



Educational Conceptual Model Design Research Methodology

Metodología de Investigación Educational Conceptual Model Design

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Abstract

This paper introduces Educational Conceptual Model Design a new research methodology to develop conceptual models in the field of educational technology. It is based on principles from Conceptual Design Methodology, Conceptual Modeling Methodology, Design-Based Research, and Design Science Research. It is a systematic methodology structured in four phases: problem

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definition, conceptual foundation, model development, and knowledge contribution. This methodology is designed to be streamlined and grounded in theory, focusing on consistency, replicability, and alignment with theoretical rigor. The methodology is particularly suited to respond to rapid advancements in technology and continuously evolving educational challenges, including the integration of emerging tools such as Artificial Intelligence in Education. Its main characteristic is that it offers a transition from problem identification to practical models with a special emphasis on the design process. This approach reduces the complexity of developing a model while maintaining its applicability across different educational technology areas, which can range from adaptive learning systems to data-driven learning analytics. The paper concludes by discussing the methodology's contributions to theory and practice, its limitations, and potential future directions, including scalability, cross-disciplinary integration, and the incorporation of disruptive technologies. This methodology serves as a foundational framework for researchers and practitioners aiming to design innovative forward-thinking solutions that meet the dynamic needs of modern education.

Keywords

Conceptual model, educational conceptual model design, educational technology, research methodology.

Resumen

Este artículo presenta Educational Conceptual Model Design, una nueva metodología de investigación para desarrollar modelos conceptuales en el campo de la tecnología educativa. Se basa en principios de Conceptual Design Methodology, Conceptual Modeling Methodology, Design-Based Research, y Design Science Research. Es una metodología sistemática estructurada en cuatro fases: definición del problema, fundamentación conceptual, desarrollo del modelo y contribución al conocimiento. Esta metodología está diseñada para ser eficiente y fundamentada teóricamente, centrándose en la consistencia, la replicabilidad y la alineación con el rigor teórico. Es particularmente adecuada para responder a los rápidos avances tecnológicos y los desafíos educativos en constante evolución, incluyendo la integración de herramientas emergentes como la Inteligencia Artificial en la Educación. Su principal característica es que ofrece una transición desde la identificación del problema hasta modelos prácticos, con un énfasis especial en el proceso de diseño. Este enfoque reduce la complejidad del desarrollo de un modelo, manteniendo al mismo tiempo su aplicabilidad en las diferentes áreas de tecnología educativa, que pueden abarcar desde sistemas de aprendizaje adaptativo hasta análisis de aprendizaje basado en datos. El artículo concluye debatiendo las contribuciones de la metodología a la teoría y la práctica, sus limitaciones y posibles direcciones futuras, incluyendo la escalabilidad, la integración interdisciplinar y la incorporación de tecnologías disruptivas. Esta metodología sirve como un marco fundamental para investigadores y profesionales que buscan diseñar soluciones innovadoras y visionarias que respondan a las necesidades dinámicas de la educación moderna.

Palabras clave

Modelo conceptual, educational conceptual model design, tecnología educativa, metodología de investigación.

1. Introduction

In the field of education, especially in educational technology, better and more effective research methodologies are required to face the increasing and rapid

changes and challenges in this sector (López-Villanueva, 2024). The need for innovative and trustworthy procedures in the development of concepts, models, and systems has increased dramatically as technology has become an inseparable component of learning environments. This demand emerges from technological evolution itself, as well as from the learners, educators and institutions' needs (Palau & Santiago, 2022; Pliushch & Sorokun, 2022). Therefore, the need for approaches that guide building conceptual or theoretical models in a systematic manner, is critical for innovation in educational technology.

The creation of new models, tools and artifacts in educational technology, is a complex multidisciplinary process that draws on cutting-edge technologies, interdisciplinary collaboration and innovative educational theories (Foelsing et al., 2021; Uden & Ching, 2024). To achieve this, selecting the most appropriate and relevant methodology is essential to provide a systematic framework that guarantees the reproducibility, credibility and reliability of the research process and findings (Adeoye, 2024; Samanth, 2024).

Over the years, various methodologies have been raised for creating models, such as Design-Based Research, Design Science Research, Conceptual Modeling, Conceptual Design methodologies, and frameworks such as Unified Foundational Ontology, and OntoUML, among others. These approaches usually follow a similar iterative process that includes creating, implementing, evaluating and refining models. They often focus on developing new models and validating them in real-world settings, with some needing extended time to collect and analyze the data required for enhancement (Fonseca et al., 2022; Fahd et al., 2021; Huseynli & Ogbuachi, 2022).

In different fields, particularly in education, theoretical models frequently emerge from the evaluation of ideas and the learners' needs and feedback. These initial ideas require significant time, effort, and thoughtful consideration before they can be fully realized (Creemers & Kyriakides, 2018). Teaching staff also faces challenges in understanding and effectively implementing the evidence outlined in scientific literature (Guinovart-Pedescoll & Palau, 2024). Moreover, these initial concepts can inspire other innovative ideas (Minai et al., 2009). In educational technology research, there is a need for an appropriate methodology to guide researchers through the stages of ideation and design, without necessarily progressing to the implementation and evaluation phases, for several reasons, either due to the high cost, because they might not be immediately testable, or the facilitating technology might not yet have evolved sufficiently to meet the requirements of the model. Therefore, the objective of this paper is to present a research methodology that supports the creation of conceptual models considered as artifacts that prioritize the theoretical and creative aspects of development in education.

2. Literature Review

The creation of conceptual models requires systematic methodologies that combine diverse approaches and frameworks. These methodologies are designed to synthesize knowledge, highlight gaps, design models and prototypes and enhance

understanding across various areas. Below the most relevant to the field of study and the ones that have the potential to benefit from educational technology research are examined.

Conceptual design methodology (CDM) offers a structured approach that emphasizes theoretical development rather than practical iteration and testing. This method is especially effective in fields where establishing a theoretical framework or achieving a deep understanding is more critical than creating a tangible result. It is particularly valuable in fields such as educational technology, curriculum development, and instructional design, where innovative and adaptive solutions are required (Ma et al., 2011). It emphasizes the synthesis of ideas, enabling designers to explore abstract concepts freely without being limited by the demands of immediate practical application and testing (Ling-ling et al., 2009).

After analyzing the existing literature under the CDM approach, several key characteristics of these methodologies can be identified: they prioritize the needs and experiences of end users (Hertzum, 2003); iterative cycles of design and testing are used to refine solutions, ensuring they better fit the identified needs (Fletcher et al., 2019); they involve professionals from various disciplines to bring different perspectives and knowledge to the design process (Faustmann et al., 2019); they allow for quick adjustments and changes in response to feedback and emerging new needs (Gee, 2022) and encourage the generation of creative ideas and novel solutions to complex problems (Nazlidou et al., 2024).

Among the most common methodologies covered by CDM in educational technology, Design Thinking is highlighted. It seeks to deeply understand users, redefine problems, and create innovative solutions by promoting creativity and collaboration (Parker et al., 2020), under a structure that does not necessarily have to follow a specific order. Another methodology to consider within CDM is Human-Centered Design, which is characterized by placing people at the center of the design process. This is achieved by understanding the needs, behaviors, and experiences of users, resulting in more accessible and inclusive solutions that help reduce the digital divide (García-López et al., 2020).

Continuing with relevant methodologies within CDM, the Lean Startup Methodology allows for the rapid creation of new educational tools from prototypes with a minimum set of tested functionalities called Minimum Viable Products, or MVPs. The new tools produced from MVPs emerge thanks to continuous feedback and suggestions from users (Shagirbasha, 2024). Finally, Scenario-Based Design allows for anticipating and planning how both students and educators will use different technological resources. This methodology ensures that the developed technology is highly applicable in real contexts by analyzing and detecting potential errors (Mills et al., 2024).

Conceptual modeling methodology (CMM) has been used in different areas such as in software design and information systems, it is a standard practice to represent complex systems through models that help to explain key concepts (Bernasconi & García, 2024). It can be defined as a foundational tool to compile and convey the essential characteristics of an application and define how elements will interact

before its development (Johnson & Henderson, 2024). Conceptual modelling acts as a bridge between ideas and technical implementation, ensuring all the processes and systems are properly analyzed and effectively communicated before being developed and implemented.

Its key features include translating and simplifying real-world phenomena into models, diagrams or frameworks, they are not linked to specific technologies, therefore they provide a high degree of flexibility. Additionally, conceptual modelling emphasizes communication and understanding, making it possible for stakeholders to understand the system without being experts in the subject.

Within the methodologies of CMM, the Unified Modeling Language is included, it is primarily used in software engineering. In the field of educational technology, it has been used as a methodology to design and document online learning systems (Clark & Evans, 1997). Another to be considered is the Soft Systems Methodology which serves to address ill-defined situations. Thanks to the perceptions of the different agents involved in the development of the technological tool, the initial problem can be correctly reformulated. In this way, this methodology allows for the detection and attempt to solve complex educational problems, adapting the different learning systems to the needs of the students (Rose, 1997).

Finally, Semantic Modeling (Ontologies) is identified. This methodology is responsible for organizing and structuring information in such a way that both machines and humans are able to understand it (Nedelcu & Ionita, 2024). All of this, applied to the field of education, would allow for the generation of adaptive learning platforms, promoting the personalization of learning and the creation of educational resources tailored to the needs of the students (López-Villanueva et al., 2024).

In education research, CMM has not been commonly used, however, since technology plays a key role in this field, it is considered that it has a significant potential for application and could greatly enhance and benefit the field's methodologies and outcomes.

Design-Based Research (DBR) is one of the most commonly used methodologies in educational technology. Its goal is to design practical interventions for specific problems in real-world education settings, it is focused on iterative cycles in order to improve and adapt educational tools (Holmberg, 2017; Obczovsky et al., 2024).

DBR is particularly interesting within the context of educational technology due to its collaborative nature between technology system developers and education professionals. A clear example can be found in the development of online learning platforms, formative assessment tools, educational mobile applications (Tinoca et al., 2022), among many others. As previously mentioned, this methodology is characterized by constant iteration between the design, implementation, and evaluation phases (Scott et al., 2020). The feedback received from users allows for continuous modifications in the design phase, enhancing the user experience with these technological tools and improving the effectiveness of the teaching-learning process in that specific context (López-Villanueva et al., 2025).

Design Science Research (DSR) commonly used in the field of product development and engineering, but increasingly been used in education as an alternative to DBR (Fahd et al., 2021; López-Villanueva et al., 2025) “is a research methodology that combines the creation and evaluation of resulting products to solve specific problems through a robust and iterative process that allows for the continuous improvement of the created product. It not only aims to generate practical solutions but also to develop the theoretical knowledge necessary for replication in various contexts” (López-Villanueva et al., 2025).

There are different methodological variants of DSR based on their purpose and applicability (Venable et al., 2017). Below, several of them will be discussed, including Action-Design Research (ADR) and the Design-Science Research Process Model (DSRPM).

ADR combines action research with DSR through a series of cycles that require a high degree of researcher involvement in the design and implementation of the resulting product (Sein et al., 2011), ensuring that the resulting products are applicable in real-world contexts (Haj-Bolouri et al., 2017).

Another widely used methodology within DSR is DSRPM, which is characterized by continuous feedback between the design and evaluation of the technological product, providing a solid structure for research (Vaishnavi & Kuechler, 2015).

The characteristics mentioned of the different DSR variants play an important role in educational technology. This is because the technological solutions generated are consistent with user needs, thanks to the collaboration between developers and users, and the rigor of their iterative processes enhances their effectiveness. Additionally, these cyclical processes promote the innovation of these artifacts through continuous evaluation and improvement of technological tools.

3. Core Principles

In this section the aim is to abstract core principles underlying each methodology and to have a better understanding of the insights each offers. In Table 1, the four primary methodologies under discussion are compared, their interrelationships are illustrated, and potential overlaps are highlighted. Additionally, it shows how these methodologies can contribute to advancements in the educational technology field.

Table 1. Comparison of methodologies: CDM, CMM, DBR and DSR

Aspect	CDM	CMM	DBR	DSR
Purpose	Solve high-level design problems and define strategies	Abstract and represent systems for analysis and understanding	Develop and refine interventions while building theory in real-world contexts	Create and evaluate innovative artifacts to solve problems and advance knowledge
Focus	Broad ideation and defining solutions	Technical abstraction and system representation	Iterative design and theory building in real-world settings	Problem-solving through artifact creation and evaluation

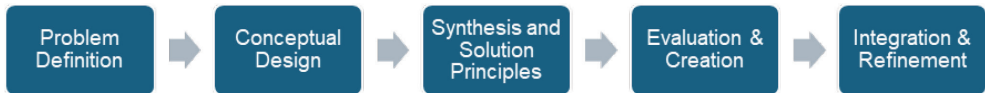
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Aspect	CDM	CMM	DBR	DSR
Outputs	Designs, prototypes, frameworks	Models, diagrams, logical abstractions	Refined interventions and theoretical insights	Artifacts (e.g., systems, models, tools)
Approach	Creative, iterative, user-centered, often flexible	Structured and formalized, relies on standardized techniques	Iterative: design, implementation, analysis, refinement	Iterative and rigorous: artifact creation, evaluation, refinement
Evaluation	Minimal evaluation at early design stages	Logical consistency, completeness, and accuracy	Real-world testing through collaboration with practitioners	Rigorous testing (simulations, performance analysis, etc.)
Discipline	Broad: engineering, architecture, software, product design	Technical fields: database design, systems analysis, simulation	Education, social sciences, design science	Engineering, information systems, management science
Tools	Mind maps, storyboards, sketches	UML diagrams, ERDs, DFDs, flowcharts	Prototyping tools, qualitative and quantitative data analysis methods	Modeling tools, evaluation frameworks, development platforms
Examples of Sub-Methodologies	Design Thinking, User-Centered Design, Sustainable Design	Entity-Relationship Modeling, Object-Oriented Modeling, System Dynamics Modeling	Collaborative Co-Design, Iterative Prototyping, Formative Design Evaluation	Action Design Research, Agile Design Research, Design-Science Process Model
Relationship with Other Methodologies	Supports DSR and DBR in the ideation phase; informs conceptual modeling	Provides structured representations used in DSR and DBR; supports conceptual design refinement	Shares iterative principles with DSR; informed by conceptual design and modeling for intervention representation	Aligns with DBR for iterative development and evaluation; uses conceptual models as artifacts
Potential Benefits to Educational Technology	Guides the creation of new educational product concepts and strategies aligned with user needs	Models complex educational systems (e.g., adaptive learning systems) for analysis and optimization	Helps design, test, and refine interventions (e.g., learning activities, apps) in classroom settings	Can develop innovative educational tools, frameworks, and systems evaluated for effectiveness

All the methodologies have in common that they are structured approaches that follow specific processes. Considering the range of sub-methodologies within each main methodology, the different processes have been synthesized and generalized to provide a comprehensive overview.

The CDM involves a series of phases that guide the creation of a product from an initial idea to a specific and detailed design. It can vary depending on the field of study, however, in Figure 1 the main phases that are most common across the different areas have been summarized and synthesized:

Figure 1. Phases of Conceptual Design Methodology



In the problem definition phase, the problem or task is clearly defined, and the demand or need to be addressed is analyzed. In particular, the understanding of education goals and the context where the design will be implemented is key in this phase. In the second step, the conceptual design, the problem is abstracted, and function structures are created to understand the relationship between different functions. In the following phase potential solutions are identified, a process synthesis conducted, and preliminary designs and flow sheets are created. In the fourth phase, the created concept variants are assessed in order to choose the most appropriate solution. The last phase, integration and refinement, consists of refining the design and integrating the process; in some high-complex products, a structural reorganization is required (Dimian et al., 2019; Liu et al., 2017; Taura, 2016).

CMM follows a structured process for the development of models that can represent complex ideas or systems. In Figure 2, the detailed phases have been generalized:

Figure 2. Phases of Conceptual Modeling Methodology



The first step is the definition or the scope of the problem that must be solved by the model. At this stage, key elements are identified, as well as the limitations of other existing models and a justification for the selected integrative model is to be provided. In the Systematic Review stage, existing literature on the topic is reviewed in order to extract relevant data, this information is synthesized, and it becomes the foundation for the conceptual model. In the third phase, the model is developed, ideas are transformed into formal facts and quality checks are applied at this stage. Integration and analysis is the phase in which the hypotheses are integrated into a model, by analyzing trends, the most important are identified and included, following that, a conceptual schema

is created to ensure that the model is comprehensible. Finally, in the last stage of the process, to ensure the conceptual model is both expressive and clear, the model is evaluated and adapted, facilitating continuous improvement and adaptability (Bozlu & Demirörs, 2008; Grames et al., 2022; Gray & Sockolow, 2016; Halpin & Morgan, 2008; Buchmann et al., 2019).

DBR is a systematic approach designed to connect theory with practice by creating and evaluating interventions within real-world contexts. Many researchers have tried to represent the stages of the process, in this case, it is considered the process model for DBR suggested by Hoadley and Campos (2022) for studying learning environments. Figure 3 shows a simplified version process model:

Figure 3. Phases of Design-Based Research (Adapted from Hoadley & Campos, 2022)



This methodology follows iterative cycles promoting ongoing refinement and enhancement of educational strategies. It is characterized by the collaboration between researchers and practitioners. In the grounding phase, the problem or theoretical gap is identified, information about the domain and data from previous experiences is gathered, it sets the direction of the project. During the conjecturing phase, problems identified in the grounding phase are given clarity and specificity by formulating a theory of action, embodiments meaning the features of the design, materials etc., as well as the mediating processes are mapped. In the iteration step, broad design principles are transformed into concrete designs, allowing researchers to gain valuable theoretical insights. The collected data is used to revise the original hypotheses about learning and to develop new designs aimed at testing these theories. In the reflecting phase, the focus is on analyzing the data collected during the testing in the iteration phase and critically evaluating it after building the artifact and testing it in a real-world situation (Hoadley & Campos, 2022).

DSR is a systematic methodology for solving complex real-world challenges by developing and evaluating innovative artifacts. There is a generalized agreement on the phases of this methodology, as illustrated in Figure 4:

Figure 4. Phases of Design Science Research



In the first phase, the problem is identified, specified and aligned with the stakeholders' needs and the practical gaps. Once identified, the objectives of a solution

are defined in a clear and measurable way for the solution to be achieved. In the third phase, the artifact is created making sure it addresses the objectives fixed on the previous stage. This is an iterative process that shapes the artifact with theories, empirical evidence or methods. In the demonstration phase, the artifact is applied in a real-world or controlled scenario to check its functionalities and if it successfully solves the problem. The evaluation stage is crucial to assess if it is effective, relevant and impactful; this can lead to refinements or revisions. In some cases, the communication phase has been omitted or taken for granted, however, it is considered an important part of the process. It consists of disseminating the outcomes, findings and contributions to have a broader adoption and impact (Premananda et al., 2022; Elger, 2024; Humble & Mozelius, 2023; Peffers et al., 2007; De Sordi, 2021).

4. Methodology Development

After having analyzed key aspects of each methodology and the process and steps they follow to create new artifacts, models, designs, etc., the foundations for our methodology have been established.

It is considered that none of the methodologies examined accurately addresses the need for a model creation methodology in educational technology that does not involve the implementation and testing of a model, to fill this gap the Educational Conceptual Model Design (ECMD) research methodology has been created. This methodology can be used for the creation of new models, artifacts and systems that include the use of technology in education, and it is drawn on CDM, CMM, DBR and DSR principles which will bring a rigorous and innovative approach to the development of educational models, systems and artifacts.

In summary, the methodological integration has been as follows: CDM has provided a foundation for structuring abstract ideas and ensuring that models are intuitively designed; CMM has contributed to systematically represent knowledge, ideas and relationships; DBR emphasizes situating the methodology in real-world educational contexts, solving existing problems and linking practice with theory; finally, DSR has brought rigor in addressing well-defined problems, constructing innovative artifacts, and contributing knowledge to the field.

The ECMD full process has been divided into four phases: problem definition, conceptual foundation, model development and knowledge contribution (Figure 5).

Figure 5. Phases of Educational Conceptual Model Design Research Methodology



Each phase is outlined below, providing detailed explanations and the specific steps to follow. This serves as a comprehensive guide for applying the ECMD effectively.

4.1. Problem Definition

In this initial phase, the problem, need, or gap within the educational technology landscape is identified and clearly defined. The aim is to establish a clear understanding of the issue at hand, ensuring that the problem is both relevant and significant to the field. This lays the foundation for the subsequent stages of the research process and includes the following:

- Determine the specific area of educational technology
- Engage with students, teachers, administrators to understand the context and priorities
- Define the gap in current knowledge, practice, or technology by identifying areas where existing solutions are insufficient or outdated
- Establish the goals and objectives in terms of its impact on learning processes, tools, or systems
- Analyze the context of the problem, the factors that influence it such as technological limitations, pedagogical challenges, socio-economic factors, etc. A needs assessment can be conducted at this stage to have more information

4.2. Conceptual Foundation

The conceptual foundation consists of building a theoretical basis for the model. This includes a literature review, identifying key concepts and principles that will be the basis of the conceptual model. This provides the basis for the following steps and ensures that the model will be meaningful, innovative and effective. In order to create the conceptual foundation, these steps can be followed:

- Conduct a systematic review of existing theories, frameworks and models related to the problem identified in the first phase
- Identify gaps in current knowledge and opportunities for contribution
- Identify and extract key concepts that will help to understand and address the problem
- Review relevant methodologies or approaches that have been applied to similar problems or in the same area of study
- Define the theoretical framework that will be followed to approach the problem

4.3. Model development

In this phase, a diagram is developed to represent key elements and relationships of the model. The model is created to answer the problem identified in phase 2 and founded on the methodologies or approaches defined in phase 3. To create the model, the steps outlined below can be followed:

- Translate the conceptual model into a design
- Identify the key components
- Create a diagram that describes the process
- Specify the technical requirements

- Document the process: record the design decisions, maintain a version history of the model as it evolves to ensure reproducibility
- Ensure the development is aligned with the detected needs of the different stakeholders

4.4. Knowledge contribution

In this last phase, the theoretical insights of the model are extracted and generalized, as well as the potential benefits in the field of study. It involves analyzing, synthesizing, and documenting the outcomes and insights from the model to enhance both theory and practice in the field. This phase is key to understanding the model implications, impact, innovation and to contribute to new knowledge that can be shared with the wider community. This knowledge can take the form of innovative models, artifacts, systems or designs. The following steps can be implemented:

- Analyze how the model contributes to or extends existing theories and highlight its relevance to the specific context
- Identify any new insights discovered during the model's development phase
- Create design principles drawn from the process or guidelines that can help future development in educational technology
- Synthesize the knowledge that has been created during the model development process. Answer the following key questions:
 - What have we learned about the problem?
 - How has the model advanced understanding or practice in the educational technology field?
- Identify the model's limitations and areas for improvement
- Provide future research recommendations

This methodology provides a systematic approach that concentrates on the design phase and ensures that it is grounded on theory, it is rigorous and reproducible. It is specially designed to serve as the foundation for creating a model's functionality and its representation, transforming abstract ideas into models that can solve real-world problems. After following all the steps, the resulting model is ready to be implemented and tested at later stages. This is especially helpful when the model cannot be immediately implemented due to high-cost constraints, the facilitating technology is not yet sufficiently advanced or simply to dedicate more time and effort to the design process for this kind of educational conceptual models.

5. Discussion and Conclusions

The objective of this study is to develop a comprehensive research methodology for creating conceptual models in the field of educational technology that can also be used in general education, by synthesizing and integrating principles from CDM, CMM, DBR and BSR methodologies. It is composed of 4 phases: problem definition,

conceptual foundation, model development and knowledge contribution. Each phase integrates insights from these methodologies. This combined approach ensures a balance of rigor, relevance, and innovation in the conceptual models created by the new ECMD research methodology.

Based on the proposed methodology, the theoretical debate in educational technology can be advanced by connecting abstract conceptual models to practical solutions. DBR emphasizes the application of models or artifacts in real-world contexts (Bordeau, 2017) while DSR aims at the systematic creation and testing of artifacts (Weigand & Johannesson, 2023). Our methodology integrates these complementary approaches by using the systematic abstraction of conceptual modeling (Robinson et al., 2015) together with the practical structuring of conceptual design (Kulesa et al., 2024).

In DBR there is a lack of guidance and theoretical grounding on how to actually design an intervention since the majority of studies focus on the output, rather than on the design process itself (Obczovsky et al., 2024). In conceptual design, there is a need for effective analytical ideas that offer theoretical support with the aim of reducing poor design outcomes and improving their efficiency (Liu et al., 2017). In conceptual modeling, there is a lack of contributions to knowledge regarding the methodological strategies used for the generation of conceptual models indicating a gap in existing literature (Valencia-Contrera et al., 2023).

The structure of the ECMD is designed to enhance the rigor of theoretical grounding and systematic processes for model creation, ensuring that clear concepts and domain expertise guide the development of innovative artifacts. This approach provides much more streamlined workflows, mitigates major potential biases from having different points of view among the various stakeholders, and insists on the importance of consistency of application and replication in different scenarios.

The proposed methodology is a short-term methodology that enables researchers to share their results and findings in a short period of time, in contrast with DBR methodology that involves multiple iterative steps of refinement and redesign, with numerous cycles incorporated throughout its implementation process, its complete cycle might require several years to be completed (Vaezi et al., 2019).

Our model responds to the constant changes and accelerated pace of society 3.0, a society shaped by high-speed changes and advancements in technology such as the introduction of AI (Rettberg et al., 2024). In which digitization and connectivity are central to interactions in society (Henriksson & Grunewald, 2020) and in learning environments where the lines between the physical and digital worlds are becoming more blurred (Manov et al., 2022). In education there is a high demand for innovative approaches that enhance and facilitate learning and teaching (Muzuva, 2024).

In DSR, the artifacts created can be difficult to document and share due to their complexity which makes more difficult knowledge transfer (Müller & Thoring, 2011), moreover, there is a lack of guidance on artifact development to make successful designs and it can be difficult for early-stage researchers to use this approach (Delport et al., 2024). However, ECMD offers a clear path, guides researchers from

theoretical ideas to functional and practical models. Since it focuses on theoretical rigor, it guarantees that the resulting artifacts are not just innovative but also relevant in different educational settings.

After outlining the benefits ECMD presents, it is important to recognize its limitations. The design development phase does not include the stakeholders' participation (since the needs and context are evaluated in the problem definition phase) nor does it include iterative refinement, although the methodology simplifies the process of conceptual model design, this might result in a less adaptable model to specific local contexts or emerging needs during future implementation. This could create a gap between the theoretical design and the challenges that future users might encounter.

Moreover, the lack of iterative testing may restrict the chances to identify and address issues or areas for improvement that have not been identified during the development phase. The methodology thus relies on high levels of precision and proactivity in the initial phases, which could be difficult to implement in a dynamic or unpredictable environment.

On the other hand, while the study establishes a theoretical framework for conceptual model design which provides it with rigorousness, it lacks empirical evidence or case studies that show and test this design in real-world contexts. It will require the use of other methodologies or methods to validate and implement the models in future stages, such as the process of expert judgement which consists of selecting experts on the subject to evaluate the model, tool or methodology created, its main objective is to guarantee the educational technology or material meets the required quality standards (León-Garrido et al., 2024).

Future research should focus on exploring ways to improve the adaptability of the methodology without changing its non-iterative nature. For instance, incorporating mechanisms for feedback after deployment such as longitudinal studies or controlled field tests, could create opportunities for evaluation and improvement without changing the fundamental development process.

Future studies could also concentrate on discovering if this methodology could be escalated to large-scale educational technology projects such as global online platforms or national-level initiatives. For instance, developing frameworks for integrating the methodology with large datasets and advanced analytics. On the other hand, this methodology has also been thought of for helping to create AID models, however, it will have to be applied in order to evaluate how well it supports cutting-edge technologies.

Scholars could also examine how the methodology might be enriched through integration with other disciplines, for instance, Human-Computer Interaction (HCI) to improve usability and accessibility, Cognitive Science to refine learning systems designs, or data science to apply machine learning to predict the model's capabilities.

The proposed methodology presents an advancement in the creation of conceptual models in educational technology, it offers a theory approach to the field that provides consistency, replicability and theoretical rigor. It is capable of responding to speed-up technology and society changes, including incorporating AI in education. This level

of adaptability makes it a valuable tool for researchers and practitioners who want to create impactful and innovative educational solutions.

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