Going beyond traditional approaches on industrial engineering education

David Ernesto Salinas-Navarro
Escuela de Ingeniería y Ciencias Tecnologico de Monterrey
Mexico City, Mexico
dsalinas@tec.mx

Christopher Mejia-Argueta
MIT Center for Transportation and Logistics Massachusetts Institute of Technology
Cambridge, USA
cmejia@mit.edu

Agatha Clarice Da Silva-Ovando
Industrial Engineering and Systems Department Universidad Privada Boliviana
Cochabamba, Bolivia
agathadasilva@upb.edu

Claudia Lizette Garay-Rondero
Escuela de Ingeniería y Ciencias Tecnologico de Monterrey
Puebla, Mexico
clgaray@tec.mx

Abstract—This Research-to-Practice full paper refers to academic perspectives on educational innovation for industrial engineering education. Two common views prevail in educational innovation that turn into different results. One view refers to the use of pedagogical approaches to improve in-classroom students' learning. This is an operational perspective about teaching activities, instructional facilitation and the use of academic resources. The second view refers to educational value creation for students, educational partners, society and to improve the academic positioning of universities. However, both views complement each other and can articulate a holistic approach on educational innovation. To proceed in this direction, this work unfolds in three parts. First, a literature review illustrates the differences between the two complementary views. Second, a conceptual framework is provided to connect the two perspectives and guide further educational innovation efforts. Third, a descriptive and exploratory application case is offered to exemplify the framework at the MIT Supply Chain and Logistics Excellence (SCALE) Latin America Network for industrial engineering education. This work contributes to educational practice with a tool to reflect upon innovation efforts, identify instances and align initiatives with intended educational purposes.

Keywords—Educational Innovation, Higher Education, Industrial Engineering, Logistics and Supply Chain Management

I. INTRODUCTION

Educational innovation involves new approaches to achieve superior results in the learning process and academic performance of students. Multiple initiatives exist at a global level, some of them creating novel ways of conceptualizing universities, education, teaching and learning. To make this happen, educational institutions take diverse perspectives based on the understanding upon their role in society, their strategic positioning and their conceptualization of education. Some other efforts focus on pedagogical approaches to improve how education is produced and delivered in multiple means.

Educational innovation in universities (e.g., undergraduate programs) has come up as a wide effort to respond to societal, governmental, organizational and individual's demands to improve on the quality and relevance of competencies and learning outcomes that students develop in their academic studies [1]. Societal expectations upon higher education consider that education triggers social development, economic growth, knowledge creation and technological innovation in communities and countries, leading them to a better quality of life because of increasing job prospects and salaries [2]. Accordingly, higher education is seen as a plausible way to improve country's progress and a good investment for people to access high-quality professional opportunities in the future. Actually, educational innovation should be driven by value contribution and the impact of education on societies to create knowledge, wealth and wellbeing for everyone.

Universities might work on educational innovation to assert their own identity and reputation, compete in the educational market, push the novelty of their academic work, and enhance the development of learning outcomes in their students that go beyond traditional education models. This idea is a strategic orientation to improve academic quality, value contributions and operations in education [3]. Thus, universities may use it to innovate in their educational programs and to achieve their own institutional goals, adapt to contemporary demands and opportunities, and remain relevant for society and their communities [4]. Educational innovation should help universities to achieve excellence.

Moreover, educational innovation also influences how learning processes take place with the use of diverse pedagogical approaches for the benefit of students [5][6]. Hence, the focus is on learning objectives, competencies development, engagement and participation, as well as the enhancement of educational activities and the diversification of learning resources [7]. This learning-oriented view, which promotes an operational perspective on education, highlights the recreation of specific enriching educational experiences [8]. Most of the authors work this perspective of educational innovation to improve in-classroom instruction and student's learning processes, with the aim to answer *What to learn* and *How to learn.*

High-education institutions should properly identify and signify educational innovation. This work may help gaining a comprehensive understanding of educational innovation to support future efforts in the field as well as to give an adequate orientation and coherence to their efforts to change the mindset of students and evolve learning procedures used by lecturers and faculty to the benefit of deep thinking, improvement of

rationality using real-life cases that supplement the theoretical concepts and shape the knowledge about *what* and *how to learn*.

This work reflects about educational innovation taking a complementary view on strategic and operational perspectives. These two perspectives mutually interact and feedback each other, and if properly analyzed, they would result in improved operational capabilities aligned with a strategic positioning and long-term sustainable value contributions. This position on educational innovation goes beyond the traditional approach, which implies the sole use of novel instructional methods with limited institutional impact or espoused educational purposes, to build a proper justification for an educational strategy that is adequately grounded on educational practices.

The goal of this work is to explore the notion of educational innovation to identify instances on the strategic and operational perspectives and to exemplify their use. Also, we provide a framework to understand how educational innovation may help merging both perspectives and to support the conceptualization of our approach. We conduct descriptive and exploratory analysis of the proposed framework in high-education institutions like *Tecnologico de Monterrey* from Mexico, *Universidad Privada Boliviana* (UPB) from Bolivia and the support of the *MIT Supply Chain and Logistics Excellence (SCALE) Network* in Latin America. We consider topics related to transportation, logistics and supply chain management within the industrial engineering education to limit our scope. This work has allowed the involvement of new academic partners, stressing the relevance of innovation in education within the network and expanding strong collaborations with other organizations and institutions to carry out applied research.

II. THE TRADITIONAL NOTION OF EDUCATIONAL INNOVATION

Our reality has changed dramatically the societal bonds, economy, science, technology and human behavior [9]. The continuous evolution has pushed innovation into education. Pressure comes from different directions such as the shift in knowledge-intensive jobs, the creation of new roles in organizations and requirements of new skills, the democratization of knowledge which threatens typical on-site educational models, the increasing population growth, and the continuous search of meaning for human kind. Other forces within education require to disseminate knowledge across communities, build up partnerships and multidisciplinary collaborations, and an effective integration of faculty and students in educational, sometimes multi-disciplinary and multi-country grids [10] [11]. Therefore, education must evolve to meet current and future challenges at local and global levels.

Educational innovation is still a fuzzy concept with no consensus. It is referred as a novel combination of teaching and learning approaches or as a set of techniques that improve the effectiveness and impact of education by using specific methods [12]. Hence, an educational innovation is usually understood as a new pedagogic theory, curriculum, methodological approach, teaching technique, instructional tool, learning process, or institutional structure. Its goal is to improve how to *teach and learn* to increase impact on both activities for the benefit of students [13]. However, there is not much discussion on how the innovation should be driven into long-term, practical education

and better ways to connect this strategic thinking to the emerging techniques to teach growing cohorts of tech-savvy students.

Educational innovation has been widely studied from an incremental innovation perspective. It relates to producing refinements or improvements but without significantly altering the original educational base or paradigm. In effect, educational innovation should be also considered when it drastically changes the educational context and modifies how it is organized [14]. Innovation does not only promote adaptations in curriculum, academic content or teaching formats, it should also focus on transforming practices into new directions or attempts to increase quality, value contribution or educational impact [15].

Efforts such as reinforcing new pedagogical styles, creating novel instructional techniques, pushing practicality, teaching foundations for scientific and technical progress as well as promoting societal changes through education must drive educational innovation. Thus, innovation might also be referred as revolutionary when involving new paradigms in the teaching and learning conceptualization and practices.

This work proposes that educational innovation should take a key role in universities beyond instructional interests, administration requirements or just incidental efforts. The core idea is to convert educational innovation into a force to develop core competencies that drive quality and value generation for the society in strategic and high-impact ways, which are grounded on educational structures. This require a change of mindset to guide further contributions and motivate the integration of existing work in the field to this important perspective that has been barely discussed in the academic community.

From an operational angle, educational innovation is typically applied and widely studied to provide a positive impact on learning. It involves all activities, resources and roles to produce intended learning outcomes and the development of competencies in students. The use of contemporary approaches in higher education such as competency-based education, experiential and collaborative learning, among others, can be regarded to use for these purposes. Results and the impact on learning might be measured in terms of students' satisfaction, course grades, and attainment levels per competency. These works emphasize that educational quality, outcome and impact are the most relevant measures.

A strategic angle considers all stakeholders or partners related to the learning process such as learners, parents, faculty, educational administrators, researchers, practitioners and policy makers, which requires more active involvement and support [16]. In this case, innovation becomes a social phenomenon that is a consequence of the interactions among all participants to guarantee collective benefits and contributions [17].

Furthermore, educational innovation drives and shapes the identity, academic positioning and overall performance of educational institutions to create genuine value within their community and for the society. Thus, innovation becomes a core asset rather than just being a mere instructional improvement tool. In consequence, educational innovation should produce an in-depth change on faculty development, research possibilities, admission of new students, retention of the most talented students, high rates of employability, improved and

synchronized outreach programs through partnerships with corporate and public partners, collaborations to tackle urgent and important needs from the community, attracting funding, among others. This perspective calls for an explicit advancement in educational innovation towards strategic value contributions.

III. A NOVEL FRAMEWORK FOR EDUCATIONAL INNOVATION

In this effort to build a new approach for educational innovation that allows for matching the widely studied operational angle to the strategic angle, we propose a holistic framework of the interplay between both angles. This framework has been created out of different ideas about the educational requirements from challenges faced by humanity, the future of jobs and skills development, perspectives about the purpose of higher education, the conceptualization of the learning process, pedagogical approaches to support learning, and the definition of educational structures and resources.

The framework in Figure 1 considers five big elements: Context, purpose, requirements, method and structure. Accordingly, educational innovation covers different aspects starting from a situational context that defines relevant stakeholders, academic partners and conditions in which educational innovation takes place. The situational context translates into an educational purpose, which contains the definition of value contribution and educational quality and impact. These two elements outline the strategical perspective. Then, educational requirements set objectives and expected outcomes, which require specific pedagogical approaches, methods and tools for their implementation in terms of particular educational experiences and activities within a given learning space [18]. These other elements outline the operational perspective of educational innovation.

The framework helps to conceptualize and reflect upon educational innovation as follows. First, we need to understand challenges, conditions and trends. International organizations (e.g., United Nations, the World Bank, the World Economic Forum), have highlighted concerns about the way current global issues such as income disparity, malnutrition and socioeconomic and technological trends may impose big constraints and more barriers for education, undermine value contribution and innovation, and reduce the formation of graduates and future professionals for low-skilled regions [2][19]. These situations are grounded onto specific contexts to identify educational opportunities and learning challenges, which brings forth relevant stakeholders around educational innovations.

Second, we must change the baseline of educational models to go beyond expectations upon higher education, setting a different purpose to organize and structure managerial practices from diverse economic, social and political views in a long-term sustainable way [20]. This change results in defining new types of value propositions, reshaping education quality standards and extending the impact of educational outcomes to other beneficiaries, not only students and faculty.

Third, educational objectives, learning outcomes and competencies should be demarcated to reflect espoused purposes, value propositions and desired educational contributions. Educational objectives must map contributions to diverse stakeholders such as students, faculty, other academic partners and the wider society. Moreover, learning outcomes and competencies should be declared according to disciplinary academic requirements but contextualized to make sense and increase their relevance. Accreditation boards criteria can help in this direction with simultaneous conversations with other stakeholders such as academic boards, employers or alumnus.
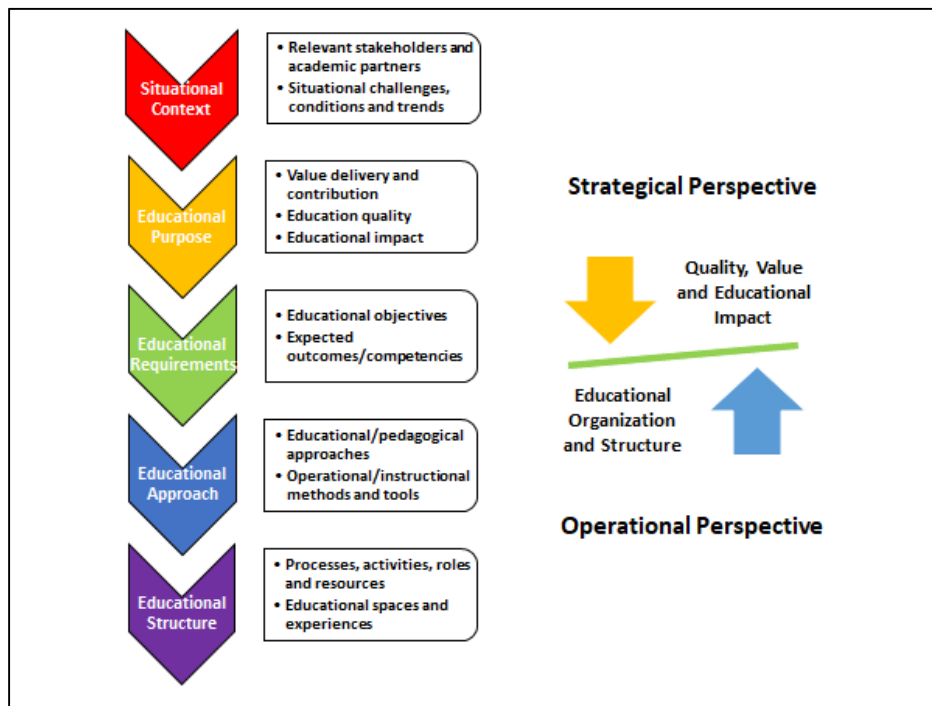

Figure 1. Educational innovation framework

Fourth, the proposed framework is based on learning theory to outline how students engage and participate from this process to positively influence their learning and long-term knowledge retention (i.e., passive or active way) [21]. The framework refers to various pedagogical methods from multiple disciplines with the aim to compile a wide set of teaching and learning tools for learners and educators. This is about the use of challenge-based learning, inverted classrooms, project-oriented and problem-based learning, gamification, virtual reality, and others [7].

Last, education and learning require the support of active roles, dynamic, forward-looking activities and enough resources (including infrastructure and learning spaces) to offer unique, disruptive learning experiences to forge new leaders [22]. Collaborations with diverse organizations, institutions and communities are necessary to develop the mechanisms to recreate the relevant learning experiences and other required academic activities to produce value contributions.

The integration of these aspects defines the framework. This allows for observing and reflecting upon educational innovation efforts to recognize the innovative orientation, logic and consistency towards the enhancement of educational quality, value contributions and educational operations [23].

The articulation of the operational and strategic perspectives is crucial for conceptualizing educational innovation, supporting their implementation and determining its value contribution. Both perspectives should feedback, leverage and complement each other, adjusting themselves as strategic requirements change or vary over time and as new type of operational resources and activities create new possibilities for improving quality, value, and educational impact. A strategic view on educational innovation enriches long-term, aggregated educational intentions, external links and improves the academic position and reputation of institutions. An operational view stresses a short-term instructional practice, internal interactions and role playing within the classroom to produce intended learning. This means a balance is required between the forces of both efforts to allow getting coherence of educational institutions and their activities and guaranteeing that day-to-day activities support a long-term vision and that the strategy is properly aligned with investment in resources, faculty development, research and outreach activities, among other high-impact tasks.

By adopting this tool, educators can guide their efforts within a wider holistic perspective to create structural capacities to support educational innovation. That is, the framework can help to build up a purposeful educational innovation system in which pioneering undertakings are clearly defined and translated into educational mechanisms for their productions. This is not an evident perspective, as isolated or occasional efforts with no supporting infrastructure can vanish over time or have limited impact because of their lack of relevance or recognition.

IV. EDUCATIONAL INNOVATION IN INDUSTRIAL ENGINEERING

According to the UNESCO report on *Engineering Education Transformation and Innovation* [19], universities are respected and responsible institutions that fulfill teaching, research and community outreach activities across many disciplines in society and communities. They must take responsibility for the challenges created by the current deficiencies in engineering education. educational innovation may help responding to those emerging issues and also, to topics related to the attraction of students into engineering and meeting their needs. In addition, this approach will help achieving community relevance, grounding curriculum design, promoting active and experiential learning, new educational models, student-centered learning, multidisciplinary fundamental principles exploration, learning technologies, programs transformation and change to eliminate barriers for education in all levels.

Engineering is an integrative process and its education should be designed towards this end in a holistic approach. Multiple studies and techniques exist calling for this approach in engineering education; however, innovation should integrate knowledge into processes throughout the curriculum rather than into traditional courses [24]. Innovation should also involve goal-oriented, outcome-related mechanisms in the process of student learning, influencing new methods and practices [25]. Moreover, other approaches call for cooperative learning, in which activities are planned to look for the positive interdependence among participants.

Within the discipline of industrial engineering, educational innovation is composed of a collection of works on teaching and learning, which focus on improving pedagogy and the development of competencies and learning outcomes. However, a comprehensive perspective is missing to complement a strategic view and to connect to the operational view (see previous section). A review on some of the existing works is presented to exemplify the limitations in the education of industrial engineering.

Some authors recognize that progress in educational innovation for industrial engineering should be done by updating curricula, academic content, materials, and classroom teaching methods [26] [27]. These efforts highlight knowledge provision, answering the question about *What to learn* in the discipline. The value of this perspective focuses on keeping the pace of academic programs with respect to the practical skills and knowledge needed in the job market (i.e., to meet professional requirements). Therefore, limited attention is paid to value creation beyond the definition of learning contents. This is the case of manufacturing engineering education, which focuses on educational methods, teaching of teams, collaboration, and the inclusion of topics about new technologies, sustainability, global issues and other emerging topics in the field [28].

Other works emphasize the identification of necessary technical and hard skills to provide academics, students and professionals with the capacity to succeed according to current and future trends [29]. Other authors highlight the need to develop soft personal skills such as critical thinking, problem-solving, communication and teamwork as enablers for professional and personal activities [30][31][32][33][34][35]. These works refer to educational innovation to develop competencies as an integration of knowledge and abilities for practical work and the evaluation of learning outcomes.

Additional works focus on proposing the use of alternative instructional approaches such as cooperative methods, workshops, guest lecturers, field trips, projects and active

learning to improve the quality of teaching and learning by including real-world problem situations [36][37][38][39]. Despite these approaches allow for improving classroom pedagogy, instruction and learning activities; their application is widely limited. Likewise, there is almost null use of innovative approaches such as flipping the classroom, adaptive learning or challenge-based learning for industrial engineering.

On the other hand, the use of gamification and role playing in the discipline have been increasingly used in combination with experiential learning (EL) through game simulators and online platforms in the last decade [40][41]. The purpose of these academic resources has let learners engage in predefined scenarios for problem-solving and decision-making activities, in order to experience simplified real-world problem situations. Nevertheless, most of the simulated situations focus on operational aspects as they highlight pedagogical alternatives, instruction methods, learning activities and the recreation of learning activities.

Educational innovation efforts might commonly correspond to partial aspects of the strategic or operational views. However, their contribution can be understood of particular interest to deepen into aspects of value creation, teaching and learning. Thus, there are opportunities to integrate comprehensive perspectives to balance strategic and operational views.

Some other works can be referred in educational innovation initiatives such as those carried out within the MIT SCALE Latin America Network, an academic partnership of universities around the topics of logistics and supply chain management (SCM) for Latin America and The Caribbean. The initiative has been developed over the last three years in collaboration with top-ranked Latin-American universities to improve teaching quality, progress pedagogical approaches and graduate highly competitive professionals in the field. However, variations in the initiative across different universities have resulted in different conceptualizations upon educational innovation, which triggered the present work.

In some cases, some universities of this academic network have used educational innovation to implement challenge-based learning experiences to develop creative problem-solving abilities in students, increase their engagement through active learning and build up links with companies and communities through real-life problems. In other cases, universities just respond, for instance, to enrich pedagogy, program accreditation requirements, students' satisfaction improvement and the need to increase new admissions.

Two contrasting views emerge when academic administrators and academics see educational innovation as a top distinctive effort to competitively situate institutions and produce academic value or when innovation is considered as an instrumental approach for teaching practice and meet administration requirements. Partial views can result in inefficient initiatives with incomplete overall impact.

In relation to industrial engineering education for this academic network, the most distinctive instances developed so far are the Undergraduate Certificate in Logistics and Supply Chain Management (UCLOG), the faculty training program on challenge based learning and the Taquiña Challenge at the UPB,

and the Social Lab for Sustainable Logistics (SLSL) at Tecnologico de Monterrey, which incorporate competency-based education, challenge-based, active, collaborative learning and experiential learning spaces. All these three initiatives involve strategical and operational aspects of educational innovation (see Figure 1).

Despite all the efforts, there is no case with a truly innovative evidence in which advancement in industrial engineering education has been created so far. However, these initiatives have set the foundations and allowed the creation of a development program in educational innovation in a regional scale within this academic network to strengthen new types of collaboration, increase value contribution for students, faculty, universities and academic partners, as well as for surrounding communities. We intent to give rise to a distributed, balanced innovation practice that links strategic and operational perspectives and facilitate an international environment of collaboration and knowledge transfer among participants. Next section describes how we applied the proposed framework into the MIT SCALE Latin America Network.

V. THE MIT SCALE LATIN AMERICAN NETWORK: DEVELOPMENT INITIATIVE FOR EDUCATIONAL INNOVATION

In Latin America, higher education is mostly limited for certain population segments and it still lags behind in terms of curriculum, teaching methods, skill development and responses to social needs and changing industries compared to other geographical regions. This has been exposed in global reports and university rankings such as the QS World University Rankings and The Times Higher Education World University Rankings in the last years. In order to remain relevant, universities in the region must innovate to adapt to global and local changes and forthcoming challenges, as well as to create benefits for the society of the region.

In 2017, the World Bank stated that Latin America is at a crossroads as higher education is required to deliver quality, equity and variety to foster economic development [42]. According to UNESCO-IELSAC and UNC, higher education in Latin America should be based on a perspective of social development, learning-centered education, entrepreneurship and research-based teaching for social action [43]. Based on this perspective, education should be regarded as an instrument to face the modern world, cultivate capable citizens and strengthen analytical, anticipatory and purposeful visions as alternatives for development and the transformation of growing issues in the region. Policies to help overcome difficulties of having access and affording higher education in Latin America should be oriented, among others, to reduce dropout rates, insert students in the labor market and increase their salary perspectives [42].

Therefore, universities in Latin America are required to respond to these challenges by transforming their visions, strategies, models and practices. A comprehensive view on educational innovation should be carried out beyond traditional classroom-based approaches for teaching and learning to deliver high value to students, employers, communities and construct a better future for society and economy in the region. Industrial engineering education must also respond to contemporary requirements in similar terms.

As educational innovation within industrial engineering is lagging behind in Latin America and the Caribbean, an initiative to progress into engineering education problems and challenges was launched in 2017 by the MIT SCALE Network in Latin America. Its main goal was to support academics from member universities to build actionable knowledge to match the strategic and operational perspectives of educational innovation.

The MIT SCALE Latin American Network was created to trigger cutting-edge research and novel educational programs in collaboration between the MIT Center for Transportation and Logistics (CTL) and the Center for Latin American Logistics Innovation (CLI) in Colombia, together with academic partners from many recognized universities in the region. The network works for a common agenda to lead cutting-edge research, education and outreach to face and embrace socioeconomic, logistics and SCM challenges, by developing and disseminating innovative strategies to address those challenges in Latin America and The Caribbean. The network helps companies, governments and organizations to compete in an increasingly complex business environment and engage academia, students, and partners to collaborate on projects that have in-depth economic, societal and environmental impact.

Therefore, the initiative in educational innovation of the network aims to grow capabilities in the region to create disruptive educational models, update academic programs, rise learning experiences, encourage faculty development, research and collaboration within communities, organizations and institutions; as well as to improve education quality, make a positive impact on students and educational partners, and contribute to local and regional development. The initiative promotes knowledge transfer, create synergies among members and share resources. Specifically, this initiative involves unique projects in the discipline at the global level. Referring to Figure 1, this initiative covers aspects of the framework for educational innovation, as summarized in Table I and described as follows.

TABLE I.   THE MIT SCALE LATIN AMERICAN EDUCATIONAL INNOVATION FRAMEWORK

ELEMENTS	Description
Situational Context	Latin American logistics and supply chain context
Educational Purpose	Build up educational innovation capacities within universities to educate high quality professionals with distinctive experiences and create forefront learning outcomes that advance disciplinary education and contribute to address relevant challenges in the region.
Educational Requirements	Students' learning on contemporary challenges and issues in the discipline at the global and regional level. Develop relevant learning experiences that increase future professional opportunities for graduating students. Develop disciplinary competencies on engineering education.
Educational Approach	Active learning, competency-based education, and challenge-based learning.
Educational Structure	The UCLOG, the SLSL and specific challenge-based learning experiences and activities.

- The situational context involves the identification of regional challenging conditions and the responsibility to contribute to the development of education in the discipline. Relevant stakeholders are identified to interact and build academic partnerships for educational activities. This is the case of the relationship of the CLI with over 2,000 Colombian companies and 200 in Latin America plus interactions with the World Bank, the Inter-American Development Bank (IADB) and national and local governments in the region.

- The educational purpose is defined in terms of the value proposition that the initiative makes for different stakeholders through high-innovation activities in a regional collaborative network. This is about developing educational innovation capacities to position disciplinary education in the region at the global forefront. For instance, developing faculty with an international profile, increasing networking and taking part in top-class research projects from the network. Academic partners and external organizations have access to an international network of high-skilled academics, organizations and high-profile students that contribute to their problem-solving and decision-making processes in highly relevant projects.

- Educational objectives in the initiative refer to educational objectives of faculty training and involvement, the development of research abilities, joint research projects with faculty and students, elaboration of publications, association with external institutions, organizations and companies, the dissemination of knowledge, and the creation of novel academic programs and learning experiences to address regional challenges. All these looking to strategically position the network, universities, academics and students, and to decisively create value for partners in the collaborations with high impact academic products and learning outcomes.

- The educational strategy consists of the incorporation of multiple learning approaches and techniques (e.g., competency-based education, active, experiential and challenge-based learning) that are embedded into projects and activities that shape the participation of faculty, students, and academic partners in different projects with scientific outcomes and industry reports. Some of the projects have been configured to promote faculty development, research publications, research stays, research-based courses and learning challenges, all about intervened problem situations. Some examples can be found in the UCLOG at the CLI, the SLSL at Tecnologico de Monterrey, and challenge-based learning experiences at the UPB.

- Finally, at the operational level, projects and activities are carried out within the educational innovation initiative through mechanisms that ground the espoused purposes into spaces for interaction among faculty, students and partners. As just mentioned, the UCLOG, the SLSL and the learning experiences at the UPB have carried out learning challenges with a strategic sense of

creating a solid value proposition, not only for faculty and students, but for new prospective students and local organizations that look for interventions to solve out their problems with academic help. Learning experiences about urban mobility, last-mile deliveries, cargo load/unload operations and retail operations, among others have implemented.

Specific results of quality, value contribution and educational impact have been obtained. Three cohorts that have accounted for around 70 students in total from Brazil, Peru, Bolivia, Mexico, and Colombia have already graduated from the UCLOG program with faculty of member universities, CLI staff and CTL researchers, and with the participation of highly relevant logistics operators, retailers, municipal authorities and non-governmental organizations (NGO's). Over 40 faculty have been trained in challenge-based learning in Cochabamba, Bolivia at the UPB. Five Mexican undergraduate students from Tecnologico de Monterrey have been in research stays at the CTL and CLI. The Taquiña Challenge achieved a collaboration with the top private company in Bolivia, setting a collaboration around challenge-based learning involving undergraduate courses in two semesters. Nanostores research project has produced the participation of over 150 undergraduate students during five semesters and 15 authoring students at the MIT SCALE Latin America Conference, getting the best student paper competition award in 2018. However, the intention is to involve all universities at the network to complete a change in the way educational innovation is conceptualized and education improved in Latin America and The Caribbean.

VI. CONCLUSION

The notion of educational innovation for engineering education, and specifically for industrial engineering, is revised in this work because of current limitations in educational practice when implementing initiatives beyond in-classroom efforts to improve education quality, value contribution and impact on students' learning and the development of relevant stakeholders' development. This work proposes an integrated perspective in which educational innovation should be aligned within a conceptual framework in which strategic and operational coherence must be achieved.

The conceptualization of educational innovation has strong implications for educational practice, as innovations should be envisioned beyond instructional improvements, pedagogical approaches, learning outcomes development or curricular content. educational innovation must challenge academics and their partners to go beyond traditional education, looking for developing long-term sustainable models and provide the possibility to outreach educational institutions. This will allow institutions to significantly position universities to meet students' expectations, develop faculty and deliver high value to all those academic stakeholders involved in their operations; as well as remain relevant to communities, organizations and society.

Achieving this type of disruptive innovation turns difficult as traditional approaches on innovation favor teaching and learning practices immersed in short-term courses. To advance in a comprehensive view on innovation, universities should build up organizational and structural capabilities that support the interplay with initiatives that keep a balance between strategical and operational considerations.

This research-to-practice work emerged from difficulties to progress into the implementation of innovation initiatives in the Latin American region within the MIT SCALE Network. Overcoming the barriers to involve and convince other universities and academic partners allowed for reconceptualizing the notion of educational innovation. Nowadays, the implementation of educational innovation initiatives at the network has allowed universities to push unique and attractive learning experiences in the discipline. Most importantly, educational institutions have impacted favorably communities, private organizations and society, which has opened the possibility to establish strong collaborations for applied research.

The MIT SCALE Latin America Network overcame the physical distance of its members with the help of web-based technologies but also by creating mechanisms of collaboration and incentives to adopt new initiatives. The increasing participation of new institutions, faculty members, students and corporate partners internally validates the value contribution and the impact of this work. Moreover, the search for advancing in educational innovation has resulted in academic association links to train faculty, research on education, carry out research stays, develop academic programs and learning experiences, among other activities. This knowledge will be reused and replicated in internal forthcoming initiatives and transferred outside the network to expand innovation capacities, including conversations about the educational innovation framework and the experience of building up new collaborations. This is the case of new actions against disruptions in food supply chains during and after the COVID-19 pandemic, which open multidimensional possibilities for novel responses from education to expand learning possibilities.

However, there is still work to extend the interest and involvement of other members and institutions, which might take to trigger further insights and new ideas about educational innovation. Therefore, future work is under way to extent applications and replicate or create new initiatives in the region.

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