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ORIGINAL ARTICLE

Description of the scientific method for the preparation and validation of educational technologies in digital format: a methodological study

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Abstract

Introduction: the use of digital technologies constitutes a process that allows the dynamization of the care process, based on aspects related to criticality and creativity. It is emphasized that the development of technologies must, therefore, be inserted in a context for changes and innovation in response to the population's health demand, and must follow a precise methodological path that goes from the construction to the validation of the appearance, content and effect .

Objective: to describe the scientific method of elaboration and validation of educational technologies in digital format.

Methods: methodological study, conducted according to the following steps: development of the research project and submission to the Research Ethics Committee; data collection; elaboration of the content, script, illustrations and layout of the booklet; and validation of educational technology.

Results: the process of developing a technology requires methodological rigor, enabling coherence between theory and the purpose of the desired product, guaranteeing the internal quality of the developed technology. The use of educational technologies in health reinforces information, serving as a guide for guidelines regarding care and assisting in decision-making. Technological innovations in health, consists of a socio-technical process , permeated by professional and user reflections and experiences.

Final considerations: educational technologies represent a potential resource for the development of health education practices, encouraging greater interaction between professionals and users, and an active attitude regarding self-care actions related to their health condition.

Keywords: teaching materials, health education, validation studies.

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Authors summary

Why was this study done?
To expand knowledge about the construction and validation of health technologies, expanding theoretical concepts about these processes, and strengthening discussions about the recognition of technologies as products of innovation regarding the practice of health education.

What did the researchers do and find?
Methodological study with the aim of describing the scientific method of elaboration and validation of educational technology for the use of health education practices.

What do these findings mean?
It is expected to contribute to knowledge about the development and validation of health technologies, which can be used by health professionals as tools for building knowledge in practices anchored by reflective discussions.

Highlights
Health Technology
Elaboration and validation of health technology
Reliability of the developed technology
Dissemination of health promotion practices

INTRODUCTION

The plurality of the concept of technology is polysemic, allowing for different ideological strands in the field of health. In this context, the term technology cannot be understood only as equipment, but also as the operating knowledge/doing that gives meaning and reason to the equipment itself, directly relating to the characteristics of the subject – such as capacity and creativity and their actions[1] .

Technologies correspond to processes implemented from the daily experience of health care or research on the development of a set of activities produced and controlled by human beings [2] . They are applied as tools to mediate health education actions, as they enable individuals to think, reflect and act on their self-care[3] .

Thus, it is clarified that the use of technologies in health constitutes a process that allows the dynamization of the care process, based on aspects related to criticality and creativity. It is emphasized that the development of technologies must, therefore, be inserted in a context for changes and innovation in response to the population's health demand[4] .

The use of technology in health aims to improve the practice of care, ranging from the interventionist character to the relational character, shaping health practices based on the use of technologies and their theoretical links[5] .

In this context, the term technology gains new configurations and classifications in the search for better applicability in health care. Three modalities of technologies are pointed out: educational technologies, characterized as a set of systematic knowledge that allows the development of educational actions between professionals and users; managerial technology that involves theoretical-practical actions, used in the management of care and health services; and assistive technologies constituting a set of instrumental actions in assistance[6] .

It recognizes the need for innovative technologies in care and in health education actions, since it will be able to promote significant advances in terms of generating subjects who are critical and protagonists in their health care. In this way, the present research will contribute to the knowledge about health technologies by allowing reflections on the process of elaboration and validation of technologies.

Thus, the study aims to describe the scientific method of elaboration and validation of educational technology.

METHODS

This is a methodological study related to research referring to the investigation of methods for obtaining, organizing and analyzing data, allowing the systematic description of the elaboration and analysis of instruments and research techniques, in order to allow the construction of an instrument that is reliable, accurate and usable, and can be applied by other researchers[7] .

The present study aims to describe the process of developing a technology in health, based on essential characteristics for the elaboration and validation of technologies, using as theoretical bases methodological references of multiple studies that developed educational technologies in different contexts of health.

There are several paths developed by authors for the elaboration of health technologies, namely: development of measuring instruments elaboration of educational materials[8,9] ; for digital educational materials[10] ; construction of videos[11,12] for the development of care guidelines manuals. Figure 1 shows the different paths for the development of a health technology.

This study will have as theoretical support the steps proposed by the author Echer[12] for the development and validation of educational materials; The process comprises seven steps shown in figure 2.

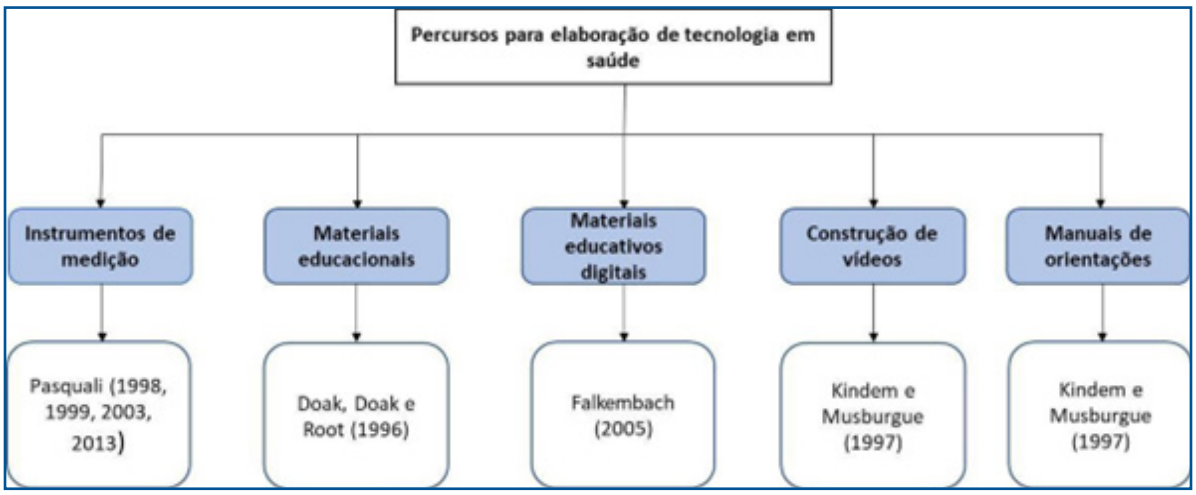

Figure 1: Routes for the elaboration of health technologies. Crato , Ceará , Brazil , 2022
Source: Prepared by the authors.

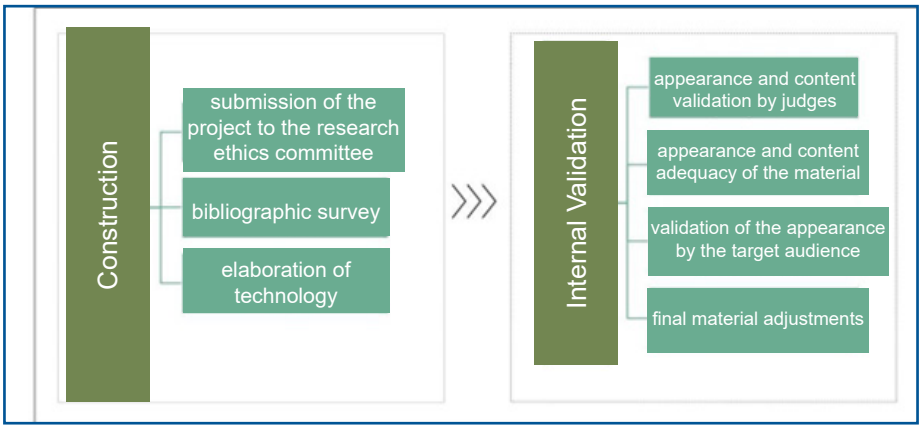

Figure 2: Flowcharts of the methodological steps used in the development of educational technology. Crato, Ceará , Brazil , 2022
Source: Image adapted from Echer (2005).

Part 1- Construction of technology

Data collect

-Submission of the project to the Research Ethics Committee

The first stage corresponds to the elaboration of a research project, which is subsequently submitted to the Research Ethics Committee (CEP), for appreciation and issuance of the research opinion.

-Bibliographic survey

The preparation of the material is carried out from the selection of contents in the literature, with publications available on the subject, allowing to synthesize the existing scientific knowledge.

The search for scientific knowledge related to the addressed topic can be carried out initially, through an integrative review of scientific productions on the subject. To guide the development process of an integrative review, the steps follow, namely, defining the theme and formulating the objectives and guiding question; literature search and establishment of criteria for inclusion and exclusion of studies; categorization of studies; evaluation of studies; interpretation of results and presentation of knowledge review/synthesis[13] .

-Exploration of investigated scenarios/reality

In the preparation of educational materials, it becomes essential to seek to know the reality of the environment to be studied and the experiences of the subjects, so that the needs of the target population are prioritized [14] .

The data collection strategies for this phase can be through qualitative or quantitative research instruments, depending on the object of study and even the researcher's expertise.

For quantitative studies, different types of data collection strategies can be followed, depending on the type of study defined by the researcher: public data collection, questionnaires, forms, medical records, among others.

For this study, examples of research strategies with a qualitative approach are presented, highlighting the semi-structured interviews that value the presence of the researcher and offer possible perspectives so that the informant can reach the freedom and spontaneity necessary for an investigation with a qualitative approach [15] . It can also be carried out through focus groups, allowing the identification of which aspects the target population considers important to contain in educational technology [16] .

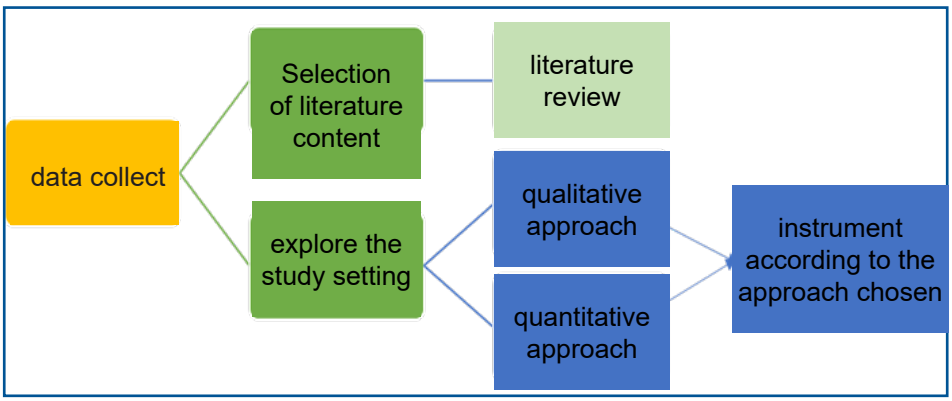

Figure 3: Data collection flowchart. Crato , Ceará , Brazil , 2022
Source: Prepared by the authors.

Part 2: Elaboration of educational technology in health

Steps to the Elaboration

1- After collecting data, the researcher will consolidate the information, using the specific analyzes as proposed and thus, started the process itself, the elaboration of the educational technology.

2- The researcher will draw the first draft of the material, indicating the order of subjects to be addressed, presentation of the texts, the selected colors, the figures that guided the designer in the construction of the technology drawings and the references used.

3- The designer, specialist in the construction of technological material, will develop the technology based on the initial presentation made by the researcher, which is a final elaboration process to start the validation phase.

To this end, it is emphasized that the process of developing an educational technology in health involves textual elaboration, making of illustrations and layout. Thus, there is a need for material that can meet the needs of the public for which it is intended, answering the most frequent questions on the subject, in a way that allows an easy understanding for readers, in an attractive, objective and not extensive way. .

Regarding language, the need for a brief, direct text, with simple and understandable language 9 , is highlighted . The message registered in the educational material, formed by the previously selected content, can be interpreted in different ways, and the reader can find himself at the time of reading without the help of qualified professionals to solve his doubts. Thus, scientific language should not be used and illustrations that complement the message of the written text should be used [17,18] .

It is also important to highlight the need to transform the scientific language, in order to make it suitable for all people, regardless of their level of education [9] . A study that built and validated a Zika virus prevention booklet opted for texts and narratives with short sentences, using common words in the active voice and attractive images, allowing easy understanding for readers, even for those with little or no education [16] .

The illustrations and text should facilitate understanding of the teachings. This fact becomes important, as it allows the development of health education practices with accessible language. The technologies developed make it possible to strengthen guidelines for patients and families, and it is essential to write them in a language that everyone understands [12] .

In this sense, there is a need to understand that in this phase of technology elaboration, the object of study and target audience must be taken into account, since its formatting must meet the specificities, in particular, of the target audience. is aimed at technology.

It is considered, therefore, a phase of paramount importance in the process of developing technologies, and which must be rigorously worked on, from the content to be addressed to the presentation of these contents, as well as other elements included that are part of materials with educational purposes.

Validation of the developed material

Once the development of the technology with regard to text and images is complete, the validation process of the material developed follows, regarding the content, appearance and suitability of the technology, carried out through evaluation with judges and later with the target audience.

Validation is a process in which a given instrument or inference made from established scores is accurately examined[19] . This stage is considered essential for the instrument development process, as it allows verifying whether the measures represented in it are valid and reliable[20] .

Emphasis on understanding the division of judges to distinguish each group regarding the choice of participants in the validation process of an educational material. Thus, the judges are divided into three groups: 1) content judges (researchers/teachers with experience in the area of interest, educational technologies and/or instrument validation); 2) technical judges (professionals with experience in the subject studied); 3) judges with professional experience in design and marketing[21] .

For Echer 12 , the evaluation by different professionals is the occasion when it can really be said that the work is being done as a team, valuing different perspectives on the same focus.

With regard to the number of judges, the literature is diverse. Pasquali 8 recommends six to 20 people; while Lynn 22 already says that a minimum of three judges is

necessary, a number greater than 10 being unnecessary. Fehring 23 recommends 25 to 50 specialists.

In the validation phase, it allows the internal quality of the health technology to be tested. In this context, validity is designated as a hypothetical attribute that the technology will be able to perform the task it proposes to do, with the minimum presence of error[8].

There are multiple types of validity, as shown in figure 4, for example: construct validity, which refers to the demonstration that the instrument actually measures what it is intended to measure, from which statements can be made when interpreting the results in execution a test, expressing through one or more variables the theoretical meaning of the concept [24]; criterion that allows assessing whether the investigated measure has an empirical relationship with predicting a specific performance of the subject [25] . This type of validation can occur in two ways: predictive validity that defines an adequate criterion and concurrent validity that measures is valid independently of the test itself, this criterion[8]. (Figure 4)

It adds that evidence of criterion validity is obtained by comparing the instrument investigated and another instrument, called external criterion, which has the same purpose, but which already has proven evidence of its validity[26] .

Appearance validations , consists of a judgment regarding clarity and understanding; content, which refers to verifying the adequacy of the concepts used, as well as a way of analyzing whether the items and texts used are representative within the universe of the entire product [27] .

Content validity constitutes a representation of a sample of the universe of content that educational technology needs to contain [19,28] , corresponding to an assessment of how representative a sample of items is within a defined universe or domain of a content [27] .

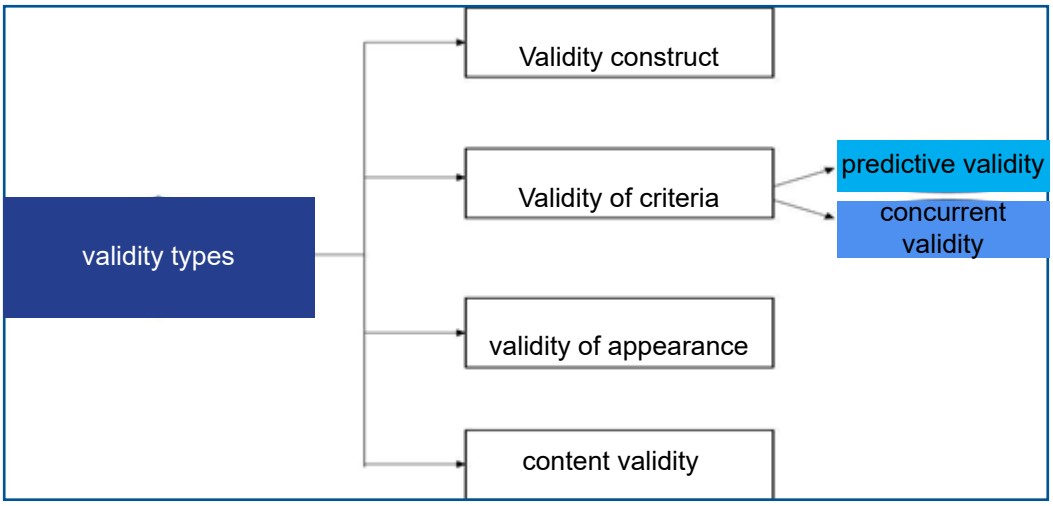

Figure 4 - Flowchart with validation types. Crato, Ceará, Brazil, 2022
Source: Prepared by the authors.

Instruments for data collection regarding the validation process with expert judges

For the development of the validation process of a technology, it is necessary to look for evaluation instruments that allow verifying the presence of the validity attribute [28] . Figure 5 shows the instruments used in methodological studies for the validation process with specialists.

Studies that validated their technologies with content specialists and technicians used the Suitability Assessment of Materials (SAM), which consists of an instrument that allows the development of a systematic method of evaluating the adequacy of health materials in an objective way, in a short evaluation time[19,29]. The SAM is a material adequacy assessment instrument initially intended for use with printed materials and illustrations, but has also been successfully applied to video and audio instructions The SAM instrument has a checklist for content-related attributes , writing style, appearance, motivation and cultural adequacy of the educational material[9] .

Another instrument used by researchers corresponds to a questionnaire, which allows evaluating the technology items according to the following criteria, namely: language clarity, practical pertinence and theoretical relevance. For this purpose, the Likert scale is used , where 1) Very little; 2) Little; 3) Average; 4) A lot and 5) A lot[16,30] .

The instrument used by Dodt , Ximenes and Oriá 20 and adapted by Santos[31] evaluates the technology in relation to the clarity of the figures through the understanding of script-cards, regarding the degree of relevance of the presence of the figure, visual composition and appropriation of the content for the target audience.

Validation data analysis

Validation studies adopt multiple processes to analyze the level of agreement among experts. The Content Validity Index (CVI) is commonly used to measure the proportion or percentage of experts regarding the representativeness of the items in relation to the content under study[32] .

The CVI measures the proportion of judges in agreement on a certain aspect of the instrument. Allows you to analyze each item separately and then the instrument as a whole. This method uses the Likert scale to assess agreement and representativeness of items and responses.

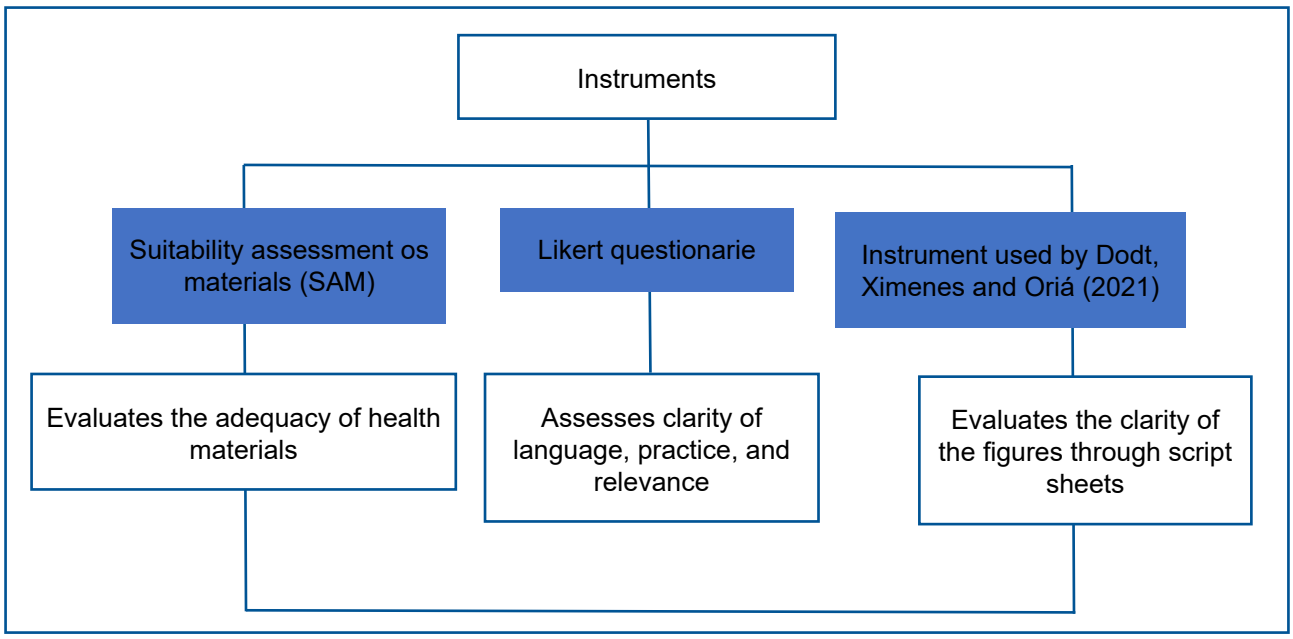

Figure 5: Instruments for data collection. Crato, Ceará, Brazil, 2022
Source: Prepared by the authors.

Likert scales it can be calculated based on three mathematical equations: S-CVI/Ave (average of content validation indexes for all scale indexes); S-CVI/UA (proportion of items on a scale that reach scores 4 "Very" and 5 "Very much" and the I-CVI (Content validity of individual indices)[33] .

Items that receive a ''1" or ''2" score are reviewed or eliminated for having a content validity of less than 0.78 by three or more experts. For a technology to be judged with good quality content validity, it must achieve a CVI of 0.78 and/or higher. Thus, the CVI was defined as the proportion of items that received a score of 3 or 4 by the specialists [33] .

The Intraclass Correlation Coefficient (ICC) allows estimating the stability of continuous variables, taking measurement errors into account. the intraclass correlation is considered the best measure to assess the intra and interobserver correlation , as it analyzes the correlation and agreement between the results, in addition to allowing the strength of the relationship between the classifications of the observers to be demonstrated [27] .

The Kappa coefficient is a measure used for interobserver evaluation, applied to categorical variables. It is a measure of agreement between the evaluators and assumes a maximum value equal to 1.00. The higher the Kappa value, the greater the agreement between observers. Values close to or below 0.0 and 0.2 indicate the lack of agreement[34].

Audience Validation: Appearance

Once the technology has been validated by the expert judges, a consultation can then be carried out with the target audience, with the aim of expanding and reaffirming the reliability of the material produced, aiming to assess whether the proposed material is comprehensible to the audience for which it is intended, allowing evaluate how many aspects related to objectives, organization, writing style, appearance and motivation[6] .

It points out that in the semantic analysis, it corresponds to the construction of the test together with the subjects for which the technology was designed. Important points are highlighted in the semantic analysis, in the instrument validation process, namely: verifying whether the content is intelligible for the lowest stratum (skill) of the population; avoid disproportion in the formulation and presentation of the content verify that the items are intelligible for the lowest stratum (skill) of the target population and, therefore, the sample for this analysis must be made with this stratum; and to avoid clumsiness in the formulation of the items, the semantic analysis should also be performed with a more sophisticated sample (with greater ability) of the target population (to guarantee the so-called apparent validity of the test)[35] .

Semantic validation is considered as a subjective process of validating an instrument developed with a group of people regarding aspects related to clarity, ease of reading, understanding and presentation of instrument items[36] .

Studies indicate that, during the validation process of their technologies with the target audience, they make use of the same instrument used in the validation with the specialist judges, thus allowing to evaluate the quality of the educational material from the content domains, literacy requirement , illustrations, layout and presentation, stimulation of learning and cultural adequacy, being possible to classify the items as superior, adequate, not adequate and not applied[4,37] .

Effect of educational technology: clinical validation

It infers the importance of verifying the reliability of the technology developed and validated by judges and the target audience. This external validation process aims to evaluate the effect of educational technology and can be carried out through an experimental or quasi-experimental study, allowing technologies for interventions or care modes to be tested[38] .

In experimental studies, the researcher is constituted as an active agent, as there is the intentional manipulation of one or several actions or interventions with the aim of analyzing their possible effects. Thus, one or more independent variables are manipulated to assess the consequences of manipulation on one or more dependent variables within a situation controlled by the researcher[39] .

Experimental studies must have three essential properties: manipulation (the researcher makes some intervention directed at the study participants); control (the researcher introduces controls on the experimental situation, such as control/comparison group); and randomization (the researcher randomly assigns participants to the control/comparison and experimental/ intervention groups)[27] .

As regards quasi-experimental studies or non-random experiments, these do not have randomization or control group characteristics, in which the investigator intervenes in the characteristic being investigated, however there is no random allocation of participants[27,40] . This includes only the experimental group, in which the moment before and after interventions is used, allowing each subject to function as his own control. Thus, it makes it possible to observe cause and effect relationships[41] .

Emphasis on the use of the Knowledge, Attitude and Practice Survey (KAP), as an instrument that allows evaluating the effect of an educational technology in a health education intervention, making it possible to verify whether the technology is a health promotion instrument that facilitates the process educational[42] .

The CAP instrument aims to identify data from a given population, in order to measure the effectiveness of health interventions. Knowledge is conceptualized as the ability to acquire and retain information to be used, a mixture of understanding, experience, discernment and skill; Attitude as inclination to react in a certain way to certain situations; see and interpret events according to certain predispositions; organize opinions within an interrelated and coherent framework; and Practice as the application of rules and knowledge that lead to the execution of action in an ethical manner [43] .

DISCUSSION

The use of technologies is characterized as an emancipatory tool, especially in the possibility of changing attitudes and adherence to preventive practices, since it favors the multiplication of knowledge and knowledge among individuals regarding their self-care, in order to favor the communication process and guidance from health professionals, patients and the community [44] .

Technologies represent support in the transmission of information based on clinical evidence. From this perspective, it is considered relevant, in the process of elaborating educational materials in health, the interdisciplinarity of knowledge that complement each other and make technology more attractive, using the pillars of teaching and scientific knowledge [45] .

Studies reveal that technologies improve the knowledge of health professionals in their practice, given the ease they provide to mediate the teaching-learning process. It is also an effective resource for the development of health education practices [46,47] .

Health education stands out as a pedagogical process that induces critical-reflective thinking among participants. Revealing the collective reality, and the subjects' emancipation and autonomy, in addition to enabling them to make health decisions for self-care 48 .

However, there is a need to develop health technologies aimed at education and health promotion interventions as innovative and creative subjects, which enable greater interest in learning[49] .

The use of innovative health education technologies enhances the knowledge of the target audience and awakens the learner's interest in debates on health and well-being, as it favors the construction of spaces aimed at promoting health[50,51] .

In this way, technologies are seen as strategies that allow the junction between meaningful learning and recognition of the importance of skills for health care, stimulating healthy behaviors in coping with the health-disease process that demand temporary or permanent changes[52].

Santos[31] points out the main innovations in the elaboration of a health technology, namely: technology aimed at the target population; transfer of knowledge and knowledge that interfere in the process of developing actions aimed at prevention and health promotion; participatory process in the development of technology, identifying themes that are important for self-care.

The development of studies aimed at the elaboration of educational technologies in the field of health is highlighted, as strategies that allow subsidizing the production of care, in order to create a horizontal and dialogical relationship between professionals and users, thus highlighting the relevance of this protocol , since, by providing a step-by-step guide on how to structure the elaboration of educational technologies, it gives researchers the opportunity to elaborate an educational technology respecting the scientific method for this type of study.

In this context, the development of a quality educational technology in health enables the development of health education strategies based on structured knowledge, aimed at improving the teaching-learning process and encouraging healthy practices [53] .

The development of educational technologies in the field of health, when appropriate to the socioeconomic and cultural context of the population for which it is intended, consists of powerful tools for reducing inequalities related to the health context. Thus, the successful use of these technologies in health education strategies is highlighted, given that it allows the user to recognize actions to prevent a given condition, and allows them to act as a multiplier of knowledge [16] .

In the meantime, considering the relevance of knowing the step-by-step development of educational technologies, this article presents some ideas on how to elaborate following a methodological rigor, illustrating that each step requires meticulous care that goes from the object of this technology to the public. which is intended.

The choices of paths that the researcher will follow are crucial for the success of the technology in terms of actually promoting changes in the intended reality/public.

Finally, figure 6 presents a summary of the stages of the educational technology elaboration process, which is the protocol presented in this material.

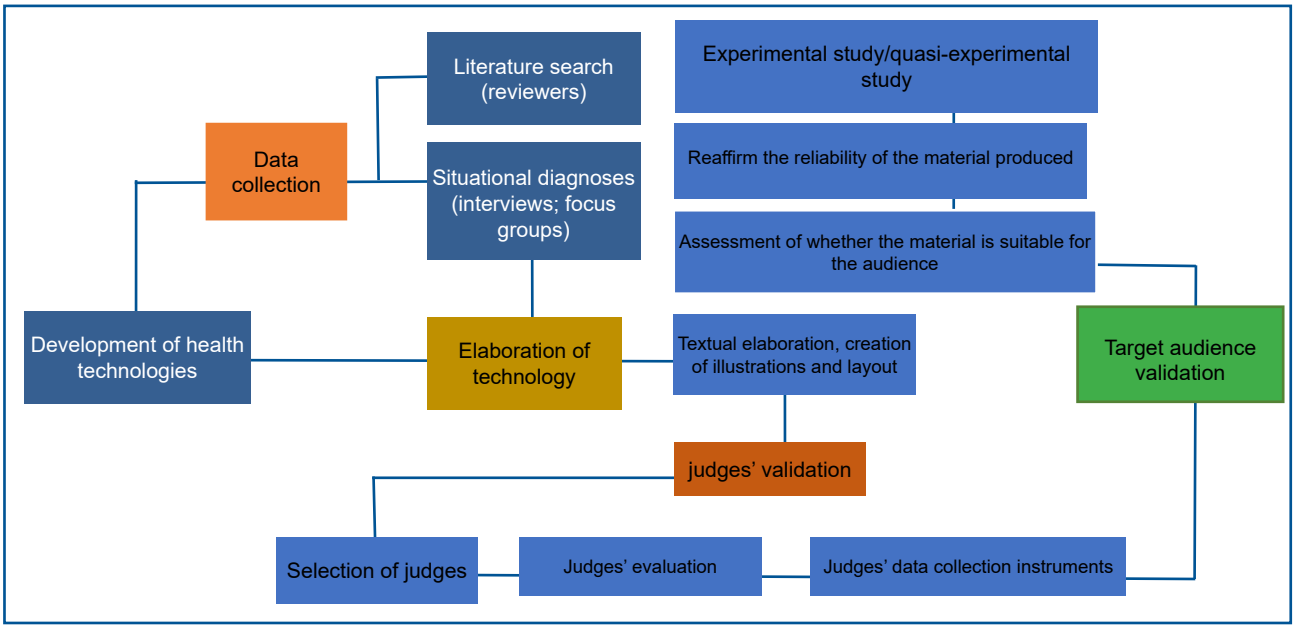

Figure 6: Flowchart of the stages of the technology elaboration process. Crato, Ceará, Brazil, 2022
Source: prepared by the authors.

CONCLUSION

For the solution of existing problems in society, scientific research is considered essential for technological development, however, for it to be considered scientific, it must follow a series of systematic investigation procedures, which guarantees the necessary rigor to reach of the results.

It is known, therefore, that it is the scientific method that gives value and scientific reliability to research, directing the production of valid knowledge. Thus, this article brings a discussion on the development of educational technologies, seeking to elucidate steps that enable the construction of these technologies in the most reliable way.

When talking about educational technologies, we are talking about a product of reflection regarding the development of subjects' emancipation processes, contributing to the transformation of professionals' practices regarding actions aimed at health promotion; thus, when you have a product that was built following scientific rigor respecting the principles and guidelines of the method outlined by the researcher, you have a technology that will actually achieve the objectives it proposed, since by involving systematized data collection, validation by specialists in the area, by the target audience itself and, evaluating its effect, there is a rigorously elaborated technology bringing valid knowledge.

Author's contributions

SAAA design, design, analysis and interpretation of data; LCA critical review and approval of the version to be published; NCPC critical review; ADAJ final approval to be published; CIPOA final approval to be published; JLSR final approval to be published; MGP final approval to be published; IMPB design, design, analysis and interpretation of data and approval of the version to be published.

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Conflicts of interest

We declare that there are no conflicts of interest.

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Resumo

Introdução: o uso de tecnologias digitais constitui como um processo que permite a dinamização no processo de cuidar, pautada nos aspectos relacionados a criticidade e criatividade. Enfatiza-se, que o desenvolvimento de tecnologias deve, portanto, insere-se em um contexto por mudanças e inovação em resposta a demanda de saúde da população devendo seguir um percurso metodológico preciso que vai desde a construção à validação da aparência, conteúdo e efeito.

Objetivo: descrever o método científico de elaboração e validação de tecnologias educativas no formato digital.

Método: estudo metodológico, conduzido de acordo com as seguintes etapas: elaboração do projeto de pesquisa e submissão ao Comitê de Ética em Pesquisa; levantamento dos dados; elaboração do conteúdo, roteiro, ilustrações e diagramação da cartilha; e validação da tecnologia educacional.

Resultados: o processo de elaboração de uma tecnologia requer rigor metodológico, possibilitando coerência entre teoria e finalidade do produto desejado, garantindo qualidade interna da tecnologia elaborada. O uso de tecnologias educativas em saúde reforça informações, servindo como guia para orientações quanto ao cuidado e auxiliando nas tomadas de decisões. Inovações tecnológicas em saúde, consiste em um processo sócio-técnico, permeado por reflexões e experiências profissionais e usuários.

Considerações finais: tecnologias educacionais representam um recurso potencializador para o desenvolvimento de práticas de educação em saúde, estimulando maior interação entre profissionais e usuários, e uma postura ativa quanto a ações de autocuidado relacionado a sua condição de saúde.

Palavras-chave: Materiais de ensino, educação em saúde, estudos de validação.