. Finally, they noted that the internet videos used by students, while useful as a supplement, lack scientific rigor and are not adapted to the Dentistry curriculum. Therefore, the professors explicitly endorsed the need for an audiovisual educational resource specifically designed with sound scientific and pedagogical criteria.

The designed OER was validated by experts in four dimensions (scientific accuracy, instructional clarity, technical quality, and suitability for the target audience), all of which were rated as highly appropriate. An average expert competence coefficient (K) of 0.89 was obtained,

considered high. Suggestions for improvement (greater emphasis on the concept of "metastasis" and adjustment of the speed in a sequence) were incorporated into the final version of the design.

4. Discussion

The diagnostic results confirmed an unmet pedagogical need. Most students expressed difficulty understanding the dynamic and sequential nature of the process, and all requested a specific resource. These findings fully coincide with those reported by Collazo et al. (2) and Jiménez et al. (3), who documented that pathophysiological concepts involving movement and spatiotemporal relationships are internalized more effectively when dynamic visual resources are used compared to traditional static ones. Similarly, Hansen et al. (4), in a systematic review, demonstrated that educational videos significantly improve knowledge acquisition in health sciences, supporting the use of an audiovisual format.

Regarding the instructional model, the use of ADDIE has been widely adopted in medical education (6-8). Avendaño et al. (16) point out that rigorous adherence to its phases (analysis, design, development, implementation, and evaluation) guarantees the quality and relevance of digital educational materials. The authors agree with this statement but add a specific contribution: the integration of ADDIE with Mayer's cognitive theory of multimedia learning.

This integration of ADDIE and Mayer's theory has been used internationally (10). In Cuba, there was no prior documentation of its application in medical education. The present study fills this gap by demonstrating how ADDIE operationalizes the principles of Mayer's Theory in a video infographic for dentistry students. This combined approach not only addresses a specific didactic need but also establishes a methodological precedent that can be replicated in other biomedical disciplines.

According to Putri (17), video infographics are an integrative digital medium that presents information in an audiovisual format and combines visual and audio elements to enhance comprehension and participation in the learning process. Similarly, Putra and Zahra (18) point out that they are visual representations of information designed to convey complex data in an attractive and easy-to-understand format. Another study (19) argues that video infographics improve data presentation by making it more engaging and easier to remember. Furthermore, they allow for the rapid transfer of large amounts of information compared to static infographics. This dynamic format captures attention and facilitates faster comprehension, making the information more impactful.

The video infographic's duration of 4 minutes and 29 seconds aligns with the recommendations of Miri et al. (20), who found that educational videos between 4 and 6 minutes optimize attention and retention in health sciences students. However, some authors, such as Broche Candó and Bermúdez Lamadrid (5), suggest that durations of up to 8 minutes can be equally effective if the content is well-segmented. In the authors' opinion, the chosen duration is appropriate because it allows for covering all the steps of the learning cascade without fatigue, and the suggested pauses between modules facilitate reflection. According to Saadi and Aidouni (21), this type of resource promotes student autonomy and improves knowledge retention, making it an effective pedagogical strategy.

The proposed design seeks to transcend the function of simple illustration to become a scientific modeling tool. Its potential pedagogical effectiveness should be verified through future quasi-experimental studies that measure its impact on learning. By animating the sequence, the OER makes the invisible visible, allowing the student to observe the "history" of tumor dissemination. This approach aligns with current trends in medical education, which favor the use of visualizations to teach complex mechanisms (22-23).

The choice of a continuous narrative, as opposed to a complex interactive resource, is justified by the specific teaching objective: understanding a linear causal sequence. A well-structured video reduces extrinsic cognitive load and allows students to focus on understanding the process, thus fulfilling the principle of cognitive load modulation. Its integration into a blended learning environment is versatile: it can be used as pre-class preparation material, as support during the teacher's explanation, and as strategies supported by evidence of the effectiveness of educational resources in healthcare settings (22,24). Similarly, it aligns with the findings of Rufín et al. (25), who demonstrated how digital tools strengthen educational continuity and academic resilience in adverse scenarios.

In addition, the designed video infographic includes subtitles. This feature is not merely an optional aesthetic complement but a fundamental pedagogical decision. It ensures universal accessibility, reinforces retention through dual encoding (visual and verbal), facilitates review and note-taking, and complies with regulatory standards for educational inclusion, regardless of hearing, linguistic, or attentional conditions.

Once the technical development of the prototype was completed, it was validated through expert review. The high expert competence score obtained supports the scientific and educational validity of the design. The choice of a continuous narrative, rather than a complex interactive resource, is justified by the need to reduce extrinsic cognitive load and promote focus on the causal sequence.

The authors of this research believe that video infographics play an important role in educational environments increasingly mediated by the digital age. This type of resource promotes content acquisition, stimulates critical thinking by highlighting causal relationships, and allows for knowledge appropriation according to different learning styles. Accordingly, the authors point out that dismissing their use in the classroom is tantamount to forgoing a first-rate cognitive scaffolding tool capable of transforming students from passive spectators into agents of change in knowledge acquisition.

In recent literature, authors such as Carino and Aybar Odstrcil (26-27) have proposed an innovative instructional model applied to the teaching of oral pathology, which optimizes participation and reduces cognitive load. Their proposal integrates microlearning with digital tools, thus facilitating the understanding of histopathological patterns and the transfer of knowledge to clinical practice. This approach confirms that brief, focused audiovisual resources constitute an effective means for teaching complex content in the health sciences and provides a methodological framework that complements the use of video infographics in the training of dentistry students.

Despite its alignment with these precedents, the present study has limitations that must be acknowledged: the student survey results are subject to self-perception bias, as the responses reflect reported opinions about difficulties and not necessarily actual performance on assessments. Expert validation, while rigorous, may exhibit institutional proximity bias, since all judges came from the same faculty. These aspects should be considered when interpreting the generalizability of the findings.

As a future direction, an implementation and impact evaluation design is proposed that includes: (a) application of the OER in the classroom as pre-assessment material; (b) post-assessment of knowledge using an objective test on the metastatic cascade; (c) retention analysis at 8 weeks; and (d) analysis of student perception of the OER using the “Instrument for the Evaluation of Digital Educational Resources” (Appendix), provided by the National Center for Distance Education (CENED) in Cuba. This proposal will allow for the generation of empirical evidence on

the actual effectiveness of the resource in learning, overcoming the current limitations of prototype design and validation.

5. Conclusions

- The design of the video infographic constitutes a well-founded pedagogical response to the identified need to dynamically represent the metastatic cascade.
- Its structure, based on the principles of multimedia learning theory and the ADDIE model, guarantees the scientific rigor of the content of Pathological Anatomy.
- Its digital nature makes it accessible, reproducible, and adaptable to different teaching strategies within the curriculum.

Ethical considerations: The study was conducted in accordance with the principles established in the Declaration of Helsinki. All participants provided written informed consent after receiving detailed information and confirmation of the voluntary nature of their participation. The evaluation by the three experts was conducted independently, ensuring the absence of conflicts of interest. The research stemmed from an institutional project, NA108604SC-034, "Technological Package for the Teaching, Clinical, and Extension Management of Dentistry in Support of Local Development," approved by the Scientific Council and the Research Ethics Committee of the Faculty of Dentistry at the University of Medical Sciences of Santiago de Cuba.

Funding: There was no funding for this work.

Declaration of conflict of interest: The authors declare that they have no conflict of interest.

Authors' contributions: ESD, study conception and design, literature search and analysis, and manuscript writing. BOHM and VLRU, proposal validation and critical manuscript review.

6. References.

1. Gerstberger S, Jiang Q, Ganesh K. Metastasis. *Cell.* **2023,** 186, 8, 1564-1579. http://doi.org/10.1016/j.cell.2023.03.003
2. Collazo AP, Hidalgo NR, Valdés EB, Alvarado OF, Pino GB, Herrera LLS, et al. "CITOPAT" Open educational resource for teaching and learning vaginal cytology in the subject of Pathological Anatomy. Panorama. *Cuba y Salud.* **2023,** 18, 1, 26-35. https://revpanorama.sld.cu/index.php/panorama/article/view/1566
3. Jiménez-Tobón GA, Jiménez Tobón HA, Vélez Hoyos A. Use of simulation in the teaching of surgical pathology. *Rev Salud Bosque.* **2019,** 9, 2, 56-64. https://www.researchgate.net/publication/338703360_Uso_de_la_simulacion_en_la_ensenanza_de_la_patologia_quirurgica
4. Hansen S, Jensen MT, Schmidt AM, et al. The Effectiveness of Video Animations as a Tool to Improve Health Information Recall for Patients: Systematic Review. *J Med Internet Res.* **2024,** 26, e58306. http://doi.org/ 10.2196/58306
5. Broche Candó JM, Bermúdez Lamadrid I. The power of educational video: innovating medical teaching in the 21st century. *Science and Innovation in Health.* **2023.** https://cisalud-ucmh.sld.cu/index.php/cisalud/2023/paper/download/563/187
6. Hernández CE, Mora DM, Gaspariano LA. Application of the ADDIE model for the creation of a virtual learning center in basic electronics concepts. *Revista Brasileira de Informática na Educação.* **2025,** 33, 347-70. http://doi.org/10.5753/rbie.2025.5113
7. Loján Carrión MD, Zambrano Solís MJ, Torres Torres OL, et al. ICT-mediated pedagogical model integrating ADDIE and gamification: A proposal to improve educational research. *UISRAEL Scientific Journal.* **2025,** 12, 1, 185-201. http://doi.org/10.35290/rcui.v12n1.2025.1438
8. Moreno FE, Mendoza JG, Juárez CM. ADDIE model for developing doctoral dissertation proposals in an online postgraduate program. *IE Journal of Educational Research of REDIECH.* **2025,** 16, 2352. http://doi.org/10.33010/ie_rie_rediech.v16i0.2352

9. Muñoz GF, Letechi AL, Zamora YE. Comparative analysis of the ADDIE and SAM instructional models in the design of digital learning environments. *Reincisol.* **2024,** 3, 5, 745-66. http://doi.org/10.59282/reincisol.V3(5)745-766
10. Betancur V, Muñoz AG. Application of the principles of the cognitive theory of multimedia learning to the design of learning situations and training scenarios: Systematic literature review. *Education in the knowledge society (EKS).* **2023,** 24, e30882-. https://doi.org/ 10.14201/eks.30882
11. Li Y, Liu F, Cai Q, et al. Invasion and metastasis in cancer: molecular insights and therapeutic targets. *Signal Transduct Target Ther.* **2025,** 10, 1. https://doi.org/10.1038/s41392-025-02148-4
12. Kumar V, Abbas AK, Aster JC. Robbins and Cotran. Pathologic Basis of Disease. 10th ed. Barcelona: Elsevier. **2021,** 189-237.
13. National Cancer Institute. Definition of metastasis. Bethesda (MD): *National Institutes of Health.* **2024.** https://www.cancer.gov/espanol/publicaciones/diccionarios/diccionario-cancer/def/metastasis
14. Santiago Dager E. Video infographic on the metastatic cascade [video]. *Zenodo.* **2025.** https://doi.org/10.5281/zenodo.20602734
15. DeepSeek AI. DeepSeek Chat. Hangzhou (China): Hangzhou DeepSeek Artificial Intelligence Co., Ltd. https://www.deepseek.com/
16. Avendaño-Cruz WA, Herrera Sánchez S del C, Cajigal Molina E, et al. ADDIE instructional design in English vocabulary learning for elementary school students. *EDUSCIENTIA. Educational Science Dissemination.* **2024,** 7, 14, 93-110. https://eduscientia.com/index.php/journal/es/article/view/499
17. Putri NAM, Hanifa S, Nurmawati I. Efektifitas Media Videoinfografis Terhadap Pemahaman Mahasiswa. *Likhitaprajna,* **2025,** 27, 2, 133–142. https://doi.org/10.37303/likhitaprajna.v27i2.430
18. Putra RW, Zahra S. Perancangan Video Infografis Stunting Pada Pusat Kesehatan Masyarakat Ketapang Kota Tangerang. *Kartala Visual Studies,* **2025,** 4, 2, 43–52. https://doi.org/10.36080/kvs.v4i2.251
19. İnfografiklerde Hareketli Grafik Tasarımın Rolü. *Repository,* **2023,** https://doi.org/10.5281/zenodo.8409003
20. Miri K, Yaghoubi A, Kholousi S, et al. Comparative study on the impact of 'Infographic versus video feedback' on enhancing students' clinical skills in basic life support. *BMC Med Educ* **2024,** 779. https://doi.org/10.1186/s12909-024-05763-x
21. Saadi N, Aidouni H. Microlearning dans l'Enseignement Secondaire: Impact des Outils Audiovisuels sur les Performances Académiques et les Compétences Transversales au Maroc-Une Étude Longitudinale. *Sciences et Éducation.* **2024,** 12, 1, 25-45. https://hal.science/hal-04990531/
22. Martínez-Ciarpaglini C, Asensio J, Alenda C, et al. Pathological Anatomy for the Medical Student: Video Tutorials with Integration of Digital Pathology as a Valuable Tool to Make the Subject More Practical and Attractive. *Educ Med.* **2022,** 23, 2, 100741. https://doi.org/10.1016/j.patol.2021.08.001
23. Vidal A, Pavicic F, Ehrenfeld P, Figueroa CD, Matus CE. Digital educational resources as support tools for teaching general pathology in undergraduate health sciences courses. *Int J Morphol.* **2022,** 40, 6, 1656-1661. https://doi.org/10.4067/S0717-95022022000601656.
24. Sandoval-Zavala M, Millán-Flores R, Sambuceti-Núñez C. Creation of audiovisual resources for nursing students as an innovation project in teaching. *Spirat. Academic Journal of Teaching and University Management.* **2025,** 3(NE1), e5370. https://doi.org/10.20453/spirat.v3iNE1.5370
25. Rufín LA, Vega MN, García DR. Challenges for teaching medical sciences under contingency conditions. *Rev Méd Electrón.* **2024,** 46, e5528. https://revmedicaelectronica.sld.cu/index.php/rme/article/view/5288
26. Carino SN, Aybar Odstrcil AC. Innovative educational design in Oral Pathology: current state of evidence on microlearning and proposal of an instructional model. *Rev Esp Educ Med.* **2026,** 3, 701661. https://doi.org/10.6018/edumed.701661

27. Odstrcil ADC, Cariño S. Use of virtual microscopy in the teaching and learning of oral pathological anatomy. Learning levels achieved in postgraduate courses. *Rev Esp Educ Med.* **2024,** 5, 4. https://doi.org/10.6018/edumed.635251

APPENDIX. DIGITAL EDUCATIONAL RESOURCES EVALUATION INSTRUMENT
(Prepared by the National Center for Distance Education, Cuba)

Resource to be evaluated:

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Instructions:

1. Navigate through the entire Digital Educational Resource before you begin filling out the assessment instrument.
2. Fill in each of the sections of this assessment instrument by assigning a score to each *item* according to the following scale.

Punctuation	**Meaning**
5	It fully meets the indicator. (Very adequate)
4	It's adequate, but there are aspects that could be improved. (Quite Adequate)
3	It partially meets the requested specifications. (Adequate)
2	It barely meets the requested indicator. (Inadequate)
1	The requested indicator is not met or present. (Inadequate)
N/A	The presence of the requested indicator is not considered necessary.

3. Each indicator has a section called observations; use it to make clarifications and/or recommendations.
4. When the selected option falls within the scale of four (4) to one (1), you must write suggestions and/or observations that allow you to detect opportunities for improvement of the indicator being evaluated.

Dimension: Content Quality			
No	**Indicators**	**Assessment**	**Observations and suggestions**
1	Content current.*		
2	Compliance with spelling and grammar rules.*		
3	Validity of the concepts and terms issued.*		
4	Sufficiency of the content for the achievement of the objectives.		
5	Resource license specification.*		
6	Distinction of the authorship credits of the resource		
	Total		
Dimension: Pedagogical			
No	**Indicators**	**Assessment**	**Observations and**

			suggestions
7	Introduction to the topic to be discussed.		
8	Target accuracy*		
9	Correspondence between objective and content*		
10	Correspondence between objective and evaluation*		
11	Description of the learning activities to be carried out		
12	Structuring the pedagogical sequence into introduction, development, and conclusions.		
13	Presence of closing activities that promote the integration of knowledge.		
14	Orientation towards individual and/or collaborative work of students		
15	Promoting motivation		
16	Treatment of correct or incorrect answers in self-assessment exercises		
	Total		
Dimension: Technological			
No.	**Indicators**	**Assessment**	**Observations and suggestions**
17	The most important ideas are highlighted through the use of colors, boxes, bold text, among other things; taking into account the visual design followed in the resource		
18	Integrity of navigation links		
19	Diversity in the use of media for the representation of the displayed content		
20	Technical quality of multimedia elements (image, audio and video).*		
21	Graphic design consistency across all screens (colors, icons, typography).		
22	Metadata description		
23	Adaptability of the resource to the different mobile devices with which it can be accessed*		
24	All audio and video objects in the resource have subtitles.		
25	All objects in the resource have alternative text		
26	The text is legible or its size can be adjusted		
27	Appropriate contrast between content and background		
28	It can be used with or without an internet connection		
29	Easy access to different segments of the content		
30	Use of short videos and audio clips		
31	The resource design is well organized and intuitive.		
	Total		