MIDTs: Interdisciplinary Method for Technological Research Development with a Focus on Health

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Abstract: This study introduces MIDTs, an interdisciplinary method for technological research aimed at healthcare applications. MIDTs integrates Design Science and User-Centered Design principles, structured into six phases to ensure both scientific rigor and practical applicability. Over the last decade, it has been applied to more than 70 projects, generating academic theses, patents, and clinical solutions. Empirical evidence indicates that MIDTs fosters innovative and user-centered outcomes, effectively addressing complex societal demands within healthcare. The method's adaptability is further demonstrated through its potential application in other sectors. By providing a clear framework for interdisciplinary collaboration and solution development, MIDTs offers a robust approach to bridge research, practice, and user needs in technology-driven health initiatives.

1 INTRODUCTION

Interdisciplinarity is considered of great relevance for the development of science, technology, and innovation. Contemporary challenges, with their inherent complexity, demand a diversified and integrated perspective of knowledge.

Interdisciplinary studies are processes developed to answer a question, solve a problem, or address a broad or complex topic that cannot be adequately handled by a single discipline. These studies rely on disciplinary perspectives, which integrate their knowledge and experience to produce a more comprehensive understanding or cognitive advancement (Repko, 2008).

The expansion of interdisciplinarity as a research and teaching practice gained greater visibility as disciplinary knowledge created dissatisfaction among scientists, as it seemed insufficient to address the new phenomena in society.

Thus, interdisciplinarity stands out in innovative projects, where Information and Communication Technologies (ICT) play an important role in the implementation of interdisciplinary projects. The major needs of society, such as in health, housing, transportation, financial services, entertainment, and more, are being and will continue to be reinvented by technology, increasingly accessible to all (Khosla, 2018). Interdisciplinary collaboration has been identified as a critical driver for innovation, particularly in addressing societal challenges that demand integrated perspectives (Gorman & Groves, 2020).

Scientific knowledge (and research) aims to develop theories with broad applications, whereas technological knowledge is responsible for developing theories with limited applications, aimed at solving specific and often isolated problems, primarily focused on technological innovation. In this way, technological research is characterized as a systematic and scientific process in search of knowledge and solutions to technology-related problems. It involves applying scientific principles and methods to develop artifacts or products, often specific, that respond to the demands, opportunities, or problems of people or businesses. Technological research can involve different fields of knowledge, such as engineering, computer science, health, biology, among others, and can be carried out both in universities and research institutions as well as in

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companies and industries. (Lebedev, 2018; Veugelers & Wang, 2019)

The operation of systematizing and integrating knowledge from distinct areas, to improve the effectiveness of interventions, products, and services offered to the community, requires an appropriate method that directs efforts and competencies toward optimizing results. (Fredericks, 2021)

In the academic context, one of the ways to encourage and make interdisciplinary projects feasible is the creation of methods and tools that enable and systematize, with due rigor, the production of technological artifacts that respond to specific problems. In this perspective, the Coordination of Training and Technological Innovation, in partnership with the research group on Health Technologies and Innovations, based at the Vortex Laboratory of the Vice-Rectorate for Research at the University of Fortaleza (UNIFOR), is responsible for carrying out interdisciplinary projects, promoting the integration of applied research with computational resources in different areas, but with a strong focus on health.

The Coordination began in 2012, fostering, over time, the integration of interdisciplinary teams in projects involving undergraduate and graduate students (both Lato and Stricto Sensu - Master's and Doctorate), as well as researchers from the areas of Computer Science, Computer Engineering, Marketing and Communication, Psychology, Nursing, Medicine, Physiotherapy, Public Health, Nutrition, Dentistry, and Speech Therapy. Based on these diverse experiences and aiming to support scientific and academic demands, the MIDTs - Interdisciplinary Method for Technological Research Development with a Focus on Health - was conceived to accommodate the nature and specificities of the projects developed.

However, after the maturation of this method, its adaptation became necessary. Its proven applicability in multiple areas beyond health, as well as the production of artifacts and results beyond those initially highlighted, demanded evolutions in the method. Thus, the scope of this method is expanded, which, due to these changes, is now called MIDTs - Interdisciplinary Method for Technological Research Development with a focus on health.

Given the above, this chapter aims to present MIDTs, covering its conception, development, and results. It is believed that the experience presented here can inspire and support other researchers and professionals in developing interdisciplinary projects in a systematic and effective way.

2 THEORETICAL FRAMEWORK

It can be stated that scientific research is aimed at advancing scientific knowledge and understanding reality and is closely tied to scientific theories, which are subject to change. Technological research, on the other hand, is focused on developing artifacts, understood here not only as physical, tangible products but also as intellectual ones, aimed at controlling reality. This type of research is guided by the task it aims to address and is thus considered by some authors to be more precise than scientific research. The product of technological research is invariably the development of a new technology (Freitas Junior *et al*., 2014).

In a similar view, Van Aken (2004) presents Design Science as a research methodology focused on developing artifacts or technological solutions to practical problems, based on a rigorous scientific methodology. The primary idea behind Design Science is that science can be applied to create solutions that address practical problems across various fields, such as business, healthcare, engineering, and more. The Design Science process involves defining a problem, proposing a solution, implementing and evaluating the proposed solution, and disseminating the results obtained. This approach is widely used in areas like software engineering, information systems, project management, and entrepreneurship.

The knowledge generated from the foundations of Design Science also contributes to advancing research based on applied knowledge and solutions that respond to problems and demands from the market and society. This is multidisciplinary knowledge, where research focused on this type of knowledge aims to solve relevant complex problems, considering the context in which their results will be applied. Consequently, the knowledge developed by Design Science Research is not descriptive-explanatory; it is prescriptive.

In this sense, Design Science Research constitutes a rigorous process of designing artifacts to solve problems, assessing what has been designed or what is functioning, and communicating the results obtained (Çağdaş & Stubkjær, 2011). Design science research bridges the gap between theory and practice, providing a systematic approach for developing artifacts that address practical problems while contributing to academic knowledge (Hevner & Gregor, 2020).

Despite their similarities, technological research and design science are different approaches to solving technology-related problems. While technological research is broader and involves the application of scientific principles and methods for developing new products, processes, and services, design science is more specific, focusing on solving practical problems through the creation of technological solutions based on a rigorous scientific methodology.

These approaches have much to contribute to proposing methods and tools that foster interdisciplinarity and the construction of sometimes innovative artifacts that improve the lives of individuals, institutions, and businesses.

2.1 User-Centered Design

Design Science and User-Centered Design (UCD) are complementary approaches that underpin the development of innovative and practical solutions in interdisciplinary research. Design Science, as defined by Van Aken (2004), emphasizes the creation of artifacts or technological solutions to address practical problems using rigorous scientific methods. This process involves defining a problem, designing a solution, evaluating its effectiveness, and disseminating findings, aiming to produce prescriptive knowledge applicable across fields such as healthcare, business, and engineering.

Similarly, UCD prioritizes the needs and experiences of end users throughout the design process. Coined by Norman and Drape (1986), it is a philosophy and framework that emphasizes iterative development, interdisciplinary collaboration, and continuous user feedback. While Design Science provides a structured methodology for artifact creation, UCD ensures that these artifacts are user-centered and contextually relevant, bridging the gap between technical solutions and human-centric design. Together, these approaches from the theoretical foundation of the MIDTs methodology, enabling the development of effective, innovative, and user-friendly solutions. The term UCD was coined by Donald Norman in his research lab at the University of California (Norman and Drape, 1986). Notably, UCD underpins Interaction Design strategies (Preece, Rogers and Sharp, 2015), such as the Interaction Design Lifecycle Model and Design Thinking (Kimbell, 2011; Tschimmel, 2012).

UCD can be characterized as a multi-stage problem-solving process where usability goals, user characteristics, environment, tasks, and workflow of a product, service, or process receive thorough attention at each stage of the design process.

The main difference from other design philosophies is that UCD attempts to optimize the product around how users can, want to, or need to use it, rather than forcing them to change their behaviors (as long as they are correct) to accommodate the product.

Some principles indicate that a design proposal is user-centered, such as:

- The design is based on an explicit understanding of users, tasks, and environments;
- Users are involved throughout the design and development process;
- The design is directed and refined by user-centered evaluation;
- The process is iterative;
- The design addresses the entire user experience; and
- The design team includes multidisciplinary skills and perspectives.

These principles are essential for projects aimed at quality user satisfaction. It is also inherent to UCD's philosophy to accommodate different perspectives and knowledge, promoting the participation not only of the user in the process but of the entire, interdisciplinary design team. Thus, UCD conceptually supports the process presented here. The application of UCD principles in healthcare has been shown to improve usability and adoption by actively involving end users throughout the development process (Bazzano et al., 2021).

3 INTERDISCIPLINARY METHOD FOR THE DEVELOPMENT OF HEALTH-FOCUSED TECHNOLOGIES

The Health Technologies Research Group, affiliated with the Technology Directorate of the University of Fortaleza, where the process presented herein originates and develops, was established in 2012 with the aim of supporting applied research projects in the ICT field (or involving ICTs) on the University campus.

Initially, it consisted only of students and researchers from the fields of Computer Science and Engineering. However, during the first year of activity, it was observed that the development of interactive systems in the academic context was an interdisciplinary process. This realization opened space for students, professionals, and researchers from the areas of Marketing, Communication, and Administration, who joined to contribute knowledge and experience.

Over time, the laboratory began receiving project demands, mostly academic, from various fields, predominantly health (e.g., Psychology, Medicine, Public Health, Physiotherapy, Speech Therapy, Nursing, and Dentistry). This interdisciplinary demand required specific tools to accommodate the specific needs of the involved areas and the academic environment.

In this context, in 2015, the Academic Integration Program was created, leading to the conception of MIDTs – Interdisciplinary Method for the Development of Health-Focused Technologies. The focus on health stemmed from the proliferation of cases in the area.

3.1 Scientific Framework of the Methodology

The scientific framework of the proposed multimethod methodology is significant, given its adherence to academic research and technological development processes, which is one of its distinguishing features. Regarding the approach, the methodology accommodates both quantitative and qualitative research, as the data obtained can be analyzed numerically using statistics—click counts, interaction time, errors (Sampieri, Collado and Lucio, 2013)—or through a study involving a statistically valid sample population and/or data revealing user perceptions and experience quality, which are not entirely quantifiable (Minayo, 2014).

Its nature is applied, as it generates hypotheses and specific solutions (artifacts) for concrete problems, producing multidisciplinary and prescriptive knowledge.

Regarding its objectives, MIDTs proposes technological research, focusing on the development of multidisciplinary, applied knowledge aimed at artifact-based solutions for complex problems and specific societal demands. Validation and/or evaluation of tools and research strategies aim at creating reliable instruments (in this case, the technological artifact) that are accurate and usable, which can be employed by other researchers and users (Polit; Beck, 2018; Wazlawick, 2014). (Freitas Junior et al., 2014; Van Aken, 2004).

As for procedures, the method proposes bibliographic research in its phases, positioning the researcher in relation to the investigated problem through information not previously available. It also considers itself experimental, given the perspective of introducing technology controlled by the researcher into the context under investigation (Wazlawick, 2014).

3.2 Proposed Process

MIDTs is inspired by academically inclined approaches such as Interaction Design (Preece, Rogers, Sharp, 2015), Design Science Research, and market-oriented methods such as Design Thinking (Kimbel, 2011; Tschimmel, 2012), conceptually anchored in User-Centered Design. The method proposes six phases (Figure 3), each with specific inputs and outputs that feed into subsequent phases or contribute to revising the output of the preceding phase. The ultimate goal of the process is to develop a functional prototype to test a research hypothesis. Delivering a market-ready product is not the initial scope of the methodology, though the process can be adapted for such purposes, adhering to necessary legal and regulatory aspects.

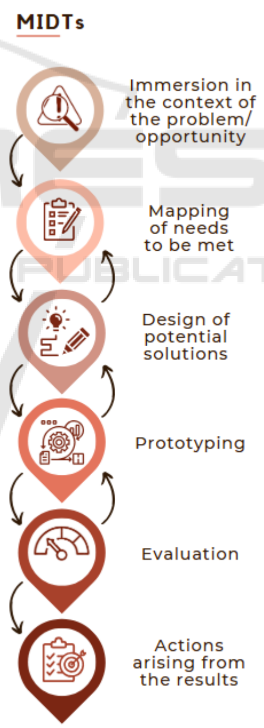

Figure 1: Framework of method activities.

The First Phase consists of understanding the context of the problem at hand, based on scientific evidence and market data. It is common at the beginning to lack clarity about the problem and potential solutions, only a superficial perception of a need. Therefore, meetings are held with an interdisciplinary team of specialists to clearly identify the problem and its possible causes, as well as align this understanding among the team. Based on this, a hypothesis is established that emerging technologies such as artificial intelligence and the Internet of Things (IoT) have shown great potential in driving innovation in interdisciplinary methods, enabling scalable and adaptive solutions to complex problems (Sarker et al., 2022).

Based on preliminary discussions, the hypothesis is used as a guiding question for a systematic review (Staples; Niazi, 2007) or integrative review (Torraco, 2005) of the literature, using scientific databases and portals to deepen the theoretical understanding of the topic and identify existing similar solutions. As a result, the scientific validation of the problem and potential solution alternatives are expected.

Consider the following example of a problem: injuries caused by falls in elderly individuals in home care settings, observed by a master's student in nursing working for a health cooperative. In the first phase, the student conducted a root cause analysis to identify the motivations behind the falls. With data from the cooperative and interdisciplinary team support, it was identified that the falls occurred due to multiple causes, including the lack of a dedicated caregiver, who had to step away for other domestic duties such as meal preparation. Consequently, specialists proposed a monitoring system using IoT (Internet of Things) for fall detection and prevention. Using this hypothesis, the student searched scientific databases such as Google Scholar, Elsevier, and others specific to health to identify similar research and solutions that could support her work. She found technologies aiding fall detection but none for prevention. With this result, she moved on to the second phase.

The Second Phase involves identifying user needs (target audience) and establishing requirements to solve the identified problem. Methods to identify these needs include: 1) interviews and focus groups with potential users (aligned with designed profiles), 2) creation of personas and usage scenarios (Barbosa and Silva, 2011) by the interdisciplinary team (Carrol, 2006), and 3) market data research. Based on these needs, specialists analyze and define the technological requirements (functional and non-functional) of the solution. These requirements are used to structure a matrix, comparing solutions found in the market and academia, indicating full, partial, or unmet requirements.

Continuing the example, the nursing student conducted a needs assessment through interviews with cooperative clients. These interviews revealed that families did not adopt existing preventive techniques like physical bed restraints, as they were deemed invasive and uncomfortable, compromising the elderly's quality of life. Additionally, the routine of the elderly included natural activities like hygiene and meals. Based on these reports and other needs, the team mapped functional and non-functional requirements for the system. For instance, a non-functional requirement was non-invasive monitoring that preserves the patient's privacy and quality of life, while a functional requirement was the ability to temporarily pause and resume monitoring to accommodate caregiving routines. With these requirements, the student revisited her research and confirmed that existing technologies did not meet all mapped requirements, justifying the development of new technology, and proceeding to the next phase.

The Third Phase encompasses the ideation process to design the initial solution. Based on the requirements and alternative technologies identified in earlier phases, the interdisciplinary team meets to conduct brainstorming sessions (Godoy, 2001) to devise a solution. Initial drafts are created according to the technology (e.g., low-fidelity app screen prototypes (Barbosa and Silva, 2011), schematic drawings of small hardware devices, etc.). The group validates these drafts with potential users and refines them as needed to ensure the solution makes sense.

When a viable theoretical solution is achieved, a more refined version is produced. The team specifies components such as electronic hardware, visual identity (if applicable), color palette, and other details to enhance fidelity to the final product.

In the fall prevention system case, the last phase concluded with mapped requirements. In the third phase, the team produced a general architecture of the solution, listing necessary components to satisfy the requirements. Low-fidelity drafts were conceptually validated, followed by high-fidelity versions closer to the final output. Using the same approach, low- and high-fidelity versions were created for each component of the architecture, such as information panel screens. With the designs completed, the team proceeded to the next phase.

The Fourth Phase proposes the development of an interactive or functional prototype, which may also take the form of a Minimum Viable Product (MVP) (Ries, 2011), based on a selected design proposal. At this stage, the technological architecture of the solution is defined, including the development environment and platform, tools, programming languages, software components (libraries, database management systems, frameworks), hardware design and components, or other technical artifacts associated with the product. The resulting deliverables typically include software documentation, hardware schematics, source code, or other technical materials detailing the proposed technological artifact.

In some cases, the project does not advance to the physical development or coding of the artifact but instead creates an interactive simulation of the artifact's behavior using specific software (e.g., Figma). This strategy reduces project costs and time but may negatively impact the ability to conduct evaluations or tests requiring functional technology.

In the nursing master's student example, the team developed each technological component defined in Phase 3. The application's backend logic was created, high-fidelity screens were implemented (frontend), and hardware components were integrated and housed in custom 3D-printed enclosures.

The Fifth Phase involves evaluating the produced artifact using specific tools and methods, such as usability evaluation (Barbosa and Silva, 2011), content evaluation by judges, utility/acceptation evaluation (Saravanos, 2022), and clinical validation through a pilot study. These evaluations aim to comprehensively assess the artifact, determining whether it is easy, understandable, and pleasant to use for its target audience, whether the content and processes it proposes are scientifically correct and appropriate from the perspective of experts, and whether it is useful for the intended activity.

The proposed methods are complementary, each offering a distinct perspective on the technology. A careful assessment of what needs to be measured and the available time is essential. However, all methods share common steps, typical of any evaluation process: selecting participants, ensuring a sufficient and representative sample of project personas, avoiding selection biases, and considering factors like age range, familiarity with technology, or the project itself. Additionally, obtaining appropriate consent and assent forms is crucial. Some methods also include standard scales, such as the System Usability Scale (SUS), which have specific calculation methods for results.

For the fall prevention project, acceptance model (Saravanos et al., 2022) was used as a reference. Eight health professionals (nurses, physicians, and physiotherapists) participated in the evaluation. The test was conducted in a controlled laboratory environment to capture interaction nuances with the technology. The results showed 88% total agreement among evaluators, with suggestions for improvements such as mobile device connectivity, battery use in case of power outages, and the generation of reports.

The Sixth Phase involves compiling and presenting the results obtained, typically in the form of course completion works, master's dissertations, doctoral theses, or scientific articles. As a result of this methodology, some executed projects present prototype solutions to real problems, extending beyond hypothesis testing. This sometimes enables software, trademark, or patent registrations and product market placement. Activities conducted in this phase are not limited to the project's end but can be performed at the conclusion of other phases, depending on the publication locus and format.

In the same fall prevention project example, the results of a proof of concept conducted before the fourth phase were used to write an article for a scientific initiation event. After training the neural network with real human data to parameterize the system, a second article was produced for a national-scale event. At the project's end, the student completed and presented her dissertation to an examining committee, which awarded her a master's degree. Although no specific brand was developed, a patent application was submitted through the University with consent from all involved, given the perceived applicability of the concept to other contexts, such as baby fall prevention.

3.3 Ethical Aspects

Regarding ethical and legal aspects, all research supported by the method proposed herein adheres to the ethical and legal standards for research involving human subjects. In Brazil, these must comply with the guidelines and regulatory norms outlined in Resolution No. 466, of December 12, 2012, by the National Health Council, which provides Guidelines and Regulatory Norms for Research Involving Human Beings (Brasil, 2013).

4 RESULTS

The MIDTs has been refined and utilized by the research group of the Vice-Rectorate for Research at the University of Fortaleza for approximately ten years. The outcomes achieved with MIDTs throughout its application are significant and span various areas.

The results achieved through the application of MIDTs are noteworthy, encompassing over 70 applied research projects. These have led to nine trademark registrations, 86 academic publications, and practical technological artifacts currently in use in hospitals, clinics, and public health programs. For example, IoT-based systems for fall prevention and monitoring have demonstrated tangible benefits for healthcare providers and patients.

In 2020, with the aim of sharing experiences in the development and use of eHealth technologies with the scientific community—most of them supported by the method presented here—the book *"eHealth Technologies in the Context of Health Promotion"* (Silva, Brasil and Vasconcelos Filho, 2020) was published.

Furthermore, the method has contributed to the direct and indirect training of students from diverse fields, promoting interdisciplinarity and innovation. These results highlight MIDTs' potential to transform academic research into real-world solutions that address concrete societal demands.

Currently, several other projects are at different stages of development within the Program, utilizing the method presented here.

5 DISCUSSION

The results of this study demonstrate that the MIDTs methodology effectively integrates interdisciplinary approaches and develops innovative technological solutions, particularly in the healthcare sector. However, analyzing its impact over a decade of application reveals gaps and opportunities that warrant critical reflection.

Firstly, the predominant application in the healthcare field highlights a lack of exploration in other domains, such as education, public administration, and sustainability. This limitation may stem from the method's initial framework, which prioritized challenges and solutions tailored to healthcare needs. Methodological adaptations are necessary to broaden its scope, incorporating tools like blockchain to enhance data security and emerging technologies like generative AI for solution scalability.

Another critical aspect is the ethical considerations in technological development. It was observed that aspects such as privacy, inclusion, and sustainability were not consistently addressed in the early phases of the method. Integrating these concerns from the problem-identification stage can mitigate risks and ensure solutions are more responsible and aligned with societal demands.

Furthermore, despite the success in generating technological artifacts and academic publications, the absence of consistent metrics to measure social and economic impacts limits a comprehensive assessment of its outcomes. To advance, it is suggested to implement indicators such as operational cost reductions, improvements in health indicators, and usability perceptions from end-users.

These analyses reinforce the relevance and capability of MIDTs in addressing complex challenges while highlighting areas for evolution to ensure its effectiveness and sustainability in diverse contexts.

6 CONCLUSIONS

This study presented the MIDTs methodology as an interdisciplinary and user-centered framework designed for the development of technologies in the healthcare sector. Evidence collected over a decade indicates that the method has significantly contributed to advancing technological solutions, resulting in academic publications, patent registrations, and practical applications. Additionally, it has fostered interdisciplinary training for students and researchers, promoting collaboration across diverse knowledge areas.

It is concluded that to ensure the method's evolution, it is crucial to address identified limitations, including its expansion to other sectors, the integration of emerging technologies, and the inclusion of metrics for social and economic impact. These improvements will contribute to consolidating MIDTs as a robust and adaptable tool for interdisciplinary technological development, aligned with contemporary demands.

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REFERENCES

Barbosa, S., & Silva, B. (2010). *Interação humano-computador*. Elsevier Brasil.

Bazzano, A. N., et al. (2021). User-centered design in global health: Innovative methods to engage end users in the development of digital health tools. *Journal of Medical Internet Research*, 23(3), e18974. https://doi.org/10.2196/18974.

Beck, K., et al. (2001). *Manifesto for Agile Software Development.* Disponível em: http://agilemanifesto.org/. Acesso em: 17 nov. 2023.
Brasil. Ministério da Saúde. Conselho Nacional de Saúde. (2013). Resolução nº 466/2012 que trata de pesquisas e testes em seres humanos. *Brasília: Ministério da Saúde.*
Çağdaş, V., & Stubkjær, E. (2011). Design research for cadastral systems. *Computers, Environment and Urban Systems, 35,* 77–87. https://doi.org/10.1016/j.compenvurbsys.2010.07.003
Carroll, J. M. (2006). Dimensions of participation in Simon's design. *Design Issues, 22*(2), 3–18.
Fredericks, Suzanne. "Using knowledge translation as a framework for the design of a research protocol.", 2021. https://doi.org/10.32920/ryerson.14668878.v1
Freitas Júnior, V., et al. (2014). A pesquisa científica e tecnológica. *Espacios, 35*(9), 12.
Godoy, M. (2001). *Brainstorming.* Editora de Desenvolvimento Gerencial.
Gorman, M. E., & Groves, J. F. (2020). Innovation through interdisciplinarity: Developing sustainable solutions for societal challenges. *Research Policy*, 49(7), 104079. https://doi.org/10.1016/j.respol.2020.104079.
Hevner, A., & Gregor, S. (2020). Design science research contributions: Finding a balance between artifact and theory. *Journal of the Association for Information Systems*, 21(5), 1018–1038. https://doi.org/10.17705/1jais.00659.
Khosla, V. (2020). Reinventing societal infrastructure with technology. *Medium.*
Kimbell, L. (2011). Rethinking design thinking: Part I. *Design and Culture, 3*(3), 285–306.
Lebedev, C. A., et al. "Levels of organization of scientific knowledge". *Proceedings of the International Conference on Contemporary Education, Social Sciences and Ecological Studies* (CESSES 2018), 2018. https://doi.org/10.2991/cesses-18.2018.186
Minayo, M. C. (2014). Apresentação. In R. Gomes, *Pesquisa qualitativa em saúde.* São Paulo: Instituto Sírio Libanês.
Norman, D. & Draper, S. (1986) (Eds.). User centered system design; new perspectives on human-computer interaction. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.
Polit, D. F., & Beck, C. T. (2018). *Fundamentos de pesquisa em enfermagem: Avaliação de evidências para a prática da enfermagem* (9ª ed.). Porto Alegre: Artmed.
Preece, J., Sharp, H., & Rogers, Y. (2015). *Interaction design: Beyond human-computer interaction.* John Wiley & Sons.
Repko, A. F. (2008). *Interdisciplinary research: Process and theory.* Thousand Oaks: Sage.
Ries, Eric (2011). *The Lean Startup*. United States of America: Crown Business. p. 77. 2011
Sampieri, R. H., Collado, C. F., & Lucio, M. P. B. (2013). *Metodologia de pesquisa* (5ª ed.). Porto Alegre: Penso.
Saravanos, A., Zervoudakis, S., & Zheng, D. (2022). Extending the Technology Acceptance Model 3 to Incorporate the Phenomenon of Warm-Glow. *Information*, 13(9), 421.
Sarker, I. H., et al. (2022). Machine learning and AI in IoT: Current state and future directions. *Internet of Things Journal*, 9, 1458–1475. https://doi.org/10.1109/JIOT.2021.3083576
Silva, R. M., Praça, C., & Vasconcelos Filho, J. E. (2020). *eHealth technologies in the context of health promotion.* Fortaleza: edUECE.
Silva, J. R., Brasil, C. C. P., Brasil, B. P., Paiva, L. B., Oliveira, V. F., Vasconcelos Filho, J. E., & Santos, F. W. R. (2018). Avaliação do aplicativo Doe sangue por especialistas. In *7º Congresso Ibero-Americano em Investigação Qualitativa - CIAQ 2018,* Fortaleza, CE.
Staples, M., & Niazi, M. (2007). Experiences using systematic review guidelines. *Journal of Systems and Software, 80*(9), 1425–1437.
Torraco, R. J. (2005). Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review, 4*(3).
Tschimmel, K. (2012). Design thinking as an effective toolkit for innovation. In *Proceedings of the XXIII ISPIM Conference: Action for Innovation: Innovating from Experience,* Barcelona.
Van Aken, J. E. (2004). Management research based on the paradigm of the design sciences: The quest for field-tested and grounded technological rules. *Journal of Management Studies, 41*(2), 219–246.
Veugelers, R. and Wang, J. "Scientific novelty and technological impact". *Research Policy*, vol. 48, no. 6, 2019, p. 1362-1372. https://doi.org/10.1016/j.respol.2019.01.019
Wazlawick, R. (2014). *Metodologia de pesquisa para ciência da computação* (2ª ed.).