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RECEIVED 28 January 2024

ACCEPTED 19 April 2024

PUBLISHED 10 May 2024

CITATION

Leiva-Lugo L, Álvarez-Icaza I,
López-Hernández FJ and Miranda J (2024)
Entrepreneurial thinking and Education 4.0 in
communities with development gaps: an
approach through the Sustainable
Development Goals.
Front. Educ. 9:1377709.
doi: 10.3389/feduc.2024.1377709

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Entrepreneurial thinking and Education 4.0 in communities with development gaps: an approach through the Sustainable Development Goals

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Entrepreneurial thinking is considered a desirable competency in the profile of today's professionals because it includes sub-competencies that strengthen individuals' leadership capacity and stimulate the development of creative solutions that present a high impact on society. However, it has been detected that disadvantaged communities located in areas with underdeveloped conditions and rural areas present a significant disparity in access to training models, current infrastructure, and activities that promote entrepreneurship compared to developed communities frequently found in large cities. Through a comparative analysis with quantitative methods, we seek to argue the need that these types of communities have. In addition, the design of a training model based on the design framework for Education 4.0 is presented; this training model seeks to train in the sub-competences of entrepreneurial thinking using the "push and pull" technique with the Sustainable Development Goals (SDGs) as its central axis. This seeks to close the existing gap, provide affordable resources to these types of disadvantaged communities, and, at the same time, promote local solutions through the SDGs. The study is conducted in the eastern region of Michoacán, Mexico, and will present the preliminary results.

KEYWORDS

entrepreneurial thinking, Education 4.0, Sustainable Development Goals, higher education, educational innovation

1 Introduction

By nature, human beings tend to solve problems, and the true essence of an entrepreneur is not to make money but to solve problems since problems and the search for solutions drive the human spirit (López Argueta, 2020). Currently, there is a great need to provide solutions to the global challenges and problems that we have as a society, and to do so; it is necessary to train future professionals in desirable 21st century competencies that allow them to provide the solutions that society currently demands. In today's world, around 71% of the world's population resides in countries where inequality is increasing (CEPAL, 2022). This is particularly evident in Latin America, where there are marked disparities in income, assets, and opportunities between men and women and in access to public goods and services. This

division is even more pronounced in rural communities, indigenous communities, marginalized urban areas, and communities with high rates of violence. These disadvantaged groups are often underrepresented, understudied, and underserved and face significant gaps in access to justice and resources (CEPAL, 2020). Therefore, it is considered necessary to intervene in these communities, propose initiatives and policies that address these inequalities, and provide opportunities to these communities. In this work, we seek to provide a training program addressing the competency of “entrepreneurial thinking,” which allows future professionals to have desirable competencies in the profile of the current professional and to find areas of opportunity to solve problems. We have contemporary challenges and difficulties as a society and have competencies and skills that allow them to be competitive in their professional lives.

The competency of “entrepreneurial thinking” is not exclusive to entrepreneurs but can also be used by any individual in any productive area. This is because entrepreneurial thinking comprises sub-competencies that allow it to detect areas of opportunity where a creative solution can be provided. By developing the competencies that shape entrepreneurial thinking, individuals can strengthen their leadership capacity, adapt to change, work effectively as a team, and propose solutions to complex problems. For example, large companies such as IBM encourage “entrepreneurial thinking” among their workers to devise solutions that respond to market needs (Alsafadi and Aljuhmani, 2023).

Given the vital role of the education sector in training professionals and providing lifelong learning opportunities, there is growing recognition of its relevance in teaching entrepreneurship. Higher education institutions, equipped with favorable conditions and support systems, not only offer development prospects but also serve as an appropriate space to cultivate “entrepreneurial thinking” in future professionals. In essence, the education sector emerges as a key actor in transferring knowledge and providing people with the tools to actively contribute to regional economic growth through entrepreneurial projects (Carpenter and Wilson, 2022). Promoting entrepreneurship from the educational sector helps close current gaps and establish a framework for continuous learning opportunities vital for communities in underdeveloped regions.

Raise job competitiveness and “entrepreneurial thinking” through the formation and training of key competencies desirable in the profile of the current professional so that they influence the generation of employment and the emergence of new products, services, and business models. Given the lack of cutting-edge and affordable training models within higher education to promote “entrepreneurial thinking” and strengthen the entrepreneurship ecosystem in the eastern region of Michoacán, this work proposes an alternative solution. This initiative aims to close the existing educational gap and design and evaluate a training model focusing on Education 4.0 to strengthen entrepreneurship from higher education and scale the competencies of “entrepreneurial thinking” in students and lifelong learners.

2 Entrepreneurial thinking for the solution to big problems

Entrepreneurial thinking is considered a critical competency to solve problems in the field of entrepreneurship and business (Peschl

et al., 2023). This has allowed entrepreneurs to achieve great economic impacts, and also provide creative and innovative solutions that are desirable for society. Additionally, entrepreneurial thinking will enable individuals to address and analyze problems, whether simple or complex, from an analytical, systemic, and methodical perspective. This allows individuals to understand and identify problems from the root, generating a better panorama in the design of projects, solutions, and decision-making throughout the design and development process (Valliere, 2023).

There is still no consensus on the precise definition of entrepreneurial thinking (Daspit et al., 2023). However, according to different authors, entrepreneurial thinking can generally be defined as “the mentality and cognitive orientation that entrepreneurs have.” This implies their ability to analyze problems, propose solutions, and implement them (Valliere, 2023). Furthermore, entrepreneurial thinking implies a high sense of responsibility at a personal and collaborative level. In this context, it is essential to understand that an individual with the competencies to understand entrepreneurship has desirable competencies that allow them to have a comprehensive vision and the ability to act on challenges in different areas of knowledge and professionals. In this sense, entrepreneurial thinking requires training key disciplinary (hard) and transversal (soft) competencies (see Figure 1).

In entrepreneurship, disciplinary competencies refer to knowledge and technical competencies that belong to the field of pure entrepreneurship and that are necessary to carry out very specific activities that involve using technical elements such as equipment, data, software, methodologies, and tools. The disciplinary competencies referred to in this work are described below.

- *Global vision.* This competence allows individuals to have the ability to have a broad and global perspective on problems. In this way, scenarios can be analyzed holistically to understand problems and opportunities and be able to react with better decisions.
- *Persuasive communication.* Persuasive communication is the process by which an individual transmits verbal stimuli to modify the behavior of other individuals, the audience, to direct them toward a particular purpose.
- *Adaptation to change.* Adaptation to change is necessary because entrepreneurs face dynamic and constantly evolving environments. Adaptation to change is essential because change is continuous and uncertain and because intentional transformation takes time and sustained commitment. Therefore, developing this competence allows entrepreneurs to provide responses and processes to change and identify possible assumed risks.
- *Planification and organization.* Planning and organization are essential for the success of an enterprise. Planning involves setting goals and determining the best way to achieve them, while organizing refers to allocating resources and managing tasks to accomplish those goals.
- *Use of technologies.* Technology can be an ally to reduce costs, improve productivity, and develop innovative processes that optimize the enterprise's resources.
- *Leadership.* This competence allows the entrepreneur to motivate and direct his team, foster a positive work environment, and guide the enterprise toward achieving its objectives.

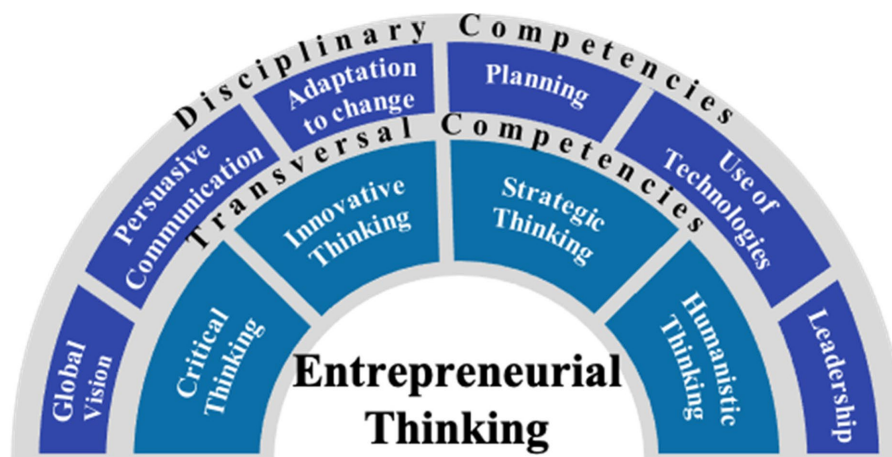


FIGURE 1
Disciplinary and transversal competencies as sub competencies of entrepreneurial thinking.

On the other hand, transversal competencies are related to the interpersonal and emotional competencies necessary to be successful in entrepreneurial projects and are generally associated with the following competencies (Peschl et al., 2021).

- *Critical thinking.* It is a competence that involves an intellectual and systematic process that mobilizes various mental actions, such as questioning, analysis, interpretation, synthesis, evaluation, and the issuance of reasoned judgments.
- *Innovative thinking.* It is the competence that allows individuals to generate new concepts and exercise the ability to make creative decisions. It involves the ability of divergent thinking to achieve objectives and develop original responses to problematic scenarios by implementing unconventional methods with the tools or context provided.
- *Strategic thinking.* This competence refers to the ability to optimally manage available resources to achieve objectives and solve specific problems. It involves anticipation, long-term planning, informed decision-making, and the efficient optimization of resources. Individuals with this competency stand out for their ability to articulate strategies that address immediate challenges and contribute to sustainable success over time.
- *Humanistic thinking.* This competence is related to the ability of individuals to conceive an objective that considers the principles of humanity, dignity, freedom, equality, equity, reciprocity, and respect for diversity.

3 Education 4.0 as an enabler for the training of 21st century competencies

The educational sector has experienced a significant evolution in its knowledge generation and transfer processes, taking advantage of the characteristic technologies of the 4th Industrial Revolution (Industry 4.0), including connectivity, datafication, digitalization, virtualization, and smartification. The combination of these

technologies with active learning methods and professional instruction to train desirable competencies in the profile of the 21st-century professional is today known as Education 4.0. Also, the term Education 4.0 can refer to forming basic competencies in engineering education for Industry 4.0 (Das et al., 2020). According to the World Economic Forum, Education 4.0 is characterized by critical changes in learning content, the development of essential competencies and skills, and experiences to redefine quality learning in the new economy (World Economic Forum, 2020). Furthermore, Education 4.0 includes the promotion of self-learning (heutagogy), collaboration (peeragogy), and the prominent use of ICTs (cybergogy) (Miranda et al., 2021). This study uses as a reference the following concept of Education 4.0 applied to higher education: “Education 4.0 is the period in which the educational sector takes advantage of emerging ICTs to improve pedagogical processes that are complemented with new learning methods and didactic tools and management. As well as the intelligent and sustainable infrastructure used during current teaching-learning processes to train and develop key competencies in today’s students” (Miranda et al., 2021).

In the design and implementation of current teaching-learning systems in the context of Education 4.0, six key components are considered, from which enablers emerge that allow us to carry out new products, processes, and infrastructure for Education 4.0. Figure 2 summarizes the key components and enablers of Education 4.0 considered in this work.

- *Active Learning.* Apply active teaching-learning methods and adaptive approaches with various modalities, such as problem-based learning, project-based learning, experiential learning, gamification, and learning-by-doing.
- *Delivery format.* Knowledge transfer encompasses various delivery formats adaptive to contemporary needs and includes remote, hybrid, and face-to-face modalities.
- *Technologies 4.0.* Use Technologies 4.0, which involve connectivity, datafication, digitalization, smartification, and virtualization.
- *Infrastructure.* Implement innovative infrastructure, including services, facilities, devices, and physical-virtual environments to

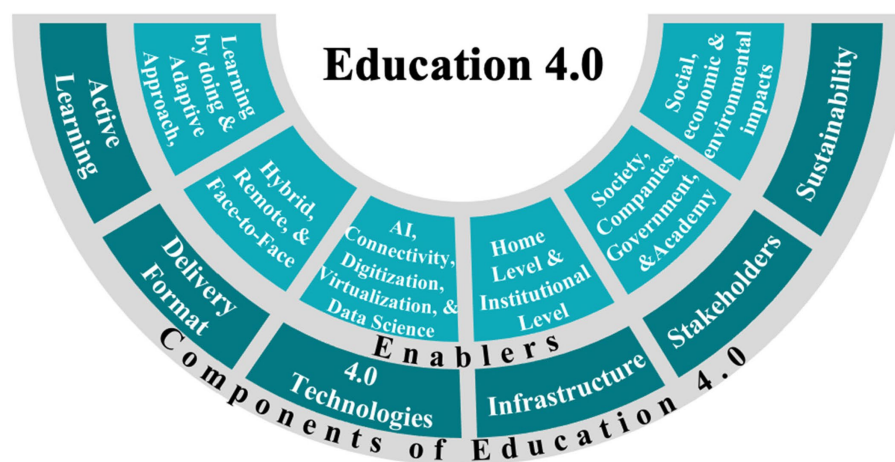


FIGURE 2
Components and enablers of Education 4.0.

improve teaching-learning processes. Currently, the infrastructure includes the classroom-home level and the institutional level.

- *Stakeholders*. Involve relevant stakeholders, such as internal actors (teachers, students, staff) and external actors (government, industry, society, and other universities) in the teaching process.
- *Sustainability*. Consider sustainable impacts within teaching-learning processes, aligning with the UN Sustainable Development Goals (SDGs) to create positive social, economic, and environmental effects.

4 Research design

The research that has been implemented in this study has a quantitative approach through a process of data collection and analysis to identify patterns, relationships, and trends of interest. This study was adapted to the context of the state of Michoacán in Mexico due to its characteristics with disadvantaged communities considered underdeveloped. According to the National Council for the Evaluation of Social Development Policy (CONEVAL), in 2020, 46% of the population of Michoacán was in poverty (Consejo Nacional de Evaluación de la Política de Desarrollo Social, 2020). Extreme poverty affects 6.1%, and moderate poverty affects 40% of the Michoacan population, of which 24.2% are educationally backward (Consejo Estatal de Población, 2020). For this study, only the eastern region of the state was selected, which has high poverty rates and rural populations where economic activity depends largely on commerce, agriculture, and livestock. Historically, these types of communities face unique economic and social challenges, such as lack of access to basic services and lack of opportunities for economic and professional development. The eastern region of Michoacán comprises 11 municipalities, has 632,511 inhabitants, and only 7.88% of the population with higher education (Instituto de Planeación del Estado de Michoacán de Ocampo, 2021).

In that sense, because of this type of localities, they do not have sufficient infrastructure and resources considered desirable in the

academy's entrepreneurship ecosystems. Consequently, it has limited access to services, dynamics, and technologies and stands out in a relevant way. The lack of human resources with a high level of knowledge and experiences on the subject allows them to advance in the generation and transfer of knowledge at the local level in the population.

The development of our hypotheses is based on a review of the literature that highlights a significant disparity in access to and quality of entrepreneurial and technological education in communities with development gaps (Lyons et al., 2018; Rodríguez-Abitia et al., 2020; Miranda et al., 2023). Previous studies have demonstrated the potential of innovative educational models, such as Education 4.0, to close these gaps (da Motta Reis et al., 2020; Qureshi et al., 2020; Costan et al., 2021). Furthermore, the literature suggests that promoting entrepreneurial thinking, when integrated with advanced educational approaches, can enhance the resolution of local problems and economic development (Lynch et al., 2021; Peschl et al., 2021; Khaydarov and Mukhtorov, 2023). Based on this evidence, we have formulated the following hypotheses to explore the application of an Education 4.0 model in communities with development gaps in the eastern region of Michoacán. This work seeks to validate the following hypotheses to determine the feasibility of implementing a training model at the higher educational level.

H1: The implementation of a training model based on Education 4.0, specifically designed with affordable resources, will result in a significant increase in the adoption of this model by higher education institutions in the eastern region of Michoacán, measured through a viability assessment.

H2: Focusing on entrepreneurial thinking within the framework of Education 4.0 will lead to a measurable increase in the development of key 21st-century skills among students in the eastern region of Michoacán, as well as to a tangible improvement in innovation within the local productive sector.

H3: The use of design methodologies centered on the Sustainable Development Goals (SDGs) as part of the Education

4.0 curriculum will encourage the generation and implementation of new products and services in the eastern region of Michoacán, evidenced by an increase in entrepreneurial initiatives that address these SDGs.

Given that it is intended to implement a training model at the higher educational level in the eastern region of Michoacán, it is necessary to identify what type of model will be most appropriate to design to ensure its adoption and sustainability over time. For this, it is necessary to know the current needs of interested parties and implement a need-and-demand validation process. Also, it is necessary to recognize design paths, requirements, and technical requirements to meet the desirable characteristics of instructional design and delivery format so that its access is affordable and its implementation is viable.

The entrepreneurship training model obtained is intended to be implemented in a population of higher education students, therefore, it is necessary to study interested parties; this specific study is limited to studying potential users. For this, students in their last semester of high school education were analyzed. Also, it is necessary to identify the current need and demand that exists in the institution where the study will be carried out, and for this purpose, also higher education students at a public university in the eastern region of Michoacán were analyzed.

For this analysis, the participation of high school students who are close to graduating and who intend to continue their studies at the higher educational level was required. The study used stratified random sampling to guarantee the representativeness of the sample considering public and private institutions. This methodology is considered appropriate due to the specific composition of the higher secondary educational institutions that exist in the region, where it is estimated that around 70% are public educational institutions and the remaining 30% are private institutions. Despite this discrepancy in distribution, a significant number of 21% of students from private institutions in the study sample were recruited for the high school level. This analysis allowed for a deeper exploration of the perspectives and experiences of this minority group, which is essential to understanding their perception of the issues in a context where private schools are less common.

It is expected that the results of this survey will provide valuable information for the decision-making process within the design process of the training program and thus have a greater understanding of the perception of high school students in relation to issues related to entrepreneurship, their level of familiarity with experiences associated with the development of new products and services, and their activities that promote the training of entrepreneurial thinking competencies. When analyzing the data collected, these are compared with the data obtained among students from public and private schools regarding their attitudes, knowledge, and needs related to entrepreneurship. Additionally, gender patterns will be examined to understand how perspectives vary by gender. These results are valuable to verify the current need and demand, as well as to obtain information for the ideation and design of the expected training program.

A total of 123 high school students participated by answering the measurement instrument enabled for this segment of the population, and where 79% are students from public institutions and 21% from private institutions; despite the low presence of these latest in the

region, the sample is considered representative in the specific context of this study (see Table 1).

This study also integrated the participation of higher education students. Table 2 shows a summary of the data from the sample obtained, highlighting the type of participant according to their gender and the educational level they attend. In the case of higher education students, a total of 136 students participated by answering the measurement instrument.

Two instruments were used for data collection, one specific for high school students, called instrument A, and another for higher education students, called instrument B. Both instruments consist of 11 questions that allow identifying the perceptions and level of familiarity with entrepreneurship topics, previous experiences, and trends on how they perceive the need to have more options to train competencies around entrepreneurship. The questions are structured to collect quantitative data and are designed to provide three types of responses, (i) closed-ended single-choice responses, (ii) closed-ended responses with a frequency scale, and (iii) closed-ended responses with a Likert scale.

In the design of the present instruments, special attention was devoted to developing a survey instrument that accurately reflected the research objectives. The selection of questions for the surveys aimed at high school and higher education levels was based on a rigorous process in order to capture the complex dimensions of entrepreneurship in education.

The instrument's validity was underpinned by a theoretical framework, derived from a review of the literature on measuring entrepreneurship intention, as well as studies exploring the significance of entrepreneurship within educational contexts, spanning both secondary and higher education sectors (Duval-Couetil et al., 2011; Mets et al., 2017; Martínez-Gregorio and Oliver, 2022). In our study, items were adapted to address pertinent constructs in the entrepreneurship domain, drawing upon items that have received prior validation, thereby ensuring the instrument's content validity. Furthermore, the engagement of domain experts during the instrument's design and adaptation phases played a pivotal role in validating the relevance and comprehensiveness of the selected items, thereby strengthening the construct validity of the instrument.

The selection of questions was intentionally aligned with the fundamental aspects of entrepreneurial education, such as behaviors, attitudes, knowledge, and self-efficacy. Valliere (2017) advocates for a

TABLE 1 Participant data by type of institution at the upper secondary educational level.

Public		Private		Total	
n	%	n	%	n	%
96	79	26	21	123	100

TABLE 2 Participant data by educational level and gender.

Educational level	Man		Woman		Total	
	n	%	n	%	n	%
Upper secondary education	69	56	54	44	123	100
Higher education	55	41	80	59	136	100

multidimensional approach to measuring entrepreneurial intent, emphasizing the critical roles of knowledge, attitude, and behavior. Similarly, Asghar et al. (2019) developed an entrepreneurial intentions questionnaire aimed at evaluating the effectiveness of entrepreneurship education on students' entrepreneurial intentions. Their study acknowledges that entrepreneurship education, grounded in enhancing business-related knowledge, skill development for business initiation, and fostering a positive attitude toward self-employment, has a direct impact on students' decisions to pursue entrepreneurship. Thus, the incorporation of a validated questionnaire aligns with the study's aim to comprehensively assess the influence of entrepreneurship education on shaping entrepreneurial intent.

Finally, self-efficacy also was considered crucial as it encompasses student perceptions of their entrepreneurial knowledge and self-efficacy. This enables an understanding of how students perceive their own abilities to embark on entrepreneurial ventures or identify the barriers they perceive during their learning process (Liñán, 2005; Duval-Couetil et al., 2011).

Although the nature of the aggregated items in the instruments (A and B) presented limitations for the direct evaluation of reliability using conventional statistical techniques, such as Cronbach's Alpha coefficient, the coherence and thematic consistency of the items point toward the instrument's high reliability. The items were carefully selected and adapted to be consistent with each other, thus increasing the reliability of the measures obtained through the survey.

5 Results

The application of instrument A was carried out between July and August 2023 with the participation of 123 high school students, which was carried out within the framework of preparation courses for admission to the higher education institute where it is intended to be implemented the training program that results from this work. The survey was voluntary and no sensitive data was requested to ensure the confidentiality of the participants. The implementation was self-managed by each of the participants and the questionnaire access format was through an online form.

The results from instrument A are shown below. The questions with simple choice answers are intended to provide information that allows us to know the familiarity that the participants have with entrepreneurship and the concepts that are considered relevant in relation to the approach that is intended to be designed. The results show that around 82% of participants are familiar with the concept of entrepreneurship, however, it is striking that a significant percentage (17%) is not sure if they understand the concept. Despite the high percentage of participants who are familiar with the concept of

entrepreneurship, around 85% of the participants have not developed projects related to entrepreneurship or are not sure they have done so. Table 3 shows details about the answers obtained in this first group of questions of instrument A.

The second set of closed-ended questions in Instrument A uses choice responses with a frequency scale. These questions help us understand and confirm the trend in terms of how familiar the participants are with the concept of entrepreneurship and how often they participate in entrepreneurship activities during their high school studies. The results obtained according to items 4 and 5 allow us to observe a tendency toward responses that indicate infrequency. On the other hand, when the participants were asked if they would like the development of new products and services for entrepreneurship to be promoted during their university studies, the responses were mostly concentrated in high-frequency responses. Table 4 details the answers obtained in this second group of questions of instrument A.

The third set, made up of two items (7 and 8) are closed questions in instrument A, and uses choice responses with a Likert scale. These questions help us understand the participants' perception of the relevance that they consider entrepreneurship to be within their professional training and the impact that entrepreneurship can have on their professional lives. The results allow us to observe a trend toward responses that indicate responses that show acceptance of the relevance of the proposed topic. Table 5 details the answers obtained in this third group of questions.

The application of instrument B was carried out at the beginning of the August–December 2023 semester with the participation of 136 students of a higher educational level, including students in the 5th and 7th semesters of the industrial engineering career at the Tecnológico Nacional de México, Zitácuaro Campus in Michoacán, Mexico.

The results from instrument B are shown below. The first group of questions with simple choice answers measures the level of familiarity that participants have with the concepts related to entrepreneurship. The results generally show that the participants are familiar with the concept of entrepreneurship; however, as in instrument A, more than 50% do not know or are not sure they know a methodology for designing new products, which it is considered a relevant finding due to the relationship that exists between entrepreneurship and the emergence of new products. Table 6 shows details about the answers obtained in this first group of questions of instrument B.

The second set of closed questions in instrument B uses choice responses that allow us to visualize trends in the frequency with which students participate in entrepreneurship-related activities. The results obtained allow us to observe a trend toward responses that indicate infrequency. On the other hand, when asking participants how often they would like the development of new products and services for

TABLE 3 Analysis of simple choice responses – upper secondary educational level.

Item	Question	Yes		No		Do not know	
		n	%	n	%	n	%
1	Do you know what entrepreneurship is?	101	82.1	1	0.8	21	17
2	Have you previously developed any entrepreneurial project (competition, academic project, project on your own)?	58	47	56	45.5	9	7.3
3	Do you know any product design methodology that helps you ideate and develop new products for entrepreneurship?	29	23.5	50	40.6	44	35.7

TABLE 4 Analysis of frequency scale responses – higher secondary educational level.

Item	Question	A		B		C		D		E	
		n	%	n	%	n	%	n	%	n	%
4	How often in your current institution is entrepreneurship promoted through the development of new products and/or services?	26	21.1	38	30.8	48	39	1	0.8	0	0
5	During your studies, how often have you designed and developed a new product or service that solves a problem or promotes its entry into the market?	3	2.4	19	15.4	33	26.8	42	34.1	26	21.1
6	How often would you like the development of new products and services for entrepreneurship to be promoted during your university studies?	26	21.1	78	63.4	18	14.6	1	0.8	0	0

Reference: (A) Always, (B) Frequently, (C) Sometimes, (D) Rarely, (E) Never.

TABLE 5 Analysis of Likert Scale responses – upper secondary educational level.

Item	Question	A		B		C		D		E	
		n	%	n	%	n	%	n	%	n	%
7	How important do you consider the competencies of an entrepreneur can impact your professional career?	81	65.8	35	28.4	7	5.6	0	0	0	0
8	At some point in your professional life, would you like to start a business?	101	82.1	16	13	5	4	1	0.8	0	0

Reference: (A) Strongly agree, (B) Somewhat agree, (C) Neutral, (D) Somewhat disagree, (E) Strongly disagree.

TABLE 6 Analysis of simple choice responses – higher educational level.

Item	Question	Yes		No		Do not know	
		n	%	n	%	n	%
1	Do you know what entrepreneurship is?	126	92.6	2	1.4	8	5.8
2	During your studies at this institution, have you previously developed any entrepreneurship project (competition, academic project)?	82	60.2	52	38.2	2	1.4
3	Do you know any product design methodology that helps you ideate and develop new products for entrepreneurship?	60	44.1	29	21.3	47	34.5

entrepreneurship to be promoted, the responses were mostly concentrated in high-frequency responses. Table 7 shows details about the answers obtained in this second group of questions of instrument B.

The third set of questions from instrument B includes closed questions using choice responses with a Likert scale. These questions help us understand the participants’ perception of the relevance that entrepreneurship represents within their professional training and the impact that entrepreneurship can have on their professional lives. The results allow us to observe a trend toward responses that indicate responses that show acceptance of the relevance of the proposed topic. Table 8 shows details about the answers obtained in this third group of questions.

Additionally, around 70% of college students who were surveyed said they would like to start a business at some point in their lives. And 75% of the same respondents say that they have had experiences in entrepreneurship processes. However, 64% of them say they do not know basic methodologies and processes of entrepreneurship. Which generates an inconsistency and tells us that there is a failure in the students’ learning process.

5.1 Training model design

For the design of the training model proposed in this work, the Education 4.0 Reference Framework was used to design teaching-learning

TABLE 7 Analysis of Frequency Scale responses – higher educational level.

Item	Question	A		B		C		D		E	
		n	%	n	%	n	%	n	%	n	%
4	How often in your current institution is entrepreneurship promoted through the development of new products and/or services?	13	9.5	73	53.6	38	27.9	12	8.8	0	0
5	During your studies, how often have you designed and developed a new product or service that solves a problem or promotes its entry into the market?	6	4.4	28	20.5	47	34.5	30	22	25	18.3
6	How often would you like this institution to promote the development of new products and services for entrepreneurship?	44	32.3	81	59.5	11	8	0	0	0	0

Reference: (A) Always, (B) Frequently, (C) Sometimes, (D) Rarely, (E) Never.

TABLE 8 Analysis of Likert Scale responses – higher educational level.

Item	Question	A		B		C		D		E	
		n	%	n	%	n	%	n	%	n	%
7	How important do you consider the competencies of an entrepreneur can impact your professional career?	95	69.8	31	22.7	7	5.1	1	0.7	2	1.4
8	At some point in your professional life, would you like to start a business?	101	74.2	25	18.3	10	7.3	0	0	0	0
9	Do you consider that your teachers have experience in entrepreneurship?	34	25	55	40.4	41	30.1	3	2.2	3	2.2
10	Do you consider that the learning obtained in entrepreneurship at this institution is adequate?	26	19.1	66	48.5	40	29.4	3	2.2	1	0.7

Reference: (A) Strongly agree, (B) Somewhat agree, (C) Neutral, (D) Somewhat disagree, (E) Strongly disagree.

systems (Miranda et al., 2023). This framework of reference allows designers to be guided during the design and development processes of new educational products, teaching-learning processes, and educational infrastructure, considering the concept and vision of Education 4.0. Furthermore, this vision represents a reference toward a progressive stance in the field of education, highlighting the integration of its key components that promote the development of both transversal and disciplinary competencies through active teaching-learning methods in different delivery forms (remote, hybrid, or face-to-face). This reference framework also allows incorporating a novel infrastructure network supported by current technologies, specific facilities, and services. It involves the participation of various stakeholders from different sectors considered key in teaching-learning. The four key elements that provide the necessary input specifications that the training program that is designed must contain are summarized; these are mentioned below (Figure 3).

- a. *Problem and identification of requirements and technical specifications.* The lack of training processes focused on key aspects of entrepreneurship, such as identifying market opportunities, problem analysis, and creating new products, stands out as a prevailing need. A training model that is easily replicable, short in duration, accessible online, and sustainable over time is required.
- b. *Definition of learning goals and instructional design.* The participant will learn the key concepts around entrepreneurship

and developing new products to provide solutions to sustainable development objectives. As well as the recommended design techniques to carry out systematic and orderly processes.

- c. *Design process and evaluation of the teaching-learning process.* Definition of active learning techniques based on learning-by-doing to train key competencies of “entrepreneurial thinking.” Evaluation of the teaching-learning process according to the six key elements of Education 4.0.
- d. *Implementation of the teaching-learning process.* Definition of the training program as an alternative and optional credential for students. This training program will be an option within lifelong learning programs.

Additionally, four characteristic elements were identified to be adopted as part of the proposed training program:

- i. Incorporation of the “push & pull” design and entrepreneurship model. The “push” strategy revolves around attracting user attention according to the specific characteristics of a solution so that it satisfies expected needs. This technique generally starts from a solution or technology shown to be functional or an existing solution that seeks to be improved with a technological megatrend. Improving the functionalities and performance of a solution has the objective of awakening interest in use in potential user-customers. In contrast, the

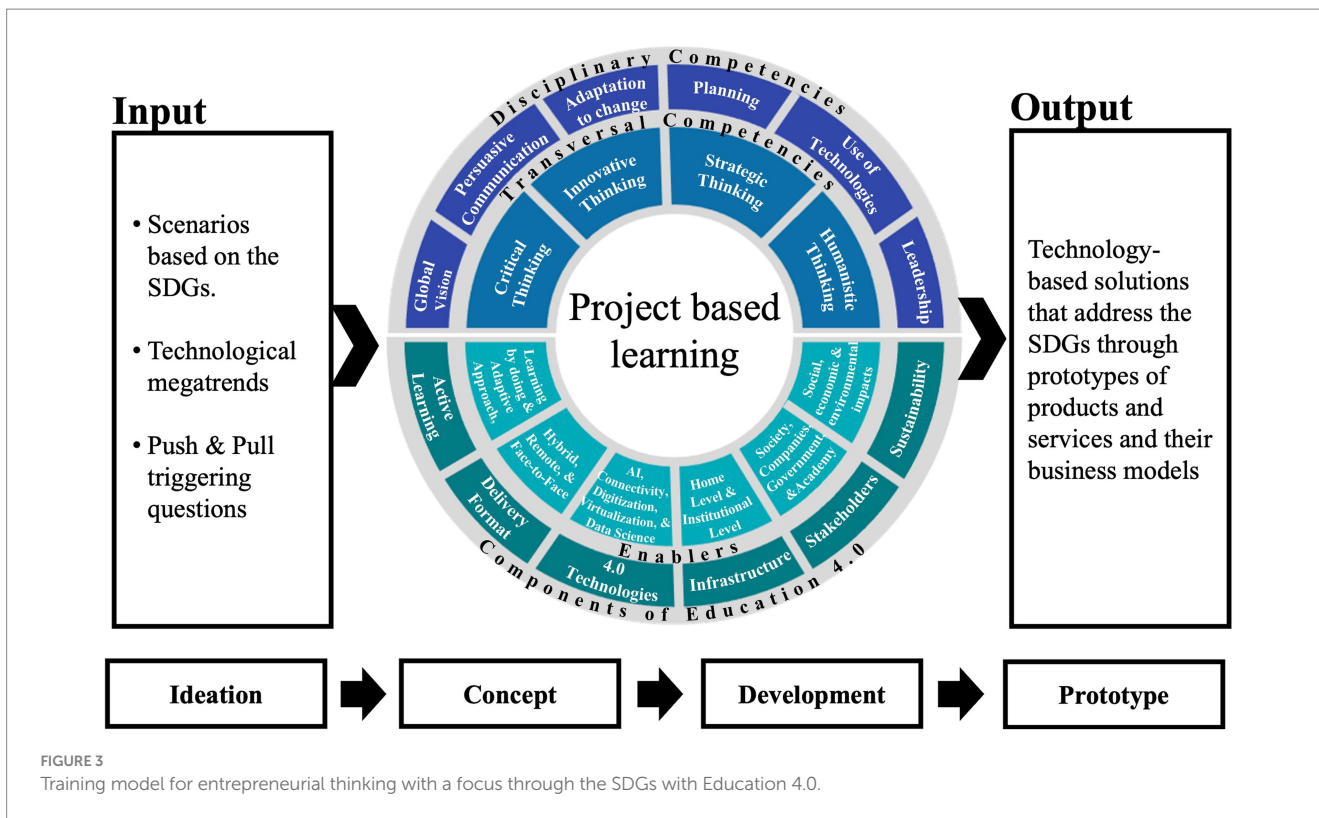


FIGURE 3 Training model for entrepreneurial thinking with a focus through the SDGs with Education 4.0.

“pull” strategy focuses on identifying a problem and understanding user-customers’ preferences, developing a design that is naturally attractive to them due to its practicality and aesthetics. This strategy will offer design alternatives and variety in the form of solutions that emerge as part of the proposed training program.

- ii. Presentation of scenarios based on the Sustainable Development Goals (SDGs), which will try to illustrate and sensitize students about real-world problems around 17 problems that represent each of the SDGs. The presentation of these scenarios will be carried out through multimedia open educational resources. This approach to presenting problems and raising awareness about specific SDGs will allow students to have “pull” approach dynamics.
- iii. Presentation of technological megatrends as main enablers of solutions that promote innovation. By bringing students into contact with cutting-edge and emerging technologies, the students will be pushed to propose solutions incorporating technological solutions. This “push” approach will allow the student to find areas of market opportunity through technological solutions.
- iv. Triggering reflection questions around the SDGs to stimulate creativity and discussion to propose solutions to the problems addressed in the SDG scenarios presented as – What specific challenges does the analyzed community face? Are there any technological solutions that are already addressing the identified problem? Where are there gaps in existing solutions? How are you researching existing solutions in industry, innovation, and infrastructure? Have you found relevant patents? In what areas do you see opportunities to propose

innovative solutions that promote industrial development and infrastructure in this area?

- v. Triggering reflection questions around technological megatrends to stimulate the development of creative and innovative solutions based on technologies. *How could you propose a solution based on some megatrend technology? Could you improve an existing solution by incorporating current technologies? Could you implement a system that involves more than one emerging technology?*

6 Discussion

The study addresses a crucial issue at the intersection of higher education and entrepreneurship. The growing demand for entrepreneurship programs by students is a global phenomenon that reflects an evolution in career aspirations and expectations about higher education. Young people are looking for competencies that will allow them to enter the labor market, reshape it, and create their business opportunities.

Education 4.0 offers a relevant framework for developing training models in entrepreneurship. However, its implementation in underdeveloped communities presents unique challenges. These environments often lack the economic and infrastructure resources taken for granted in more developed contexts. Therefore, adapting Education 4.0 in these areas must be innovative and context-sensitive, using local resources and affordable technologies.

The identification of key elements for the implementation of these models is essential. This includes understanding local needs, leveraging existing technologies, and creating partnerships with key

stakeholders for capacity building and knowledge sharing. Furthermore, the sustainability of these programs requires that they be replicable and adaptable to different contexts within the region.

Entrepreneurial thinking goes beyond simply creating companies. It involves training critical competencies such as creativity, problem-solving, decision-making, and leadership competencies. The evaluation of these competencies is complex and must reflect the multifaceted nature of entrepreneurship, which justifies the need to design new evaluation dynamics and continuous research to validate and improve the programs.

Therefore, this study revealed a marked interest and recognition of the need to adopt a training model based on Education 4.0, specifically designed with affordable resources, in higher education institutions in the eastern region of Michoacán. This interest, together with the feasibility evaluation carried out, supports the expectation that said model is viable and necessary, which aligns with the anticipation proposed in hypothesis H1. Regarding hypothesis H2, piloting practices designed to stimulate the development of key 21st-century competencies among students is currently being carried out, anticipating results that support the effectiveness of these practices in strengthening innovation within the local productive sector; This aspect will be addressed in depth in future works. Regarding hypothesis H3, the preliminary study suggests that the integration of design methodologies focused on the SDGs within the Education 4.0 curriculum has shown significant potential to propose innovative solutions to the challenges identified by the SDGs in the region, evidencing the possibility of generating a positive impact through business initiatives aimed at sustainability.

This approach advocates for equity in access to advanced educational opportunities and represents significant progress in the democratization of education. The strategic connection between design, sustainability, and regional development reveals tangible opportunities for innovation and progress in the eastern region of Michoacán.

7 Conclusion and future work

The perspective of Education 4.0 emerges as a comprehensive framework that guides the work of designers of new educational systems, providing a complete vision of the essential elements in the current context. This holistic approach encompasses educational trends and facilitates the incorporation of affordable elements, with a special emphasis on understanding the impacts on communities with development gaps.

This study reveals an evident gap in the approach to entrepreneurship in communities with underdevelopment characteristics, despite the clear importance that students perceive of the competencies of entrepreneurial thinking. Furthermore, the limitations inherent to this study are recognized, mainly related to the biases perceived by the students. There is a possibility that students overestimate their understanding of the dynamics associated with entrepreneurship, given a lack of precise knowledge and limited access to key concepts, which could distort the perception of the study interventions.

Future studies will focus on exploring the influence of entrepreneurship on the development of these disadvantaged communities, specifically analyzing the comparative impact between

the use of technologies and traditional processes. This analysis is intended not only to measure effectiveness but also to inform the design and refinement of teaching activities that address these emerging needs. Finally, the evaluation of the proposed training model is planned in a controlled environment through a pilot implementation with potential users in the eastern region of Michoacán. This process will evaluate performance and user experience, identify crucial indicators, and refine the training model toward its final version. This methodological approach promises to contribute significantly to designing more inclusive educational systems adapted to the needs of diverse populations, representing a crucial advance toward positive transformation in the educational field.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

LL-L: Conceptualization, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing. IÁ-I: Supervision, Writing – review & editing, Funding acquisition. FL-H: Supervision, Writing – review & editing. JM: Conceptualization, Investigation, Methodology, Supervision, Validation, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. Challenge-Based Research Funding Program 2022. Project ID # I004 – IFE001 – C2-T3 – T.

Acknowledgments

The authors acknowledge the support of TecNM campus Zitacuaro for its cooperation for the realization of this study. Also, the authors acknowledge the financial and technical support of Writing Lab, Institute for the Future of Education in the production of this work.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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