

Development of an online course for training nurses on Antimicrobial Stewardship Programs

Desenvolvimento de curso online para formação de enfermeiros sobre o Programa de Gerenciamento de Antimicrobianos

Desarrollo de curso en línea para la formación de enfermeros sobre Programas de Optimización de Antimicrobianos

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Abstract

Objective: to describe the process of developing, building, and validating e-learning educational technology aimed at training nurses on Antimicrobial Stewardship Programs (ASPs) based on Case-Based Learning (CBL). **Methodology:** a methodological study that begins with the following phases: Instructional Design, content validation by experts, building visual content, and course availability on a digital platform. **Results:** it was organized around a single clinical case, divided into eight modules, containing additional materials for reading and formative evaluation. The possible contexts for the progression of the initial case and its outcome were presented sequentially, thus facilitating the presentation of its content in a logical manner that is present in professional practice. **Conclusion:** the development of this course enabled the production and validation of a feasible technological resource to promote the improvement of nurses' role in terms of ASPs, thus contributing to the training of nurses in the theme.

Descriptors: Educational Technology; Digital technology; Education, Nursing; Antimicrobial stewardship

Resumo

Objetivo: descrever o processo de elaboração, construção e validação da tecnologia educativa *e-learning* voltado à formação de enfermeiros sobre o Programa de Gerenciamento de Antimicrobianos (PGA), com base na Aprendizagem Baseada em Casos (ABC). **Método:** estudo metodológico que se inicia com as fases de: Design Instrucional; validação de conteúdo por especialistas; construção do conteúdo visual e disponibilização do curso em plataforma digital. **Resultados:** organizado em caso clínico único, dividido em oito módulos, contendo materiais extras para leitura e avaliação formativa. As possíveis situações de evolução do caso inicial e desfecho foram apresentadas de forma sequencial, facilitando a apresentação do conteúdo de forma lógica e presente na prática profissional. **Conclusão:** o desenvolvimento do curso

possibilitou a produção e validação de um recurso tecnológico viável para promover o aperfeiçoamento de enfermeiros no PGA, contribuindo assim para a qualificação da enfermagem na temática.

Descritores: Tecnologia educacional; Tecnologia Digital; Educação em enfermagem; Gestão de Antimicrobianos

Resumen

Objetivo: describir el proceso de desarrollo, construcción y validación de una tecnología educativa de aprendizaje electrónico dirigida a la capacitación de enfermeros sobre Programas de Optimización de Antimicrobianos (PROAs) con base en el Aprendizaje Basado en Casos (ABC).

Metodología: estudio metodológico que se inicia con las siguientes fases: Diseño Instruccional, validación de contenido por expertos, construcción del contenido visual y disponibilidad del curso en una plataforma digital. **Resultados:** se organizó como un caso clínico único, dividido en ocho módulos, conteniendo materiales adicionales para lectura y evaluación formativa. Las posibles situaciones de evolución del caso inicial y desenlace se presentaron de forma secuencial, facilitando la presentación del contenido de manera lógica y presente en la práctica profesional. **Conclusión:** el desarrollo del curso permitió la producción y validación de un recurso tecnológico viable para promover la mejora de los enfermeros en los PROAs, contribuyendo así a la cualificación de la enfermería en el tema.

Descriptores: Tecnología Educacional; Tecnología Digital; Educación en Enfermería; Programas de Optimización del Uso de los Antimicrobiano

Introduction

Antimicrobial resistance (AMR) is one of the biggest challenges to global public health, and it is exacerbated by the inappropriate use of these medications in different healthcare settings.¹⁻³ In the hospital environment, inappropriate practices in prescribing, dispensing, and administering medications directly contribute to the increase of resistant microorganisms and therapeutic ineffectiveness, negatively impacting clinical outcomes, length of hospital stay, and hospital costs.⁴⁻⁵

In this context, Antimicrobial Stewardship Programs (ASPs) emerge as essential strategies to optimize the use of these medications, prevent adverse events, and reduce the spread of AMR. The nurses' role is crucial to the effectiveness of these programs, especially in the stages of infection prevention and control, monitoring the antimicrobial administration, and health education.⁶⁻⁸

However, studies indicate gaps in nurses' knowledge and confidence regarding their role in terms of ASPs, which may limit their contribution to the rational use of antimicrobials and evidence-based clinical decision-making. This weakness is partly related to the lack of content related to antimicrobial stewardship during undergraduate

nursing education, which leads to the theme being addressed in a superficial or fragmented manner. As a consequence, many nurses enter professional practice without conceptual and procedural mastery of the rational use of antimicrobials, surveillance actions, and therapeutic monitoring.⁸⁻¹¹

This educational gap directly affects the implementation of the competencies required for the effective role of nurses in terms of ASPs, highlighting the importance of professional development strategies that promote the development of these competencies within the healthcare services setting. In this context, continuing education and the use of digital educational technologies have proven to be effective alternatives for strengthening technical and reflective competencies, enabling autonomous and interactive learning, bridging the gap between theory and practice, and promoting critical reflection on the reality of nursing work.^{9,12-13}

Considering the need to enhance nurses' knowledge about ASPs and the need for digital educational technologies to support the updating of nursing care practices,¹⁰ this experience report aimed to describe the process of developing, building, and validating an e-learning educational technology focused on training nurses on an Antimicrobial Stewardship Program, structured based on Case-Based Learning (CBL).¹⁴

Methodology

This is a methodological study that describes the path of developing and building an online course focused on training nurses in terms of ASPs. Methodological studies enable the organization, development, and evaluation of content and scientific techniques of materials through methodological rigor.¹⁵

In order to develop the educational technology "Antimicrobial Stewardship Program: Training for Nurses," the Instructional Design (ID) framework was adopted based on the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation), which guides the creation of educational technologies in a structured and learning-centered manner. This model allows the educational process to be organized into interdependent stages, ranging from the diagnosis of training needs to the evaluation of the obtained results.¹⁶

This article covers the first three phases of the ADDIE model, namely analysis, design, and development, which correspond to the conception stages of educational technology. The implementation and evaluation phases are not addressed in this article, as they are part of a later stage, where the course will be applied and evaluated with nurses working in hospital care.

In the analysis phase, the target audience was identified as nurses working in a hospital setting, and the learning needs related to the nurse's competencies in Antimicrobial Stewardship Programs (ASPs) were evaluated. All the educational technology content was developed based on the international consensus "International Antimicrobial Stewardship Competencies for Undergraduate Nursing Education,"¹⁷ organized into four domains, guiding the content covered in the course.

The design phase involved the pedagogical and structural planning of the technology, including the definition of learning objectives, workload, course format, and the pedagogical strategy to be used. CBL was chosen, as it allows the integration of theory and practice through problem-situations contextualized to the professional reality of nursing workers.¹⁴ In this phase, the thematic units, support materials, and the logical sequence of the learning path were also outlined.

During the development phase, the production of instructional material took place, covering the development of the central clinical case, the formative evaluation questions, and the automatic feedback, as well as the creation of visual resources and interactive course interfaces. All textual content was submitted to content validation by a panel of experts composed of five professionals with experience in the field: an infectious disease physician, a pharmaceutical researcher in the field, two nurses, an infection control specialist, and another researcher in the field. The experts received the material in advance for preliminary evaluation. Subsequently, a virtual meeting was held via Google Meet®, where the entire path of the case was reviewed step by step. At this point, participants could make comments and suggestions and argue until reaching a final consensus.

The contributions from the panel were analyzed and incorporated into the final material, resulting in a consensus on the appropriateness and clarity of the content. After validation, the course was structured on the Open Courses Portal of the Federal

University of São Carlos (PoCA, as per its Portuguese acronym), as it offers free access and compatibility with mobile devices, promoting the dissemination and accessibility of educational technology. The process of designing and developing the course took place between April 2023 and April 2024.

The research project that led to the development of the course was approved by the Research Ethics Committee of the Federal University of São Carlos, under CAAE opinion n. ° 66596622.2.0000.5504.

Results

The results are presented according to the three ADDIE phases considered in this study—analysis, design, and development—which make up the process of designing the online educational technology “Antimicrobial Stewardship Program: Training for Nurses.”

The analysis phase focused on diagnosing educational needs and defining the target audience. Considering the AMR context, gaps were identified in nurses’ knowledge regarding their role in terms of ASPs. This stage provided the basis for the justification for creating an educational technology that would contribute to the strengthening of professional competencies related to the rational use of antimicrobials.

Based on this diagnosis, the framework of the international consensus “International Antimicrobial Stewardship Competencies for Undergraduate Nursing Education,”¹⁷ was adopted, which presents four domains of core competencies that served as the structural basis for the educational technology content: (1) Infection prevention and control; (2) Infection diagnosis and antimicrobial use; (3) Nursing clinical practice; and (4) Person-centered care and interprofessional practice. From these domains, it was possible to outline the priority themes to be addressed and establish the structure of the course.

In the design phase, the pedagogical planning of the course took place, with the definition of educational objectives, the teaching sequence, the pedagogical strategy, the workload (4 hours), and the format of content presentation. The CBL method was

chosen based on problem situations from the daily routine and nursing experience in hospital settings, in order to promote the contextualization of theoretical knowledge and the development of clinical reasoning.

The final structure of the course was organized into thematic units, each representing a stage in the path of the clinical case and encompassing the competence domains defined by the theoretical framework. Each unit consisted of: an introduction and specific objectives; a contextualized clinical case, a multiple-choice evaluation question, automatic feedback (positive or negative), supplementary reading material, and a unit conclusion.

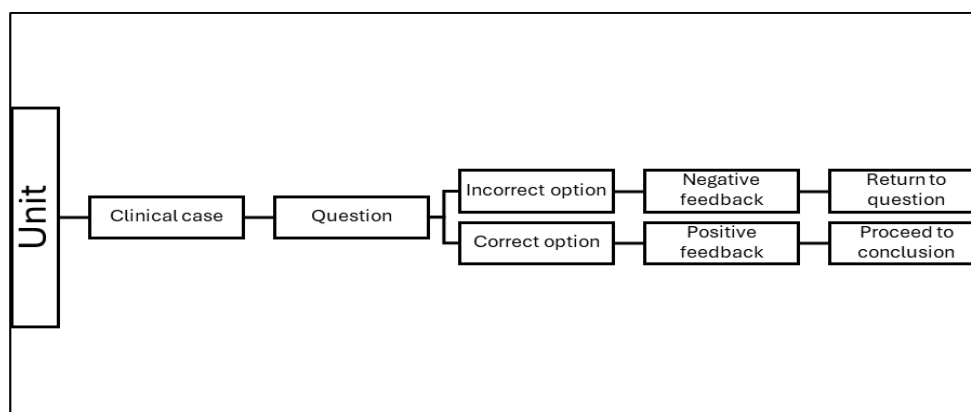
The clinical case was planned and divided into eight thematic units for the composition of the course. These thematic units, displayed in Table 1, were named in a way that could easily be related to the theme addressed in each unit.

Table 1 – Course thematic units of the course “Antimicrobial Stewardship Program: Training for Nurses.” São Carlos-SP, 2024

Unit	Theme
I	Prevention and control of perioperative infection
II	Postoperative nursing care
III	The nurses’ role in terms of diagnosing infection
IV	Microbiological culture collection
V	Antimicrobial use
VI	Monitoring after medication
VII	Changing route
VIII	Antimicrobial replacement

The course was planned to be accessible on computers and mobile devices, allowing flexibility and autonomy in the learning process. In order to ensure a logical progression of the content, a sequential browsing system was implemented, where the participant can only move on to the next unit after correctly answering the formative question, as displayed in the flowchart (Figure 1).

Figure 1 – Summary of the flowchart of the course “Antimicrobial Stewardship Program: Training for Nurses.” São Carlos-SP, 2024



During the development phase, the instructional and evaluation materials that make up the course were prepared. The textual content was built based on the four competence domains of the international framework, resulting in the creation of a central clinical case and formative evaluation questions distributed throughout the eight thematic units.

The clinical case presents the story of patient João Marcos, an elderly man who underwent hip arthroplasty and was later readmitted on suspicion of a healthcare-associated infection. The narrative was built sequentially, allowing the participant to follow the patient's clinical progression and reflect on nursing decisions at each stage of care.

After the content was developed, the content validation of the educational technology was carried out in June 2023 through a panel of experts consisting of five professionals with experience in the theme: an infectious disease physician, two nurses (one infection controller and the other a researcher in the field), and a pharmacist researcher in antimicrobial stewardship. The experts were previously provided with the material in an editable format and participated in a virtual meeting via Google Meet®, during which each thematic unit was reviewed and discussed.

The validation process was highly productive and allowed us to identify and discuss points of divergence among the experts. In Unit V – Antimicrobial use, there was a debate about the indication of the presented antibiotics, both for empirical treatment (cefepime and vancomycin) and guided treatment (oxacillin). The participation of the

infectious disease physician, with extensive experience in infection control, was essential to substantiate and adjust these recommendations.

In Unit IV – Microbiological culture collection, the main disagreement involved the care and criteria for sample collection. The practical experience of the nursing workers was decisive in terms of reaching a consensus and improving the guidelines described in the material.

Finally, in Unit VII – Changing route, the contribution made by the pharmacist was fundamental in clarifying to the other participants the safety of replacing intravenous oxacillin with oral sulfamethoxazole + trimethoprim to complete the treatment, thus ensuring alignment between recommendations and safe practice.

The suggestions related to the indication of antibiotic therapy, the proper management of microbiological sample collection, and the change in relation to the antimicrobial administration routes were incorporated into the material. These contributions allowed for achieving consensus regarding the clarity, relevance, and appropriateness of the content for the reality of nursing practice.

Discussion

The development of the online course on ASPs allowed for a broad reflection on the strategic role of nurses in terms of promoting the rational use of antimicrobials and preventing AMR. The creation of this educational technology aimed to bridge the gap between theory and practice, using the ADDIE model and the CBL methodology as the structuring axes of the pedagogical process. This approach enabled the creation of a dynamic and contextualized learning environment, aligned with international competencies and national needs for the training of nursing professionals working in hospital services.^{7,10,17-19}

The decision to choose only four of the five proposed domains was due to the fact that the four domains are related to the actions carried out by nurses in the hospital setting in Brazil. Thus, it was decided to prioritize the domains that address infection prevention and control, diagnosis, clinical practice, and person-centered care, which represent the core of the activities carried out by nurses in the hospital setting, thus reaffirming the importance of contextualizing international models to local legislation

and professional competencies, as well as ensuring the pedagogical and ethical applicability of the proposal.^{8,10}

The development of the clinical case was a challenging stage, requiring a balance among scientific evidence, accessible language, and fidelity to the nurse's routine in the hospital setting. The choice of a single case that covered the four competence fields allowed for an integrated and realistic approach, thus facilitating the teaching and learning process, which promotes understanding of how nurses carry out their tasks in ASPs at different moments of the care process. In addition, the division of the content into eight thematic units and the use of evaluative questions with feedback encourage critical thinking and clinical reasoning. Studies reinforce that active methodologies based on real practice situations, such as CBL, increase learner engagement and promote the consolidation of complex knowledge.^{9,14,20}

Another relevant aspect of the process was the participation of experts during the validation stage, which proved essential to ensure theoretical and practical coherence of this educational technology. This involved a collaborative process with qualitative analysis based on collective discussion and consensus. This strategy is recognized in the literature as a valid alternative in exploratory and methodological studies, especially when the objective is content refinement and pedagogical appropriateness.²¹ The consensus reached among the experts reinforced the relevance of the themes and the pertinence of the proposed activities, resulting in consistent, clear, and applicable material.

The developed course represents an innovation by integrating the use of CBL with the ADDIE model in an educational technology specifically aimed at strengthening nurses' knowledge about ASPs. This combination of pedagogical strategies promotes autonomy, active learning, and the development of clinical reasoning, thus providing a meaningful educational experience.^{8,11,20}

Furthermore, the proposal helps to fill out a training gap identified in national and international studies, where nurses report insecurity and knowledge limitations to work in the stages related to antimicrobial stewardship. By enabling contextualized and self-instructional learning, this technology promotes continuous updating, an essential component for evidence-based practice and patient safety.¹⁰⁻¹¹

From a pedagogical point of view, experience has shown that educational technology can be used not only as a tool for providing continuing education but also as a strategy for raising awareness of the importance of nurses' participation in ASP actions. The possibility of digital and flexible access expands the reach of the proposal, allowing professionals from different regions and levels of experience to benefit from the content, which aligns with current ANVISA (2023)⁷ recommendations on the need to strengthen the continuous training of multidisciplinary teams for the success of ASPs. In addition, the adoption of digital resources and immediate feedback encourages engagement and self-evaluation, factors recognized as key determinants for the effectiveness of self-instructional health courses.^{9,22}

This experience also highlighted the potential of educational technologies as tools for providing continuing education, thus promoting the development of technical, ethical, and reflective competencies. The use of active methodologies in digital environments has shown a positive impact on knowledge retention and the transfer of learning to clinical practice.²⁰⁻²² Accordingly, the developed course contributes not only to the filling out of the training gaps but also to the transformation in relation to the way nurses understand and apply the concept of antimicrobial stewardship in their professional daily practice.

Finally, it is worth highlighting that the proposal also has social and institutional relevance, by providing an accessible, free educational resource aligned with public policies addressing antimicrobial resistance and with the World Health Organization's (2022)²³ goals for the rational use of antimicrobials. The applicability and replicability of the course in different contexts reinforce its contribution to the strengthening of ASPs in healthcare services and valuing the role played by nurses in this process. Accordingly, the reported experience stands as an example of pedagogical innovation and commitment to continuous professional development, integrating science, technology, and care in a transformative perspective for contemporary nursing.^{12,22,24}

Conclusion

This study presented the steps for the development and validation of an online course aimed at training nurses on ASPs, designed based on the ADDIE model and

grounded in CBL. The use of a single clinical case and objective evaluation questions promoted the integration between theory and practice, allowing participants to critically reflect on care and the rational use of antimicrobials.

The course content was validated by a panel of experts in the field, thus ensuring the theoretical, pedagogical, and technical consistency of the proposal. Available on an open-access platform, the course constitutes a feasible, accessible, and short-duration educational technology, appropriate for the demands of nursing professional practice, especially given the workload and time constraints that characterize the healthcare setting.

It is believed that this educational technology can contribute significantly to the continuing education of nurses, thus expanding knowledge and strengthening competencies related to antimicrobial stewardship in healthcare services. Furthermore, the proposal aligns with national and international policies for combating AMR and can be used in future educational interventions and research, establishing itself as an innovative tool for professional development and the promotion of patient safety.

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