

Expanding horizons for the future with an open educational model for complex thinking: external and internal validation

María-Soledad Ramírez-Montoya and May Portuguez-Castro

(Information about the authors can be found at the end of this article.)

Received 17 December 2023
Revised 31 January 2024
13 February 2024
Accepted 3 March 2024

© María-Soledad Ramírez-Montoya and May Portuguez-Castro. Published by Emerald Publishing Limited. This article is published under the Creative Commons Attribution (CC BY 4.0) license. Anyone may reproduce, distribute, translate and create derivative works of this article (for both commercial and non-commercial purposes), subject to full attribution to the original publication and authors. The full terms of this license may be seen at <http://creativecommons.org/licenses/by/4.0/legalcode>

The authors would like to thank the financial support from Tecnológico de Monterrey through the "Challenge-Based Research Funding Program 2022." Project ID # I001-IFE001-C1-T1-E. Also, academic support from Writing Lab, Institute for the Future of Education, Tecnológico de Monterrey, México.

Abstract

Purpose – *The challenges facing 21st-century society are becoming increasingly complex, requiring the development of new citizen competencies. This study aims to validate an educational model focused on developing complex thinking in higher education students. Current educational models lack future-ready competencies, necessitating the emergence of new models to guide future generations toward the common good.*

Design/methodology/approach – *This was an adaptation of the causal-layered analysis (CLA) applied to 415 participants from higher education institutions in Mexico, Panama and Spain. Sessions were designed to present the proposed educational model and explore participants' perceptions of its significance and contributions to future education.*

Findings – *Key findings include the following: participants perceived complexity as difficult and challenging; causes of problems were linked to outdated educational models requiring replacement by those that develop students' competencies; participants envisioned changes that would develop individuals capable of understanding and transforming society; and participants recognized the model's transformative potential, offering a novel proposal for 21st-century education.*

Originality/value – *This research sought to gather opinions from different stakeholders using the CLA methodology, providing a deep understanding of participants' perspectives on the proposed solution.*

Keywords *Complex thinking, Educational innovation, Higher education, Educational model*

Paper type *Research paper*

1. Introduction

In the ever-evolving landscape of education, the imperative is to nurture individuals capable of tackling the growing complexities of society. Current educational systems, as acknowledged by [UNESCO \(2021\)](#), have reached their limits in promoting well-being and equity for all, necessitating the development of new paradigms for transformative learning. Therefore, education for the future requires the development of new paradigms of transformative learning where faculties engage individuals in action ([Pouru-Mikkola and Wilenius, 2021](#)). The emergence of innovative educational models becomes crucial to equipping citizens with the competencies essential for thriving and contributing to the future common good.

This study explores complex thinking as an essential competency in new educational models. Complex thinking positively impacts students' analytical skills in complex environments ([Castillo-Martínez et al., 2023](#)). Focused on over 400 participants from three Hispano-American countries, this research validates the Open Educational Model for Complex Thinking (OEM4C) through causal-layered analysis (CLA), offering innovative insights. The research targets executives, decision-makers, researchers and educators interested in a model fostering complex thinking competencies. Participants showed

interest in transforming traditional education to cultivate socially engaged citizens, with the proposed model playing a crucial role in this transformation.

1.1 New models for the future of education

To achieve the essential changes in education necessary to address the challenges of our contemporary society, [UNESCO \(2021\)](#) called it necessary to make radical changes in educational systems and curricular approaches. It can be achieved by directing education toward new models that enable teachers to prepare tomorrow's leaders with global competencies and multidisciplinary skills such as complex problem-solving, innovation, creativity and critical thinking ([Kuykendall, 2022](#)). Considering the challenges posed by the disruption caused by technological change, educational strategies must enable global and local approaches, as well as social development framed within the use of disruptive technologies ([Moravec and Martínez-Bravo, 2023](#)). It is imperative for more flexible, innovative and inspiring educational models to emerge in response to societal issues.

Creating new educational scenarios to address complex challenges is imperative. The future of education calls for developing novel spaces, adopting a perspective of complex thinking that resonates with society and using digital technology as a means of idea transmission ([Ramírez-Montoya et al., 2023](#)). The emergence of new models reflecting an understanding of educational reality will be crucial in establishing the necessary elements in new educational paradigms ([Escudero-Nahón and Ramírez-Montoya, 2021](#)). Thus, the evolution toward new educational scenarios and emerging paradigms is vital to tackling the complex challenges of contemporary society.

For higher education, making changes to educational models is challenging, given that they are immersed in complex environments. In this context, plans, programs and procedures that were useful in the past become obsolete, requiring an analysis of the opportunities and challenges that will arise in the future because of new needs ([Baradaran Ghahfarokhi et al., 2018](#)). Increasingly, institutions of higher education seek to equip students with the knowledge and skills to foster leaders capable of addressing challenges in environmental, social and economic settings through interdisciplinary collaboration and innovative solutions ([Koivunen et al., 2023](#)). In this regard, educational systems must adapt to the needs of the 21st century ([Facoetti et al., 2023](#)). The adaptation of educational systems is crucial to equipping students with updated knowledge and necessary skills, enabling them to effectively address changing challenges and contribute to sustainable development.

Within these new paradigms, education becomes a transformative element for citizens, leading them to be more committed to the society of the future. According to [Häggström and Schmidt \(2021\)](#), future education should extend educational practices toward the development of individuals who can question their surroundings and engage in self-reflection regarding their experiences, values, behaviors and attitudes. In this context, lifelong learning will be necessary to acquire the skills required for work, in addition to fostering critical thinking, problem-solving and adaptability ([Barbosa et al., 2022](#)). The development of soft skills is therefore essential in the formative process and in educational policies guiding institutions toward the cross-cutting development of these competencies ([Tsekhmister et al., 2023](#)). The promotion of soft skills emerges as a fundamental pillar in shaping an educational system that prepares individuals to face the challenges and demands of an ever-evolving society.

1.2 Complex thinking in higher education

The need to develop cross-cutting competencies in university students is increasingly evident in new educational models. One of these competencies is complex thinking, which refers to acquiring knowledge multidimensionally ([Morin, 2005](#)). [Schulz et al. \(2023\)](#) embrace Morin's vision of future education, which should be broader and more complex,

allowing for the interdisciplinary and transdisciplinary fusion of topics while maintaining individuality with global awareness. Following this approach, it is mentioned that the human being is a complex unity and must become aware of their identity in the face of the problems encountered in their environment through critical thinking and social commitment (García Cordero and Buitrago López, 2023). This integrated approach to education seeks to foster well-rounded individuals who can navigate and address the complexities of the world (Portuguez Castro and Gómez Zermeño, 2021). As education evolves to embrace Morin's vision, it has the potential to empower individuals to thrive in a rapidly changing and interconnected global society.

By embracing a more nuanced and integrated educational model, individuals can develop the adaptability and resilience needed to navigate the complexities of the modern age. Wintersteiner (2023) mentions that events in recent years, such as the Coronavirus, have brought to the forefront the importance of complex thinking for solving everyday life problems, an idea initially introduced by Morin in the 1970s. This conceptualization is based on the understanding that society is complex (Ramírez-Montoya *et al.*, 2024a), and to comprehend it, a new form of thinking must be established, allowing for the observation of reality as a system in which its parts are interconnected, even though they may be and appear very different (Ramírez-Montoya *et al.*, 2024b).

Complex thinking allows individuals to comprehend complex systems, establish connections between seemingly disparate pieces of information, and solve problems comprehensively (Silva Pacheco and Iturra Herrera, 2021). It is considered metacompetency as it involves various critical, creative, or divergent reasoning processes in student formation (Tecnologico de Monterrey, 2019). Metacompetencies are higher-order skills that empower individuals to manage and leverage a range of thinking competencies, including critical thinking, creative thinking and future thinking (Ozcinar *et al.*, 2020). Within the realm of futures thinking, metacompetencies play a crucial role in anticipating and preparing for future scenarios (Karashash *et al.*, 2022).

At the same time, this megacompetency is related to other thinking competencies required for the future, such as systemic thinking, which enables the establishment of relationships within the same reality; critical thinking, which assists in evaluating and making logical judgments; scientific thinking, which supports problem-solving based on evidence and the use of techniques; and innovative thinking, which allows visualizing problems from different perspectives (Vázquez-Parra *et al.*, 2023). It aims to interconnect different theories and information that can generate solutions for the common good.

Various research studies have addressed the concept of complex thinking. Complex thinking emerges as a valuable tool in future education (Ramírez-Montoya *et al.*, 2024b), giving rise to research that serves as guiding frameworks for cultivating skills through innovative educational strategies such as competency-based, problem-based and case-based learning and gamification (Cruz-Sandoval *et al.*, 2023). These studies suggest that conventional strategies, bolstered by the use of technological tools such as reading, debates and reflective questions, remain effective in fostering complex thinking when applied appropriately (Patiño *et al.*, 2023). In the effort to enhance educational methods and adapt to an ever-changing environment, complex thinking emerges as an essential tool.

It enables us to address contemporary challenges from a comprehensive and holistic perspective, considering various variables and relationships that influence a situation (Castillo-Martínez *et al.*, 2023). On the other hand, Suárez-Brito *et al.* (2022) highlighted the necessity of training individuals to integrate concepts across disciplines and apply critical thinking in complex situations. According to these authors, students should not only adapt to university life but also acquire the necessary knowledge for their professional careers.

This approach fosters essential skills, such as social entrepreneurship, that promote creative thinking, collaboration and the ability to adapt to complex and changing

environments to generate alternatives (Vázquez-Parra *et al.*, 2023). The competence of computational thinking is relevant in an increasingly digitized society and refers to the ability to address problems logically, analytically and systematically by applying principles and tools from computer science (Alfaro-Ponce *et al.*, 2023). Within the framework of complex thinking, computational thinking enables us to analyze situations from an algorithmic perspective, identify patterns and devise efficient solutions.

Educational experiences through robotics, virtual reality, augmented reality and Chat GPT applications, focused on fostering complex thinking, have generated innovative dynamics that enhance problem-solving skills in a dynamic educational environment. The adoption of emerging technologies has contributed to the development of complex thinking competencies, as well as to the use of educational innovation such as robotics, the metaverse and Chat GPT (George-Reyes, 2023; González-Pérez *et al.*, 2023; Ramírez-Montoya *et al.*, 2023; Lopez-Caudana *et al.*, 2020). Despite progress, additional research is crucial to effectively integrate these competencies into educational programs, providing the necessary tools to address future challenges.

1.3 External and internal validation in educational models

In education, validation is pivotal for ensuring program quality and effectiveness. External validation involves assessment by external agents who analyze the program based on various criteria, while internal validation focuses on evaluating the internal elements of a model or program (Obrelí-Neto *et al.*, 2016). Kimmons and Hall's (2018) study exemplifies this process, validating technology-incorporated models through expert-teacher evaluation and determining user acceptance. This approach confirmed which models were more accepted by users. Additionally, other studies have used methods such as the Delphi of individual aggregates, as evidenced in the research by Pinto-Santos *et al.* (2022), to identify the reliability of different elements of the proposed model. The validation of educational models not only lends legitimacy to educational practices but also significantly contributes to improving the overall quality of education.

The transformative role of education is increasingly recognized, prompting inquiries into the framework for these new models. One study sought to identify how teachers perceive the future and how they can respond to uncertainty and complex changes (Karjalainen *et al.*, 2022). Educational systems and policymakers are exploring ways to create a more inclusive, relevant and effective approach to education in the 21st century (Foster and Piacentini, 2023). The study found that teachers recognize the need for a more holistic and future-oriented approach to education, one that equips students with the skills and knowledge to navigate a rapidly evolving world.

Other studies have found that a shift toward a more interdisciplinary and integrated curriculum can enhance students' critical thinking skills, creativity and problem-solving abilities, thus preparing them for the demands of the future. (Horiashchenko, 2022). Through sessions with exploratory exercises following the CLA methodology, the study aimed to explore and question assumptions about new horizons. The methodology helped participants reflect on their roles and the role of education in times of change.

2. Method

To respond to the escalating complexities in educational environments, this study used Inayatullah's (2009) CLA methodology to explore diverse levels of understanding a problem, including the litany for superficial problem definition, causes for underlying dynamics, cosmovision for paradigms and values and metaphors and myths for actions in faced situations (Karjalainen *et al.*, 2022).

2.1 Causal-layered analysis

CLA is a methodology that has been used to gain a deeper understanding of a complex problem. It aims to be a tool that allows for extending the analysis and interpretation of social issues based on the opinions of its actors ([Baradaran Ghahfarokhi et al., 2018](#)). This method is described as an iceberg with different layers: at the top level are the litany (problems and trends), beneath which are the systemic causes (interpretation of data), followed by the worldview (which either supports or challenges the social structure) and the metaphor or myth (constituting deep stories or archetypes) ([Inayatullah, 2004](#)). CLA seeks to reveal worldviews and interests that provide greater insight into the problem and its possible causes.

This methodology has been used by various authors to seek to understand the future of education from different perspectives. [Beara and Dubovicki \(2023\)](#) used the methodology by adapting the four levels of [Inayatullah and Milojević \(2015\)](#) to demonstrate the perceptions of future teachers in Serbia and Croatia regarding the future of education, where students indicated optimism toward their own influence in this new environment. [Abdullah \(2023\)](#) used this methodology to present the results of a study with university students who used collaborative learning strategies for thinking about the future. The use of the CLA methodology allowed for a deeper exploration of the findings by identifying the students' motivational reasons.

Lastly, [Fleener \(2022\)](#) uses the four levels of the methodology to provide information on the use of blockchain technologies in education and to demonstrate their impacts. The results show the necessity of creating new metaphors that promote the value of education toward a paradigm shift from the traditional emphasis on the value of education and formal degrees. In these studies, CLA was used to delve deeper into the understanding of participants' issues and to provide guidance toward new directions for future research and practices in education.

2.2 Procedure

Information was gathered through four presentations hosted by various educational institutions across Mexico, Panama and Spain, engaging 415 attendees, including students, teachers and administrators. The OEM4C was introduced during these sessions, elucidating its components, competencies, sub-competencies, alignment with sustainable development goals (SDGs) and its futuristic implications for education. The audience was explained their interest in knowing their opinion to validate the model and its potential use in various educational settings.

The dialogues occurred in diverse contexts: a public university in Mexico with a focus on engineering and administration students; a regional meeting in Spain addressing higher education challenges in the digital era; the National Congress of Science and Technology in Panama; and a Mexican forum on innovative practices in upper secondary education. The audience was informed about their interest in knowing their opinion to validate the model and its potential use in various educational settings.

The data from which these findings were reported were generated through the utilization of the Mentimeter tool by participants during presentations. They answered questions designed to explore various layers of the CLA related to the new educational model. This process involved a questionnaire containing inquiries tailored to delve into different CLA levels, thus enabling a thorough examination of the issues at hand. As a final question, an open-ended question was asked to understand what they thought of the educational model and where they could make suggestions or observations about the model. All the responses were documented in the tool for later analysis.

To perform the data analysis, a coding process was conducted through a thematic analysis of the responses obtained in the questionnaire. Ideas were identified, organized and systematized into categories that allowed for the classification of participants' opinions into different phrases, behaviors and thought patterns (Benaquisto and Given, 2008), which were associated with the different layers of the CLA.

The litany level explored prior perceptions of complexity, while the causal level delved into the model's significant contributions to society and the educational process. The paradigm level analyzed proposed solutions for medium- and long-term problem improvement, fostering reflection on participants' goals with the model. Finally, the myth or metaphor level probed how the presented content is interpreted toward transformation, inviting audience comments on the model's impact.

2.3 OEM4C open educational model for complex thinking

The "R4C-IRG Interdisciplinary Research Group: Scaling Complex Thinking for All" developed the Open Educational Model for Complex Thinking (OEM4C) to provide a high-quality proposal for education (Tecnologico de Monterrey, 2023). This open educational model promotes critical and creative thinking training, supporting lifelong learning (Ramírez-Montoya *et al.*, 2023). Furthermore, its objective is to foster an understanding that uncertainty is inherent in people's daily lives, intersecting various social dimensions such as environmental, technological, economic and cultural aspects. OEM4C recognizes complex thinking as a metacompetency comprising four sub-competencies: critical, scientific, systemic and innovative thinking (Ramírez-Montoya *et al.*, 2024b). The model comprises four main components, as depicted in Figure 1.

The philosophical component aims to instill a sense of commitment and social engagement in students, encompassing elements such as inclusion, diversity and self-regulation. The theoretical component seeks cross-cutting (transversal) development, the use of alternative micro-credentials and the involvement of various stakeholders to cultivate the sub-competencies. Meanwhile, the educational component encompasses desirable methods, modalities and infrastructure for knowledge transfer. The political component includes teacher training programs, collaboration and evaluation.

3. Results

Below, Figure 1 presents the results of each level, aiming to identify participants' understanding of the model and its validation.

3.1 Perception of the concept of complexity

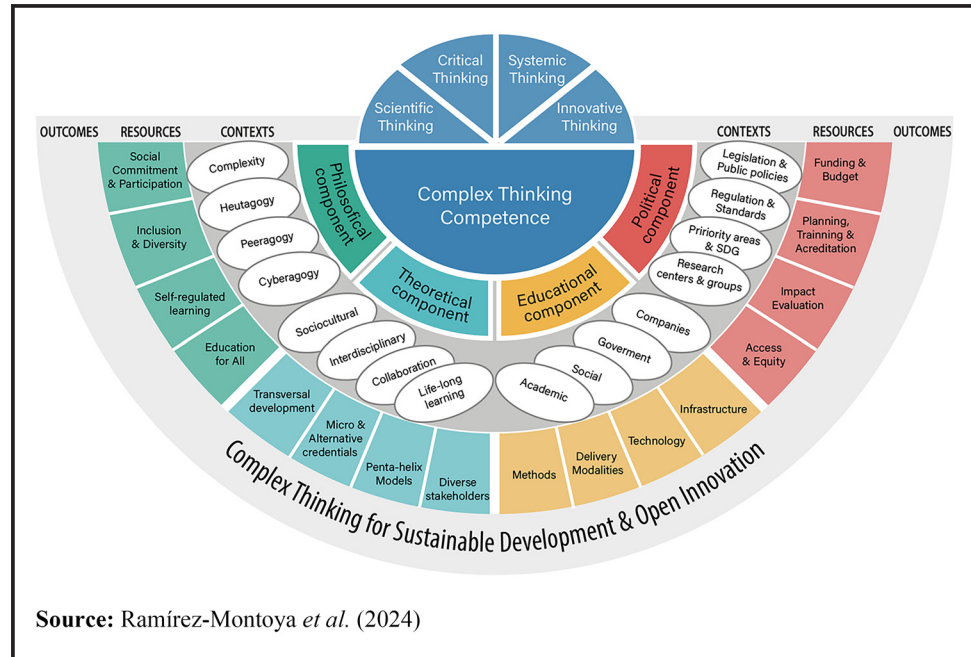
For the first activity, participants were asked to reflect on the term "complexity." Figure 2 shows a word cloud of words mentioned by the participants.

For the litany or surface level, the goal was to understand participants' perceptions of the concept of complexity. Note that they associate it with difficulty, complexity, elaboration and challenge. This superficial understanding can help comprehend how these concepts are perceived. In this case, it is linked to difficulty performing a task or overcoming an obstacle. Understanding these terms provides an initial insight into how to direct attention toward concepts that require reflection.

3.2 Contribution of the model to society and the educational process

In this second activity, participants responded to the model's most significant contribution to society and the educational process. Regarding its contribution to society, participants believed that the model mobilizes critical, scientific, systemic and innovative thinking; provides

Figure 1 Schematic representation of the open educational model for complex thinking



solutions to the challenges of sustainable development goals; aims to shape citizens with competencies to change society; and advocates for education as a common good.

Regarding mobilizing critical, scientific, systemic and innovative thinking, participants emphasized the need to “promote logical and scientific reasoning” and integrate capabilities and disciplines. Complex thinking was perceived as “very interesting,” and the importance of fostering a novel approach in education was underscored, including terms such as “innovation” and “transformative.” Responses also reflected a positive perception of the model by considering that it “provides answers to the challenges of the SDGs” and acknowledges the potential to “address global challenges and contribute to sustainable goals.”

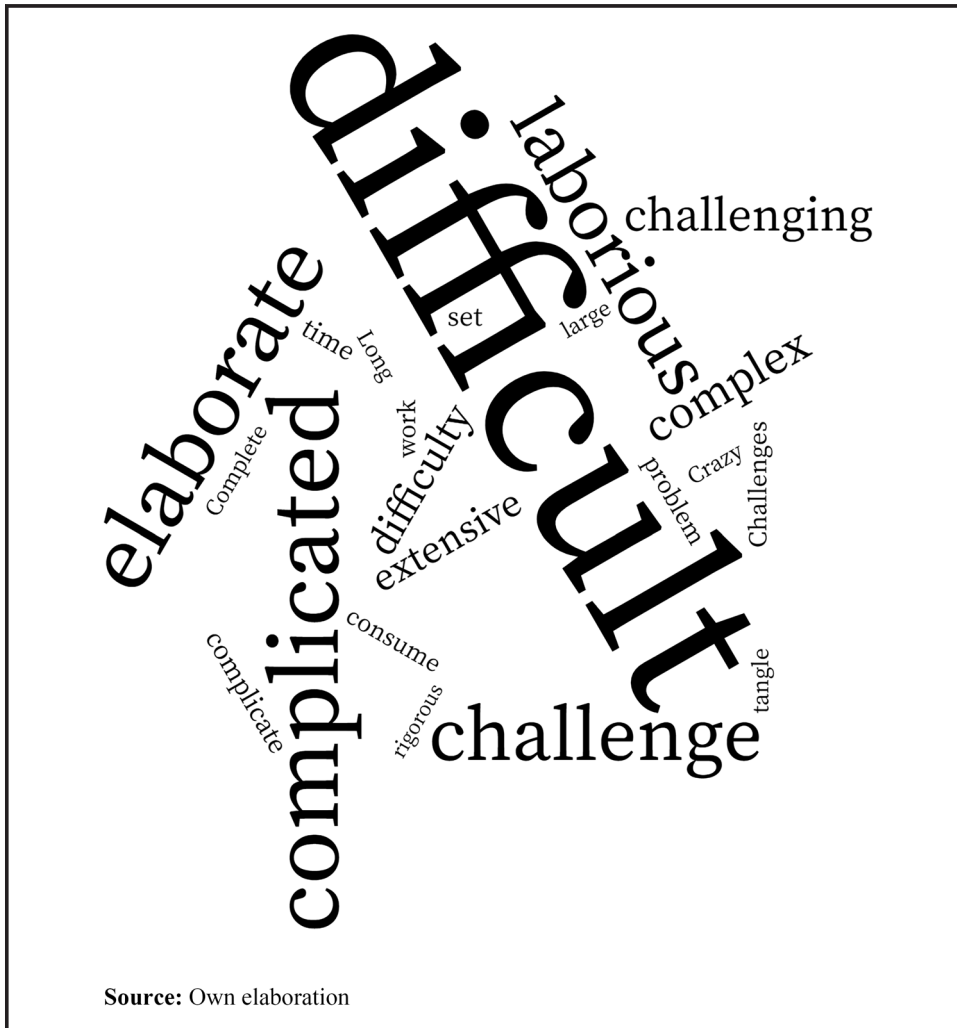
Participants believed the model aimed to “shape citizens with competencies to change society.” They recognized the importance of cultivating skills that enable individuals to influence their environment and contribute to significant changes. Responses highlighted that the model “contributes significantly to the 21st-century school,” leaving behind “outdated paradigms of the 20th century.” Furthermore, it contributes to the “development of deeper thinking” and is seen as a “comprehensive system that should be implemented in society.”

Regarding the model’s contribution to educational processes, participants considered the organization of these contributions based on their level of importance:

- integrating active strategies and technologies into the educational model;
- promoting training practices that generate value for society;
- using open educational resources for alternative credentials in complex thinking; and
- mobilizing what is considered a mega-competency.

Participants mentioned that the proposal allows them to “reflect on didactic strategies for teaching and learning.” They described it as “cutting-edge,” “innovative” and “transformative.” They continued to emphasize the generation of value for society, stating that “from teaching,

Figure 2 Word cloud on complexity



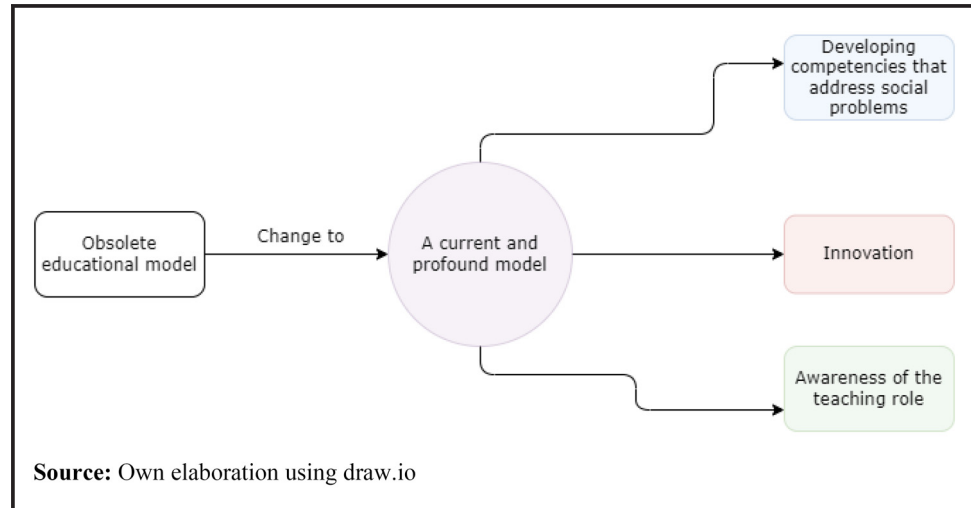
generations are exemplified”; it is “useful for making reasoned and objective decisions” and it is “wonderful that it is open” and can be contributed to from teaching to improve. It was seen as a “huge challenge, but not difficult to achieve for the sake of our students.” [Figure 3](#) displays the identified causes of this activity.

As a systemic cause, participants considered traditional educational models to be outdated. They believed that educational institutions should consider developing more innovative and profound models that cultivate competencies in students for deep thinking to address societal problems. It was emphasized that teachers should set an example for the new generations.

3.3 Contributions of the OEM4C to the future of education

In the third activity, participants responded about the most relevant aspect they aimed to shape in the OEM4C, as well as the most valuable contribution of the model. With these responses, the worldview that underpins the perceptions and objectives of the participants regarding the model can be explored. In this sense, it was possible to identify in the

Figure 3 Causes identified by participants



participants' responses that their ideologies and paradigms are related to the understanding of education in its role of shaping individuals who transform and provide new possibilities for society, develop high capacities in people, promote lifelong learning and enable them to contribute to local and global needs.

These paradigms operate in this research as lenses through which participants interpret and shape their perceptions and objectives regarding the OEM4C model. The belief in the transformative capacity of education and its role in creating a positive impact on society reflects a paradigm of social change and individual empowerment. Likewise, the importance placed on the development of capacities and skills highlights the vision of education as a means to enhance personal and professional growth.

The emphasis on lifelong learning reflects a paradigm of adaptability and resilience in a constantly changing world where continuous education is considered essential to remain relevant and competitive in the job market. Additionally, the concern for contributing to local and global needs reflects a paradigm of social responsibility and commitment to collective well-being.

On the other hand, when asked about the most valuable contribution of the model, participants indicated that this model allows to form individuals capable of understanding and positively transforming society; improve the quality of education; making it more equitable and supportive, facilitate inclusive, meaningful and continuous learning; and integrate digital ecosystems that support lifelong learning.

These responses reflect the fundamental paradigms that guide the research and implementation of the OEM4C model. Firstly, the belief in the transformative capacity of education to shape individuals capable of understanding and positively changing society reflects a paradigm of social change and individual empowerment. This paradigm drives the research toward identifying educational practices that not only transmit knowledge but also foster critical awareness and civic engagement.

Secondly, the concern to improve the quality of education and make it more equitable and supportive reflects a paradigm of social justice and equitable access to education. This paradigm directs the research toward identifying strategies and policies that address educational inequalities and promote the inclusion of marginalized or underrepresented groups.

The emphasis on facilitating inclusive, meaningful and continuous learning highlights a paradigm of student-centered learning oriented toward holistic development. This

paradigm drives the research toward exploring pedagogical approaches and educational technologies that promote active student participation, content relevance and lifelong learning continuity.

Finally, the integration of digital ecosystems supporting lifelong learning reflects a paradigm of innovation and adaptation to technological advances. This paradigm guides the research toward exploring tools and digital platforms that expand access to education and support self-direction and personalized learning. Figure 4 displays the paradigms identified by the participants.

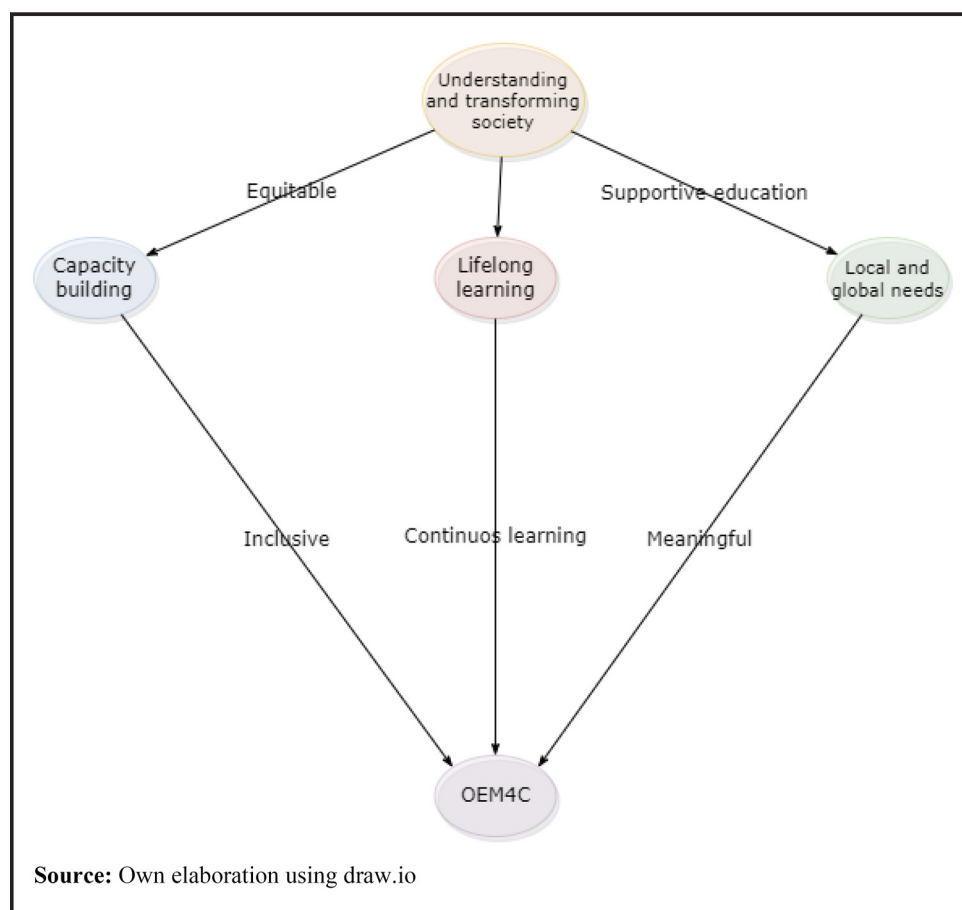
The most significant contribution of the model was its potential to understand and transform society. The elements to be considered in educational models by administrators, teachers and designers should include developing capacities, fostering lifelong learning and contributing to global and local issues.

3.4 Transformative potential of an open educational model for complex thinking

Analyzing responses to the last question regarding comments on the model turned up positive participant perceptions, highlighting its utility and relevance for improving teaching and learning. Three main findings are interrelated:

Transformation was seen as necessary to advance formative processes. There was an expressed desire to change and improve existing educational models to impact teachers and students. Participants sought to share their experiences and maximize efforts to

Figure 4 Contributions of the OEM4C for the future of education



enhance their environment with willingness and empathy. To analyze their ideas, we sought to represent their experience through metaphors that summarize their beliefs. One of the ideas expressed was “the opportunity to leave something of myself to others, and maximize what others do to improve my environment.” This idea can be transformed into the metaphor “The Gift,” where through our actions we can contribute to the well-being of others and the environment. The model was considered innovative and avant-garde, capable of transcendence into a new proposal for 21st-century educational institutions. Participants mentioned about the model: “It’s a proposal that contributes to the 21st-century school and leaves behind that of the 19th century.” Therefore, the metaphor “cutting the ties that bind” highlights the importance of transitioning toward more innovative educational practices, shedding the restrictions that limit growth potential.

Awareness and commitment highlighted the concern for social responsibility and its positive impact on students. Responses underscored the importance of raising awareness, being tolerant and inclusive and maximizing efforts to improve and contribute to general well-being. It was stated: “Inclusive, tolerant, and with the challenge of emotional competence for teachers and everyone involved,” “Big hearts” aims to embrace diversity by reflecting an approach that respects individual differences, with an open mind, and allows for resilience and empathy, where education takes on a more human and holistic vision. Additionally, there were expressions of gratitude for driving the initiative for a better world while comprehending the challenges tied to that willingness and empathy.

The impact on society was described regarding accessibility and comprehensive social improvement. Participants mentioned: “It drives us to leave a better world than the one we found,” “the key is to focus on the right places,” and “If each person’s individual world evolves, the overall world will grow.” The metaphor “From little things, big things grow” highlights how small actions can have a lasting impact on the world, with each individual effort planting the seed to grow into something transformative, provided that areas where the greatest impact can be had are identified. The comments emphasized the impact on individual development through interdisciplinarity, providing complex solutions and fostering critical thinking. The model was presented as a necessary proposal to positively impact current and future society, considering that it offers opportunities for personal and collective growth. Also, participants mentioned: “It is necessary and required that as individuals, we develop advanced capabilities for the collective improvement of society” and “it is a framework for accelerating the generation and transfer of knowledge.” In this sense, the model acts as “an engine” that represents the impulse that pushes us to progress and transform ideas and knowledge into actions that benefit society toward a brighter and more sustainable future. [Figure 5](#) shows the correlations between the responses and the metaphors.

Delving into participants’ interpretations turns up valuable elements that contribute to transforming traditional educational models. Understanding how these relationships unfold can assist administrators and decision-makers in comprehending the needs of those involved in formative processes and the contributions that the OEM4C provides as a solution to these requirements.

In [Table 1](#), the CLA and its various levels are summarized to present the main findings of the research and their relation to the analyzed model.

According to the CLA, participants highlight that the current educational model is obsolete. They consider that the OEM4C model contributes to the shift toward more innovative and profound educational models, nurturing competencies to address social issues. The need for educational transformation to understand and change society is underscored, as well as the development of skills to contribute to global and local issues.

In this sense, the model acts as “an engine,” a metaphor that represents the impulse pushing us to progress and transform ideas and knowledge into actions that benefit society toward a brighter and more sustainable future. “The gift” metaphor highlights the

Figure 5 Transformative potential of OEM4C

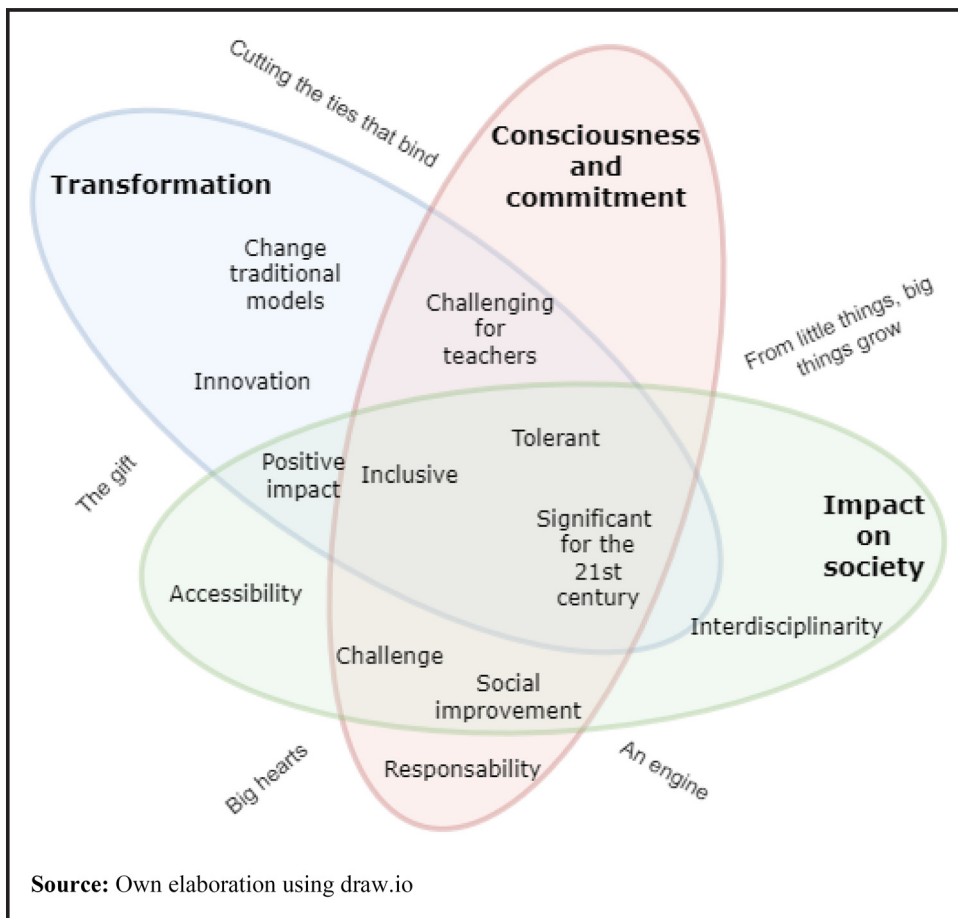


Table 1 Causal-layered analysis of OEMC

Level	Current reality	Contribution of the OEM4C	Potential for the future of education
Litany	Difficulty, complexity, elaboration and challenge	A great area to explore	Preparing people for future challenges
Systemic causes	Obsolete educational model	Change to more innovative and profound models	Cultivate competencies to address societal problems
Paradigms	Transformative capacity of education	Potential to understand and transform society	Develop capacities, lifelong learning and contributing to global and local issues
Metaphors	Cutting the ties that bind	The gift, Big hearts	The engine

Source: Authors' own work

opportunity to leave a positive impact on the environment, encouraging us to maximize the contributions of others to improve our own surroundings. “Cutting the ties that bind” urges us to break free from outdated practices, while “Big hearts” signifies the expansive capacity for empathy and inclusion. “From little things, big things grow” reflects the exponential potential inherent in small, individual changes contributing to vast societal progress.

Participants emphasized the importance of adopting a transformative educational approach focused on developing skills relevant to future challenges.

4. Discussion

Contemporary society faces emerging challenges that demand profound reflection on formative criteria for citizens in increasingly complex environments. As illustrated in [Figure 2](#), participants associated this environment with difficulty, laboriousness, elaboration and challenge. In this context, the research by [Pouru-Mikkola and Wilenius \(2021\)](#) emphasized the complexity of today's society, indicating that these dynamics challenge institutions; they urged them to reevaluate their strategies for the future. Likewise, [Karjalainen et al. \(2022\)](#) underscored the critical role of education, that they would gain significance by proposing educational programs capable of forming individuals with adaptive skills to deal with complex and uncertain environments. Understanding the characteristics of current society has implications for those developing models and educational programs to address the complexity of the environment.

Traditional educational models are no longer sufficient to address society's new challenges. [Figure 3](#) depicts obsolescence as the cause of the problems faced by educational models; it highlights the need to shift to an updated and innovative model with a teaching role that facilitates developing competencies to solve social problems. This finding aligns with international organizations' concern that the contribution of current educational systems is limited concerning the common good and a more inclusive society ([UNESCO, 2021](#)). Thus, the OEM4C proposes various components that facilitate the development of complex thinking competencies and sub-competencies through diverse strategies and guiding frameworks ([Cruz-Sandoval et al., 2023](#)). Educational institutions should consider updating their educational models with innovative and cutting-edge components that guide the development of competencies, enabling students to tackle future challenges.

Training individuals capable of understanding and positively transforming society is essential in the new educational paradigm. [Figure 4](#) illustrates the need to understand and transform society, where the construction of capacities, continuous learning and contribution to local and global needs are interconnected, beliefs influenced by the necessity of an equitable, inclusive and meaningful model. According to [Morin \(2005\)](#), reality comprises interrelated parts that make society complex and require new perspectives. Hence, innovative and disruptive educational models need to emerge that promote the formation of more critical citizens focused on seeking sustainable solutions ([Ramírez-Montoya et al., 2024](#)). Administrators, managers and educational model designers should direct their attention to the components of the OEM4C model because these are oriented toward developing competencies for societal transformation.

The OEM4C has the transformative potential to positively impact society. According to [Figure 5](#), delving into the metaphors used by participants identified three interconnected elements highlighting the relevance of OEM4C:

1. the transformation from traditional to more innovative educational models;
2. the challenge of raising awareness and commitment among teachers; and
3. positive societal impact.

The thread connecting these elements weaves others contributing to the model's fabric, such as its significance for the 21st century, interdisciplinarity, accessibility, tolerance and social improvement. Validation through the participation of external stakeholders has proven to be a valuable tool to confirm both internal and external components of educational models. This approach legitimizes these practices and plays a crucial role in continuously improving educational quality ([Kimmons and Hall, 2018](#); [Pinto-Santos et al.,](#)

2022). Understanding participants' interpretations of the educational process is beneficial for leaders and decision-makers, as it provides critical insights into the needs of these stakeholders and how the OEM4C approach can address the challenges they face.

Conclusion

This study aimed to validate an open educational model for complex thinking with various stakeholders in higher education to understand their opinions on the model's relevance and utility for the future of education. The findings, examined through the levels of the CLA methodology (litany, causes, paradigms or values and metaphors or myths), reveal a progression in participants' understanding of the model and its contributions. At the superficial level (litany), participants perceived complexity as difficult, complicated and challenging, reflecting a basic understanding of the term.

Delving into the analysis (causes) reveals that the participants recognized issues in outdated educational models and emphasized the need to shift to models that foster students' competencies. Exploring deeper into values produced a broader vision of changes connected to creating citizens capable of understanding and transforming society, emphasizing education's role. Finally, at the level of metaphors or myths, participants considered that the model under study has transformative potential and represents a new proposal for 21st-century education.

Viewing the OEM4C as an "engine" implies that education can be continuously improved and accelerated. It suggests that the model can serve as a catalyst for developing advanced skills, fostering inclusion and tolerance and focusing on areas of greatest impact. This vision aligns with the need for educational systems that are adaptable, resilient and capable of preparing students for the challenges of the future. To further develop the OEM4C, it is proposed to carry out large-scale implementations of the model. For this purpose, it is suggested to apply tools in educational settings from which information can be gathered to refine the model. Efforts will be made to document and transfer the model to institutions, social organizations, governmental bodies and companies. A study limitation is that the model was initially analyzed by presenting it to the audience, so practical testing with students and teachers is needed to understand their perspectives. For future studies, we recommend implementing the proposed model and comparing different contexts using mixed-methods research.

References

- Abdullah, N. (2023), "Learning futures studies collaboratively", *Journal of Futures Studies*, Vol. 27 No. 3, pp. 1-24, available at: <https://jfsdigital.org/articles-and-essays/2023-2/learning-futures-studies-collaboratively/>
- Alfaro-Ponce, B., Patiño, A. and Sanabria-Z, J. (2023), "Components of computational thinking in citizen science games and its contribution to reasoning for complexity through digital game-based learning: a framework proposal", *Cogent Education*, Vol. 10 No. 1, pp. 1-17, doi: [10.1080/2331186X.2023.2191751](https://doi.org/10.1080/2331186X.2023.2191751).
- Baradaran Ghahfarokhi, M., Mohaghar, A. and Saghafi, F. (2018), "The futures of the University of Tehran using causal layered analysis", *Foresight*, Vol. 20 No. 4, pp. 393-415, doi: [10.1108/FS-01-2018-0001](https://doi.org/10.1108/FS-01-2018-0001).
- Barbosa, C.E., Oliveira, Y., Coimbra, L., Salazar, H., Lyra, A., Argôlo, M., da Silva, J. and Moreira, J. (2022), "Future of work in 2050: thinking beyond the COVID-19 pandemic", *European Journal of Futures Research*, Vol. 10 No. 1, pp. 1-19, doi: [10.1186/s40309-022-00210-w](https://doi.org/10.1186/s40309-022-00210-w).
- Beara, M. and Dubovicki, S. (2023), "The Polak game and the futures of education – are university students optimists or pessimists about the future of education?", *Journal of Futures Studies*, Vol. 27 No. 4, available at: <https://jfsdigital.org/articles-and-essays/2023-2/vol-27-no-4-june-2023/the-polak-game-and-the-future-of-education-are-university-students-optimists-or-pessimists-about-the-future-of-education/>

- Benaquisto, L. and Given, L. (2008), *The SAGE Encyclopedia of Qualitative Research Methods*, Sage, New York, NY.
- Castillo-Martínez, I.M., Argüelles, A.J., Piñal, O.E., Glasserman-Morales, L.D., Ramírez-Montoya, M.S. and Carreon-Hermosillo, A. (2023), "Towards the development of complex thinking in university students: mixed methods with ideathon and artificial intelligence", *Computers and Education: Artificial Intelligence*, Vol. 5, pp. 1-16, doi: [10.1016/j.caeai.2023.100186](https://doi.org/10.1016/j.caeai.2023.100186).
- Cruz-Sandoval, M.A., Vazquez-Parra, J.C., Carlos-Arroyo, M. and Medina-Vidal, A. (2023), "Competency-based learning: an approach integrating the domains of complex thinking competency in a group of Mexican students", *European Journal of Contemporary Education*, Vol. 12 No. 2, pp. 399-412, doi: [10.13187/ejced.2023.2.399](https://doi.org/10.13187/ejced.2023.2.399).
- Escudero-Nahón, A. and Ramírez-Montoya, M.S. (2021), "El modelo y sus marcos", Vicario-Solórzano, V. (Ed.), *Modelo de Continuidad de Servicios Educativos Ante un Contexto de Emergencia y Sus Etapas de Crisis*, CUDI- ANUIES, Mexico, pp. 19-29.
- Facoetti, V., Galluzo, L. and Borin, A. (2023), "Design approaches in schools. Future design tools and processes for innovative and sustainable educational experiences", *Journal of Futures Studies*, pp. 1-15.
- Fleener, M. (2022), "Blockchain technologies: a study of the future of education", *Journal of Higher Education Theory and Practice*, Vol. 22 No. 1, pp. 26-45, doi: [10.33423/jhetp.v22i1.4956](https://doi.org/10.33423/jhetp.v22i1.4956).
- Foster, N. and Piacentini, M. (2023), *Innovating Assessments to Measure and Support Complex Skills*, OECD Publishing, Paris.
- García Cordero, M. and Buitrago López, Y. (2023), "Teaching and learning graphic design from the paradigm of complexity", *Interdisciplinaria*, Vol. 40 No. 1, pp. 301-317, doi: [10.16889/interd.2023.40.1.18](https://doi.org/10.16889/interd.2023.40.1.18).
- George-Reyes, C.E. (2023), "Imbricación del pensamiento computacional y la alfabetización digital en la educación. Modelación a partir de una revisión sistemática de la literatura", *Revista Española de Documentación Científica*, Vol. 46 No. 1, pp. 1-13, doi: [10.3989/redc.2023.1.1922](https://doi.org/10.3989/redc.2023.1.1922).
- González-Pérez, L.I., Ramírez-Montoya, M.S. and Enciso-Gonzalez, J.A. (2023), "Education 4.0 maturity models for society 5.0: systematic literature review", *Cogent Business & Management*, Vol. 10 No. 3, pp. 1-27, doi: [10.1080/23311975.2023.2256095](https://doi.org/10.1080/23311975.2023.2256095).
- Häggström, M. and Schmidt, C. (2021), "Futures literacy – to belong, participate and act!: An educational perspective", *Futures*, Vol. 132, pp. 1-9, doi: [10.1016/j.futures.2021.102813](https://doi.org/10.1016/j.futures.2021.102813).
- Horiashchenko, Y. (2022), "Analysis of the level of innovative development and susceptibility of enterprises to innovation based on an expert survey", *Economic Innovations*, Vol. 24 No. 1, pp. 64-73, doi: [10.31520/ei.2022.24.1\(82\).64-73](https://doi.org/10.31520/ei.2022.24.1(82).64-73).
- Inayatullah, S. (2004), "Causal layered analysis: Theory, historical context, and case studies", in Inayatullah, S. (Ed.), *The Causal Layered Analysis (CLA) Reader: Theory and Case Studies of an Integrative and Transformative Methodology*, Tamkang University Press, Taiwan, pp. 1-52.
- Inayatullah, S. (2009), "Causal layered analysis: an integrative and transformative theory and method", in Glenn, J. and Gordon, T. (Eds), *Futures Research Methodology, Version 3.0*, The Millennium Project, Washington, DC, pp. 1-52.
- Inayatullah, S. and Milojević, I. (2015), *CLA 2.0: Transformative Research in Theory and Practice*, Tamkang University Publications, Tamsui.
- Karashash, Z., Zhumabayeva, A., Arenova, A., Ospanbekova, M., Zhanazarova, Z. and Zhankushkov, B. (2022), "Developing metacompetence in future primary school teachers", *Cypriot Journal of Educational Sciences*, Vol. 17 No. 1, pp. 284-95, doi: [10.18844/cjes.v17i1.6709](https://doi.org/10.18844/cjes.v17i1.6709).
- Karjalainen, J., Mwagiru, N., Salminen, H. and Heinonen, S. (2022), "Integrating crisis learning into futures literacy – exploring the 'new normal' and imagining post-pandemic futures", *On the Horizon: The International Journal of Learning Futures*, Vol. 30 No. 2, pp. 47-56, doi: [10.1108/OTH-10-2021-0117](https://doi.org/10.1108/OTH-10-2021-0117).
- Kimmons, R. and Hall, C. (2018), "How useful are our models? Pre-service and practicing teacher evaluations of technology integration models", *TechTrends*, Vol. 62 No. 1, pp. 29-36, doi: [10.1007/s11528-017-0227-8](https://doi.org/10.1007/s11528-017-0227-8).
- Koivunen, T., Konst, T. and Friman, M. (2023), "Building a sustainable future: ideas and perceptions of university staff", *Foresight*, doi: [10.1108/FS-12-2022-0170](https://doi.org/10.1108/FS-12-2022-0170).

- Kuykendall, K. (2022), "New report from global google research project considers the 'future of education'", available at: <https://thejournal.com/articles/2022/11/29/new-report-from-global-google-research-project-considers-the-future-of-education.aspx> (accessed 17 December 2023).
- Lopez-Caudana, E., Ramirez-Montoya, M., Martínez-Pérez, S. and Rodríguez-Abitia, G. (2020), "Using robotics to enhance active learning in mathematics: a multi-scenario study", *Mathematics*, Vol. 8 No. 12, pp. 1-21, doi: [10.3390/math8122163](https://doi.org/10.3390/math8122163).
- Moravec, J. and Martínez-Bravo, M.C. (2023), "Global trends in disruptive technological change: social and policy implications for education", *On the Horizon: The International Journal of Learning Futures*, Vol. 31 Nos 3/4, pp. 147-173.
- Morin, E. (2005), *Introducción al Pensamiento Complejo*, Gedisa, Barcelona.
- Obreli-Neto, P.R., Guidoni, C.M., Baldoni, A. D O., Marusic, S., Castedalli, G., Lahoud, Y.M., Soares, C.F. and Pereira, L.R. (2016), "Evaluation of the effectiveness of an internet-based continuing education program on pharmacy-based minor ailment management: a randomized controlled clinical trial", *Brazilian Journal of Pharmaceutical Sciences*, Vol. 52 No. 1, pp. 15-26, doi: [10.1590/S1984-82502016000100003](https://doi.org/10.1590/S1984-82502016000100003).
- Ozcinar, Z., Sakhieva, R., Pozharskaya, E., Popova, O., Melnik, M. and Matvienko, V. (2020), "Student's perception of web 2.0 tools and educational applications", *International Journal of Emerging Technologies in Learning (iJET)*, Vol. 15 No. 23, pp. 220-233, doi: www.learntechlib.org/p/218454/.
- Patiño, A., Ramírez-Montoya, M.S. and Buenestado-Fernández, M. (2023), "Active learning and education 4.0 for complex thinking training: analysis of two case studies in open education", *Smart Learning Environments*, Vol. 10 No. 1, pp. 1-8, doi: [10.1186/s40561-023-00229-x](https://doi.org/10.1186/s40561-023-00229-x).
- Pinto-Santos, A., Pérez-Garcias, A. and Darder-Mesquida, A. (2022), "Formulation and validation of a technologically empowered and pedagogical model to promote digital teaching competency", *Formación Universitaria*, Vol. 15 No. 1, pp. 183-196, doi: [10.4067/S0718-50062022000100183](https://doi.org/10.4067/S0718-50062022000100183).
- Portuguez Castro, M. and Gómez Zermelo, M.G. (2021), "Identifying entrepreneurial interest and skills among university students", *Sustainability*, Vol. 13 No. 13, pp. 1-15, doi: [10.3390/su13136995](https://doi.org/10.3390/su13136995).
- Pouru-Mikkola, L. and Wilenius, M. (2021), "Building individual futures capacity through transformative futures learning", *Futures*, Vol. 132, pp. 1-13, doi: [10.1016/j.futures.2021.102804](https://doi.org/10.1016/j.futures.2021.102804).
- Ramírez-Montoya, M.S., Rodríguez-Abitia, G., Hernández-Montoya, D., López-Caudana, E.O. and González-González, C. (2023), "Editorial: open education for sustainable development: contributions from emerging technologies and educational innovation", *Frontiers in Education*, Vol. 8, pp. 1-5, doi: [10.3389/educ.2023.1131022](https://doi.org/10.3389/educ.2023.1131022).
- Ramírez-Montoya, M.S., Quintero Gámez, L., Sanabria-Z, J. and Portuguez-Castro, M. (2024a), "Exploring complex thinking in latin American universities: comparative analysis between programs and alternative credentials", *Journal of Latinos and Education*, Vol. Ahead of Print, doi: [10.1080/15348431.2024.2329671](https://doi.org/10.1080/15348431.2024.2329671).
- Ramírez-Montoya, M.S., Basabe, E., Carlos Arroyo, M., Patiño Zúñiga, I.A. and Portuguez-Castro, M. (2024b), *Modelo Educativo Abierto De Pensamiento Complejo: Horizontes en El Futuro de la Educación*, Octaedro, Barcelona.
- Schulz, F.E., Freire, L.H. and da Cunha, J. (2023), "The 7 complex lessons from Edgar Morin applied in fashion design education for sustainability", in Raposo, D., Neves, J., Silva, R., Correia Castilho, L. and Dias, R. (Eds), *Advances in Design, Music and Arts II. EIMAD 2022. Springer Series in Design and Innovation*, Vol 25 Springer, Cham, pp. 193-208, doi: [10.1007/978-3-031-09659-4_15](https://doi.org/10.1007/978-3-031-09659-4_15).
- Silva Pacheco, C. and Iturra Herrera, C. (2021), "A conceptual proposal and operational definitions of the cognitive processes of complex thinking", *Thinking Skills and Creativity*, Vol. 39, pp. 1-19, doi: [10.1016/j.tsc.2021.100794](https://doi.org/10.1016/j.tsc.2021.100794).
- Suárez-Brito, P., Baena-Rojas, J.J., Lopez-Caudana, E.O. and Glasserman-Morales, L.D. (2022), "Academic literacy as a component of complex thinking in higher education: a scoping review", *European Journal of Contemporary Education*, Vol. 11 No. 3, pp. 931-945, doi: [10.13187/ejced.2022.3.931](https://doi.org/10.13187/ejced.2022.3.931).
- Tsekhmister, Y., Stetsenko, N., Volyk, O., Gumennykova, T. and Sharov, O. (2023), "Forecast of educational trends in the role of 'soft skills' for the professional development of future specialists in the conditions of distance learning: the challenges of our time", *Journal of Higher Education Theory and Practice*, Vol. 23 No. 10, pp. 212-219, doi: [10.33423/jhetp.v23i10.6195](https://doi.org/10.33423/jhetp.v23i10.6195).
- UNESCO (2021), "Futures of education. Learning to become," available at: <https://unesdoc.unesco.org/ark:/48223/pf0000375746> (accessed 14 December 2023).

Vázquez-Parra, J.C., Alfaro-Ponce, B., Guerrero-Escamilla, J.B. and Morales-Maure, L. (2023), "Cultural imaginaries and complex thinking: impact of cultural education on the development of perceived achievement of complex thinking in undergraduates", *Social Sciences*, Vol. 12 No. 5, pp. 1-12, doi: [10.3390/socsci12050272](https://doi.org/10.3390/socsci12050272).

Wintersteiner, W. (2023), *Conceptualising Change in the World System*, Routledge EBooks, doi: [10.4324/9781003340522-5](https://doi.org/10.4324/9781003340522-5).

Further reading

Morales Menéndez, R., Molina, J.M., González Mendoza, M., Alonso Galicia, P.E., Vázquez Parra, J.C., López Caudana, E.O., Ponce Cruz, P., Burgos Aguilar, J.V., Suárez Brito, P., Lindín Soriano, C. and Hernández Gress, N. (2022), "R4C (research for complexity) escalando el razonamiento complejo Para todos", paper presented at 52 Congreso de Investigación y Desarrollo, Tecnológico de Monterrey, México, available at: <https://repositorio.tec.mx/handle/11285/645228> (accessed 14 December 2023).

Tecnológico de Monterrey (2019), "Razonamiento Para la complejidad", In *Competencias Transversales. Una Visión Desde el Modelo Educativo TEC21. Documento Guía Para el Docente de Educación Superior*, Tecnológico de Monterrey, Monterrey.

Tecnológico de Monterrey (2023), "Proyecto OEM4C modelo educativo abierto Para el pensamiento complejo", available at: www.research4challenges.world/complex-thinking (accessed 14 December 2023).

Author affiliations

María-Soledad Ramírez-Montoya is based at the EGADE Business School, Tecnológico de Monterrey, Monterrey, Mexico and Future of Education, Tecnológico de Monterrey, Monterrey, Mexico.

May Portuguese Castro is based at the Departamento Académico de Posgrado en Negocios, CENTRUM Católica Graduate Business School, Lima, Peru and Departamento Académico de Posgrado en Negocios, Pontificia Universidad Católica del Perú, Lima, Peru.

About the authors

María-Soledad Ramírez-Montoya is a Research Professor at the EGADE Business School and the Institute for the Future of Education, Tecnológico de Monterrey (Mexico). She coordinates the Interdisciplinary Research Group Escalando el Razonamiento para la Complejidad para la Complejidad para todos, as well as the Research Unit Tecnología Educativa. She designs training systems supported by Open Science and Technology 4.0 strategies, linked to projects that apply the quadruple helix (university-industry-government-civil sector) and solutions for sustainable development. As Coordinator of the UNESCO and ICDE Chairs, "Open Education Movement for Latin America", she mobilizes, through networks, training, production and research initiatives for open education.

May Portuguese-Castro is a Doctor in Educational Innovation from the Tecnológico de Monterrey. She is Professor Researcher at the Direction of Graduate Studies in Business and Chief of Innovation and Academic Quality Assessment at CENTRUM Graduate Business School at Pontificia Universidad Católica del Perú. She is also a member of the Center for Entrepreneurial Studies at Centrum PUCP and of the Educational Innovation and Research Group at the Tecnológico de Monterrey Researcher Level 1 for the National System of Researchers in Mexico and Researcher RENACYT Level III, Concytec, Perú. She focuses her activities on researching educational innovation initiatives to continuously improve educational processes in different areas of knowledge. May Portuguese-Castro is the corresponding author and can be contacted at: may.portuguez@pucp.edu.pe

For instructions on how to order reprints of this article, please visit our website: www.emeraldgroupublishing.com/licensing/reprints.htm
Or contact us for further details: permissions@emeraldinsight.com