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(Re-)shaping learning experiences in supply chain management and logistics education under disruptive uncertain situations

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Introduction: Disruptive uncertain events often necessitate universities to abruptly shift from face-to-face to remote online learning, posing challenges to instructional quality and learning outcomes. Remote online instruction may lack social interaction, educational resources, and practical activities, hindering effective learning.

Methods: This study presents an experiential learning framework designed to foster active learning experiences amidst disruptive uncertain events. The framework incorporates such events as study situations to enhance student motivation and engagement. A methodology for designing learning experiences is proposed, with a focus on incorporating real-world disruptions into educational settings.

Results: A case study is presented, detailing the implementation of the framework in supply chain management and logistics education at a private university in Bolivia, amidst the COVID-19 pandemic. Results indicate that the novel learning experience positively impacted student motivation and engagement, facilitating the achievement of learning outcomes.

Discussion: The initial implementation suggests that the novel learning experience positively impacted student motivation and engagement while achieving their intended learning outcomes. However, further instances of utilizing the proposed framework are necessary to ascertain its generalizability and effectiveness across diverse contexts and situations. Identifying similarities or invariances will help validate the applicability of this approach in different educational settings affected by disruptive uncertain events.

KEYWORDS

uncertain situations, COVID-19, remote learning, constructive alignment, experiential learning, educational innovation, higher education

1 Introduction

This study investigates the development of active learning experiences for supply chain management and logistics (SCML) education within disruptive uncertain situations, necessitating the preservation of student motivation, engagement, and learning relevance. In contemporary Higher Education (HE), an emphasis on active approaches is imperative for sustained learning and professionally related activities (Kember et al., 2008). This perspective encompasses hands-on, reflective, and student-centric methodologies, often executed through collaborative, challenging, and competency-based educational initiatives. However, during uncertain situations such as conflicts, anthropogenic or natural disasters, emergencies, or

epidemic lockdowns, conventional on-campus face-to-face HE activities are frequently transitioned to remote learning experiences. These activities are characterized by limited personal interactions, reduced or no access to educational facilities, a lack of learning resources and services, and constraints on student practical work. Consequently, the richness of learning experiences diminishes for students, posing a threat to their learning and educational achievements. In this context, remote synchronous education during uncertain situations often becomes unattractive and more challenging for students unless their learning motivation, engagement, and perceived educational value are enhanced (Khan et al., 2017).

To address these challenges, universities have implemented diverse strategies to sustain remote teaching and learning activities, utilizing online quizzes, video demonstrations, tutorials, software simulations, virtual laboratories, and other web-based tools to facilitate virtual networking under remote learning conditions. Moreover, universities have also rethought and changed their assessments with methods that can demonstrate students' learning, under campus shutdowns, to achieve their intended learning outcomes and overcome concerns about academic integrity (Winstone and Boud, 2020). These include, for instance, online examinations with remote proctoring, oral examinations with video conferencing, portfolio assessments, and case studies with practical projects, among others.

However, students in such situations frequently encounter learning-related issues such as internet access problems, personal distress, or inadequate home study environments, exacerbating existing educational pressures (Hadar et al., 2020; Vieyra Molina et al., 2020). Thus, remote assessments, are frequently less rewarding and require more cognitive effort, in comparison to traditional methods, given the pedagogical unfamiliarity, extended timings, availability of learning resources, learning conditions, and uncertainty of expectations (Slack and Priestley, 2023).

Additionally, teachers face challenges and institutional limitations related to instructional designs, the availability of appropriate educational technology, a lack of time or knowledge to develop new teaching resources, insufficient budget or technical support, and overwhelming remote teaching training to adapt to the new realities (Salinas-Navarro and Garay-Rondero, 2022). Furthermore, in some instances, the software and resources used by teachers may not align with the learning objectives or may refer to theoretical situations that are overly abstract. Moreover, given that the predominant delivery method in contemporary HE continues to be in-person teaching, there still exists negative perceptions against online education (Stewart et al., 2016). Consequently, these learning experiences often result in limited or insufficient academic implementations, adversely affecting students' learning.

Previous research has acknowledged that instructing and learning within uncertain circumstances necessitate prompt transformations in the learning environment, the surmounting of existing obstacles, and the implementation of academic interventions (Salinas-Navarro and Garay-Rondero, 2022). These adjustments encompass integration activities and the incorporation of active learning pedagogies, aiming to furnish students with hands-on and reflective experiences to augment their motivation, engagement, and pertinent learning (Fenech et al., 2020; Pultoo and Oojorah, 2020). Nonetheless, these modifications also necessitate varied remote activities to address real-world situations, thus enhancing the relevance of the learning

experience (Salinas-Navarro et al., 2021). Consequently, there exists a need for innovative learning approaches to amplify the ease of learning in courses and address prevailing educational challenges.

Accordingly, a problem definition in this work regards the educational difficulties and limitations in remote learning conditions during disruptive uncertain circumstances and the need to provide students with relevant and active learning possibilities for their learning, particularly, in SCML education. Therefore, this work aims to develop relevant learning experiences for remote education under disruptive uncertain situations concerning the use of active pedagogies to achieve their expected learning outcomes while enhancing student motivation and interest. This proposition calls for incorporating the study of disruptive uncertain situations into learning activities to allow students to perceive, reflect, conceptualize, and experiment under remote learning conditions (Christian et al., 2020).

Experiential learning, which goes beyond repetition and memorization to foster a deeper understanding of academic subjects through reflective and practical activities, plays a pivotal role in this context (Kolb, 1984). Experiential learning is a theory of learning that emphasizes what students must do to construct their knowledge and achieve their intended learning outcomes. From a constructionist perspective, this view fosters deeper understanding, critical thinking, and hands-on activities among students, making it a valuable addition to presence and remote learning (Kong, 2021).

Hence, this work comprises six sections. Section 2 investigates existing educational challenges in uncertain situations, delineating specific barriers. This section also proposes a pedagogical approach based on constructive alignment and experiential learning for relevant learning experiences during uncertain situations. Section 3 outlines the methodology for developing these learning experiences. Section 4 reports the results from experiential learning activities in an SCML course during the COVID-19 pandemic, focusing on food supply issues in Bolivia. The learning experience advances the conceptualization of relevant learning experiences under lockdown conditions, exploring disciplinary implications and the necessity for experiential learning. Section 5 engages in a discussion of results, identifying main findings, limitations, and future work. Section 6 concludes the work, summarizing key insights.

2 Background

2.1 Learning experiences during uncertain situations

Uncertain situations involve unpredictable outcomes with meaningful ramifications or significant changes. Extreme uncertainty can lead to disruptions due to high instability, impacting normal event operations. In the context of education, universities face sudden disruptions, forcing closure or reorganization (Bennett and Lemoine, 2014; Jung et al., 2021).

Transitioning from face-to-face to home remote learning in HE during uncertain events poses challenges (Mou, 2023; Selvanathan et al., 2023). Students navigate home-schooling, but encounter issues like engagement difficulties, limited interactions, unclear teaching materials, insufficient resources, inequitable infrastructure access, and social isolation (Kundu and Bej, 2021; Alawamleh et al., 2022). Addressing these challenges requires supportive teaching, learning,

and assessment activities aligned with novel scenarios to maintain motivation and engagement (Biggs and Tang, 2011). Hence, this work focuses on (re-)shaping learning experiences, defined as specific engagements with learning purposes that transform perceptions and promote knowledge, skills, and attitudes acquisition. Disruptions of learning experiences lead to a shift from on-campus to online interactions, affecting instructional designs and learnability, especially in practical courses like laboratories (Bangert, 2020; Christian et al., 2020; Burki, 2021).

To address difficulties, this work proposes incorporating real-world uncertain conditions in remote learning experiences as study situations. This possibility can enhance relevant learning by doing, emphasizing active learning. Thus, teachers play a crucial role in developing suitable learning experiences, and aligning intended learning outcomes with content, activities, and assessments in this type of situation under a constructive alignment (Biggs and Tang, 2011; Hailikari et al., 2022). This approach emphasizes “what-to-learn,” “how-to-learn,” and “how-to-assess-learning.”

2.2 The constructive alignment of learning experiences and activities

Learning activities provide the building blocks of learning experiences but these are required to form a constructive alignment (Biggs and Tang, 2011). The notion of constructive alignment refers to a holistic approach to curriculum design and pedagogy that

emphasizes aligning intended learning outcomes with teaching strategies and assessment practices. Constructive alignment theory is based on three central principles, (i) intended learning outcomes (ILOs), (ii) teaching and learning activities (TLAs), and (iii) assessment tasks (ATs). The theory proposes that effective alignment between these components leads to enhanced student engagement, deep learning, and the development of desired knowledge and skills. Alignment is achieved by ensuring that ILOs reflect the desired learning outcomes or “what-to-learn,” TLAs facilitate the achievement of those outcomes as “how-to-learn,” and ATs assess students’ attainment of the intended outcomes in terms of “how-to-assess-learning.” Teaching and learning activities become crucial in developing the requisite ILO verbs whereas the AT challenge is to authentically students’ achievements.

A conceptual framework for constructive alignment in Figure 1 situates a structure of educational components under the effects of disruptive uncertain situations, embedded in ILOs, TLAs, and ATs (Fenech et al., 2020). In addition, aspects of disruptive uncertain events, as relevant study situations can define learning experiences to carry out experiential learning activities. Thus, students can find relevance in this type of experience to increase their motivation and engagement.

In terms of “what-to-learn,” learning objectives define the purpose of a course, outlining its content. Conversely, learning outcomes articulate the expected abilities of a successful learner after a module or course. Regarding “how-to-learn,” instructional design shapes the pedagogical approach, considering factors such as active or passive

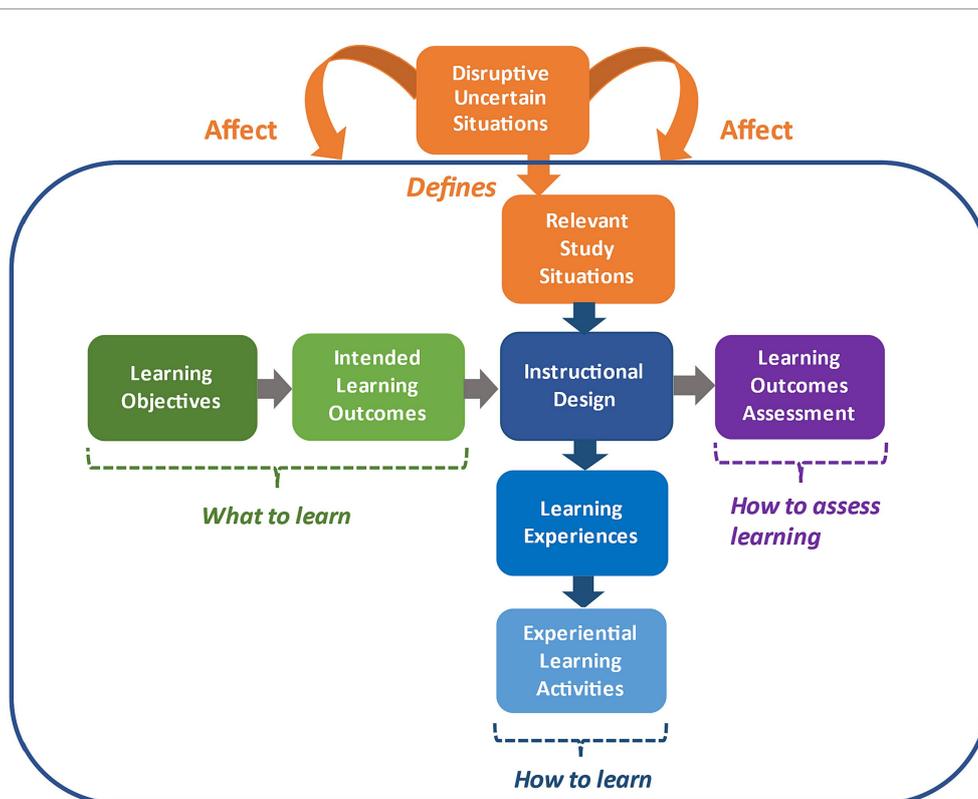


FIGURE 1
A conceptual framework for the constructive alignment of learning experiences under disruptive uncertain situations (own elaboration, adapted from Biggs and Tang, 2011; Fenech et al., 2020).

learning and individual or collaborative approaches. This work adopts Kolb's experiential learning (Kolb, 1984), enabling students to learn by actively engaging in tasks within meaningful situations. Experiential learning aligns with Higher Education's emphasis on real-world relevance and skill development through four stages of concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE) occurring in a continuous experiential learning cycle.

In "how-to-assess-learning" achievements, instructors focus on students' attainment of intended learning outcomes. This involves formative and summative approaches, using methods like practicums, presentations, projects, reflective journals, and portfolios. Additionally, the assessment includes evaluating students' expectations fulfillment, motivation, engagement, and perceived learning relevance through surveys and questionnaires, ensuring a comprehensive understanding of the learning experience's success.

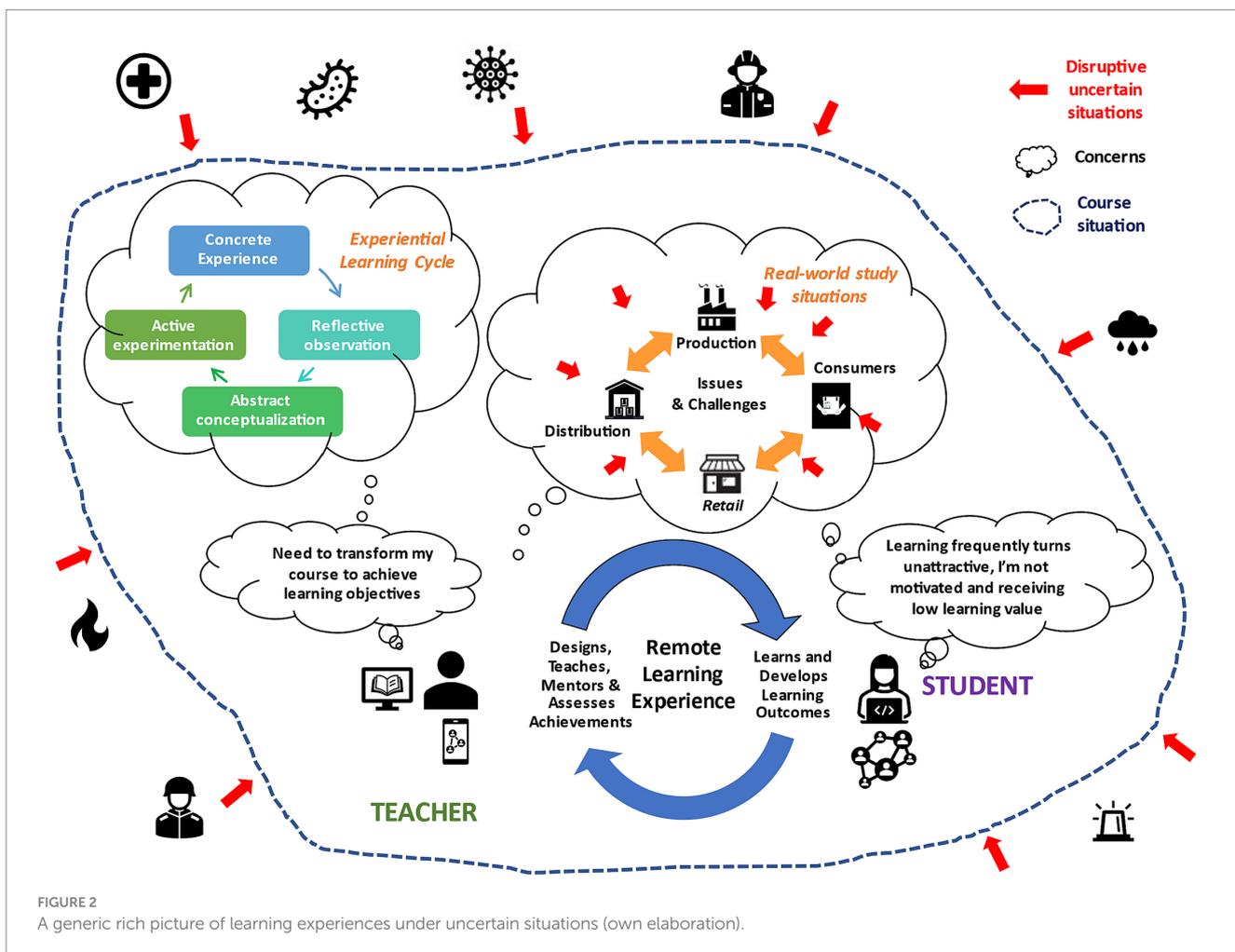
2.3 The conceptualization of learning experiences

The next step is to conceptualize learning experiences in disruptive uncertain situations. In this sense, this work regards the use of the rich picture and purpose statement tools because of their possibility to

structure problem situation definitions under multi-perspective, vague, and unclear scenarios (Checkland and Scholes, 1999).

A rich picture is a systemic pictorial representation of a situation from an observer's viewpoint highlighting relevant participants, issues of concern, and a structure of participants' relations and transformative processes (Checkland and Scholes, 1999). An example of a rich picture is presented in Figure 2 to describe a generic remote SCML course under an uncertain situation in which a teacher and students express their concerns. This rich picture stresses the need to transform the existing instructional design and improve the students' experience by adopting real-world study situations to enrich experiential learning activities. In the case of SCML education, the focus of this work, the study situations can involve diverse issues and challenges during natural disasters, sanitary emergencies, or humanitarian crises, among others regarding, for instance, the delivery of products and services to end consumers.

In addition, purpose statements, also known as root definitions, are commonly used in appreciative systems theory to name situations where peoples' viewpoints and concerns turn paramount to structure systems' definitions (Checkland and Scholes, 1999). A purpose statement follows a statement structure of what to do (To do X), how to do it (by means of Y), and with what purpose (with the purpose of Z). The corresponding purpose statement of the rich picture in Figure 2 is presented below.



A remote learning experience to (X) develop supply chain management learning outcomes for SCML education under an uncertain situation, through (Y) studying real-world challenging scenarios in experiential learning activities, with the purpose of (Z) providing students with engaging and motivating experiences.

Therefore, learning experiences can be identified in a rich picture and named with a purpose statement to summarize experiential learning activities. This aspect defines “what-to-learn” in the learning experience. Furthermore, learning experiences’ conceptualization must be translated into arrangements of activities according to the four stages of Kolb’s experiential learning cycle to produce the intended learning outcomes. This is about defining “how-to-learn” in the learning experience. Finally, the purpose statement can also help to define “how-to-assess-learning” achievements by providing performance criteria for X, Y, and Z.

3 Methods

The methodology of this work considered a mixed-method approach to conceptualize instances of learning experiences based on qualitative and quantitative approaches in combination to examine their complexity (Timans et al., 2019). In this regard, the methodology helped in advancing the exemplification of learning experiences and the evaluation of results for conducting research in the social domain (Vahl, 1997).

Accordingly, a single exploratory case study was proposed to study a learning experience for SCML education during a disruptive uncertain situation concerning an undergraduate logistics course in a private university in Cochabamba, Bolivia. A case study applies to a unique or a small number of situations, locations, or events to explain a new method or gain insights into its particularities, rather than conclusions on other cases or generic issues (Tharenou et al., 2007). Accordingly, the case study illustrates the instructional design of a single learning experience using an in-depth exploration using the proposed framework of constructive alignment and experiential learning. In this regard, the learning experience for SCML education was designed based on the use of rich pictures, purpose statements, Kolb’s experiential learning cycle/activities, and assessment methods to examine constructive alignment as indicated in Figure 1. As the selected case study in this work refers to a single learning experience implementation, no comparisons are made with control groups to develop inferences, generalizations or characterising broader populations concerning other disruptive situations. In this case, the emphasis is on describing the articulation of constructive alignment and experiential learning.

A mixed method approach was used for data collection and analysis to construct formulations and statements on the learning experience. The collected primary data included observational reports from teachers about their course instructional design and the learning experience, providing the necessary background information based on the proposed framework in Figure 1. Secondary data included (i) students’ examinations to inform about their learning results (as continuous variables), (ii) assessments of students’ achievements in learning outcomes (as ordinal qualitative variables), and (iii) students’ opinions on their learning experience (i.e., motivation, interest, engagement, and learning relevance as ordinal qualitative variables)

through a longitudinal process with an intervening period of time during the academic term. These variables required specific instruments for data collection, which also involved evaluation rubrics, checklists, opinion surveys, interviews, and direct observation. Later, collected data was analyzed using descriptive statistics (i.e., mean, standard deviation, median, and interquartile range (IQR)) and non-parametric tests (i.e., Mann–Whitney test) to describe and elaborate on formulations and statements regarding the learning experience’s results. The case study background and results are presented in Section 4.

The discussion of results (see Section 5.1), regarding the learning experience and students’ achievements and opinions, was further contrasted against the underlying theories and the research aims to (re-)elaborate statements regarding the learning experience, the implementation, or further actions (i.e., instructional design improvements). Finally, results allowed for discussing the research findings, including limitations, and future work. If claims and statements on learning experiences reach consistency with the underlying theories, the results may be transferred and applied or used to develop other instances. Nevertheless, further implementations are required to continue testing and validating the propositions of this work.

Furthermore, collected data relate to observations, opinions, or reports of what people claim to have seen or experienced (de Zeeuw, 1996). Hence, in this work, observations depend on viewpoints, behaviors, or reactions of what or who is being observed (e.g., students and academics). As a result, observations, analysis, and their interpretations are constrained to this single instance of a learning experience.

Accordingly, the next section presents the application of the methodology (steps 1–3) in one instance of a learning experience to describe its implementation as a case study. Moreover, in Section 5 the analysis of results is discussed to evaluate and interpret results (step 4), and findings, limitations and future work are presented to conclude the case study. Overall, this approach intends to identify the contribution of learning experiences to students reach their intended learning outcomes while maintaining motivation, engagement, and learning relevance during their prevailing learning context.

4 Results

This section describes a case study of a learning experience under a disruptive uncertain situation. The case study unfolds in two subsections. First, the description of the background circumstances of an undergraduate course during the COVID-19 pandemic at a university in Bolivia, including its justification, implications, and requirements to face the novel learning conditions. Second, the development of a particular instance of a learning experience as indicated in Section 4.1.

4.1 An undergraduate course under an uncertain situation

During the COVID-19 pandemic in 2020 and 2021, the Universidad Privada Boliviana (UPB) in Cochabamba, Bolivia, implemented an innovative educational initiative for SCML education

in the Industrial and Systems Engineering program, to maintain active learning despite the remote learning conditions. The initiative focused on the II3012 Integral Logistics course, addressing disruptions in food supply chains for nanostores (i.e., small independent grocery retailers). Despite remote learning challenges, the course aimed to offer practical experiences considering the unique circumstances of the pandemic.

The II3012 Integral Logistics course broadly covers the necessary processes and operations to allow for the effective and efficient flow of goods, services, or information, through the entire activity networks of organizations and their supply chains. The appropriate supply chain planning, organization, direction, and control contribute to meeting internal and external customer requirements from raw material producers to end consumers, concerning production activities, inventory management, distribution, as well as the physical transportation of goods. Accordingly, effective supply chain management generates profitability, customer value, and a positive sustainability impact, which represent overall a great managerial and operational challenge for organizations.

Therefore, this course aims to equip students with the knowledge, methods, and tools to respond to this type of challenge. Accordingly, students should develop skills for problem solving and decision making in complex contexts as part of supply chain-related learning experiences.

Disciplinary and transdisciplinary learning outcomes are defined in the course syllabus. ABET disciplinary student outcomes emphasized problem-solving, engineering design, and experimentation (ABET, 2021). Transdisciplinary outcomes included creativity, innovation, and critical thinking as indicated in the course syllabus. The course also employs active learning methods to develop the intended learning outcomes. One example is the real-world Taquiña Challenge to improve logistics for a brewery company in Cochabamba (Silva-Ovando et al., 2022). In this case, this experience provided insights concerning the development and implementation of experiential learning activities following Kolb's experiential learning cycle in a business context, improving the warehousing and distribution of goods in the last mile of urban areas.

Overall, students are provided in this course with study situations concerning different supply chain scenarios, like:

- Consumer preferences and retail choices across different social, cultural, economic, and geographical profiles in urban areas,
- Last-mile supply service level for beverage retailers,
- Short food supply chains of perishable products, from farmers to consumers,
- Loading and unloading operations of supply chain intermediaries in a beverage company,
- Food loss of fresh food supply chain in last-mile distribution,
- Consumer-packed goods' delivery times in densely populated areas, among others.

However, the COVID-19 pandemic disrupted on-campus courses and fieldwork, necessitating a shift to remote learning. The course adapted by conceptualizing a new challenge related to household food supply chain disruptions during the pandemic. This allowed students to explore disciplinary scenarios under uncertain situations.

This initiative was developed through the remote collaboration of academics of the UPB and Tecnológico de Monterrey in Mexico within the umbrella of the MIT Supply Chain and Logistics Excellence

Network in Latin America and the Caribbean (MIT SCALE LATAMC). Previous work on experiential learning concerning last-mile logistic operations provided the conceptual background for upgrading previous face-to-face learning experiences to overcome the COVID-19 pandemic sanitary restrictions (Salinas-Navarro et al., 2021; Silva-Ovando et al., 2022).

Accordingly, the course during the COVID-19 pandemic emphasized food last-mile supply chains and logistic design. It covered processes and operations facilitating the flow of goods, services, and information, with an emphasis on sustainable supply chain planning, organization, and control. During the COVID-19 pandemic, end consumers of grocery products encountered challenges related to the accessibility, availability, and affordability of goods. These difficulties arose due to abrupt increases in product demand and prices, production stoppages, delivery interruptions, and staff shortages. In response to these issues, improvements were necessary in the supply chain of food products to ensure the continuous provision of goods within communities and neighborhoods. Addressing this situation required modifications in various aspects of food supply, including inventory management, warehousing, distribution strategies, transportation, deliveries, retailing operations, decision-making models, and communication practices, among others. Therefore, sustainable solutions must be designed to effectively connect distributors and retailers with consumers for last-mile deliveries to enhance food supply during disruptive situations.

Consequently, students had to undertake a comprehensive study of the prevailing food supply situation from their residences without leaving their homes. This involved engaging with suppliers (during their home deliveries and maintaining sanitary restrictions) to understand the challenges they faced. Additionally, students had to observe and document their own difficulties and those experienced by family members, relatives, and neighbors. This collaborative approach aimed to gather and share information, facilitating a broader contextual understanding of the difficulties posed by the pandemic on the grocery supply chains.

The course addressed the broader implications of the COVID-19 pandemic on SCML education, particularly concerning disruptions in food chains and food security. The link between food supply and SCML was highlighted because of the logistic inefficiencies that created the difficulties people experienced in securing their food supply, jeopardizing their nourishment and wellbeing, particularly impacting vulnerable regions like Latin America (Salinas-Navarro et al., 2021). Therefore, the relevance of the SCML discipline was recognized by students to overcome the existing food supply issues. The course also provided an opportunity to innovate in sustainable logistics and supply chain management education, aligning with Sustainable Development Goals (SDG) #2 Zero Hunger and #11 Sustainable Cities and Communities (United Nations, 2015). The learning experience offered an opportunity to incorporate the concepts of food security and community resilience to study SCML topics under the effects of the COVID-19 pandemic, as an uncertain disruptive situation. This proposition provided active experiential learning in the SCML education approach despite the limitations. No other similar learning experiences have been offered for SCML education in the literature in these terms.

In conclusion, the learning experience focused on the disruption caused by the COVID-19 pandemic on food supply chains in peripheral neighborhoods in Cochabamba, Bolivia, in 2021. The

following section explores the corresponding remote learning experience during this period and its potential for providing students with relevant study situations amid disruptive and uncertain restrictions.

4.2 The learning experience development

The course offered an alternative for thirteen students to overcome remote learning limitations during the COVID-19 pandemic while overcoming their educational limitations. It aimed to develop intended learning outcomes, maintain an experiential learning approach, and enhance engagement, motivation, and learning relevance. This approach aligns with the research aim. The learning experience for the I13012 Integral Logistics course was designed based on pre-course surveys conducted in Bolivia and Mexico between March and May 2021. The survey focused on understanding how the pandemic affected food purchase behavior, identifying lockdown restrictions, and assessing changes in house baskets due to food supply chain disruptions. The results informed the learning experience for the first semester of 2021, allowing students to actively learn and study the disruption of food supply chains during the pandemic. Students

prioritized and studied the most affected supply chains identified disruption factors, and proposed solutions for last-mile logistics. This approach defined the learning experience's content. The application case for the I13012 course in the first semester of 2021 is summarized using the HAS method, as outlined in Section 2.4, with Figure 3 depicting a rich picture of the learning experience for SCML education in real-world, multidisciplinary situations during the pandemic.

The rich picture shows participants' concerns, relations, and roles to depict their contextual learning conditions. Moreover, a purpose statement of the learning experience reads as follows:

A learning experience (X) to engage students in the exploration of the effects of supply chain and logistics operations on the resilience and impact of city neighborhoods and communities over the COVID-19 pandemic; (Y) by actively observing, reflecting, designing, and applying Logistics and Supply Chain Management knowledge in a remote learning class under the lockdown restrictions; (Z) to develop problem-solving abilities in a relevant real-world learning situation.

To achieve the intended learning outcomes, students followed an active learning approach, engaging in individual and collaborative

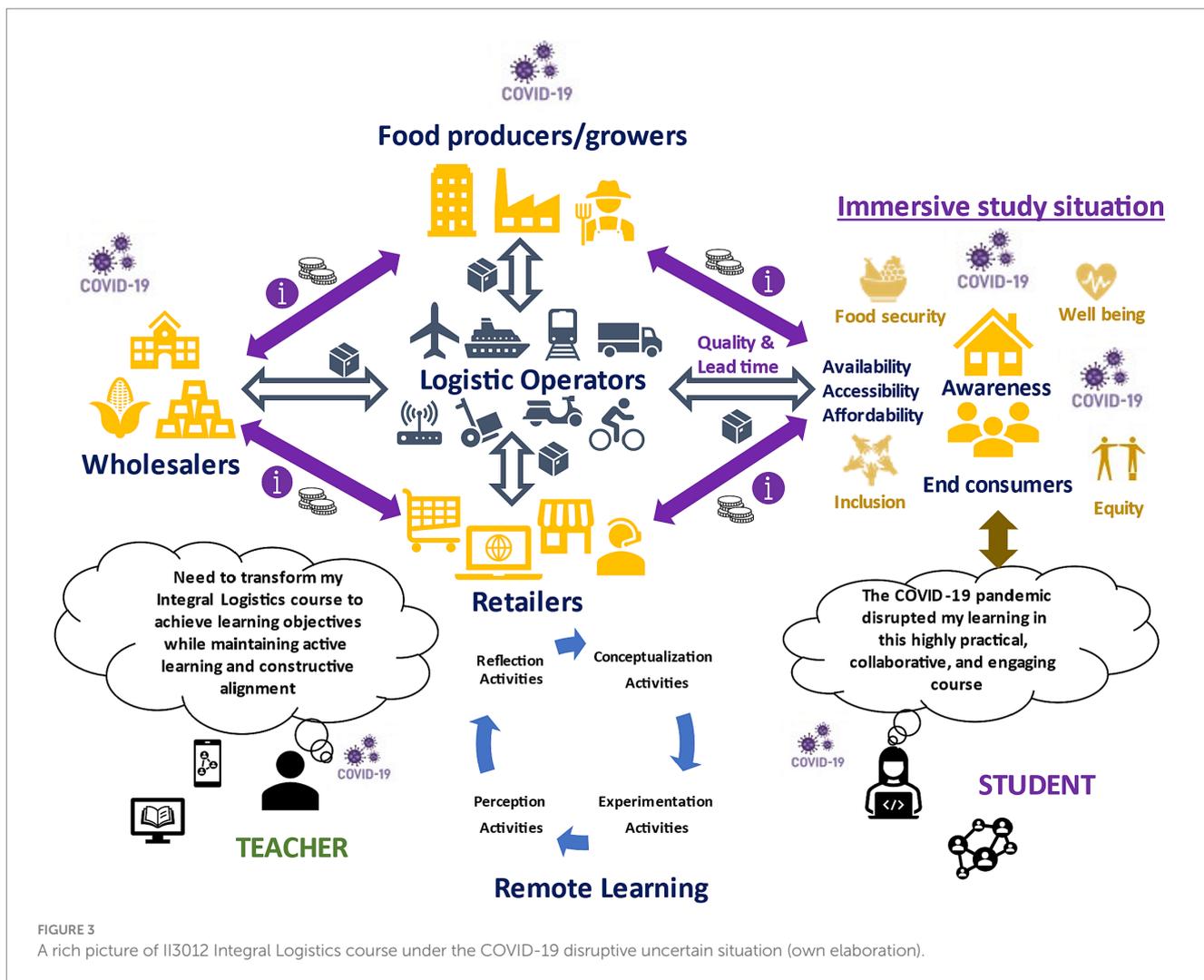


FIGURE 3 A rich picture of I13012 Integral Logistics course under the COVID-19 disruptive uncertain situation (own elaboration).

activities (in teams of 4 to 5 members) based on Kolb's experiential learning cycle (see Table 1). This approach dictated the learning process. Initially, students collaboratively designed a methodology for collecting, collating, and analyzing primary and secondary data, completing the concrete experience (CE) stage. Using methods such as literature review, structured interviews, surveys, and direct observation, students gained an understanding of the effects of the COVID-19 pandemic on food supply chains, family consumption preferences, and purchasing patterns.

Next, students identified and analyzed key variables (see Table 2) influencing a specific food supply chain's continuity in a chosen urban region. Employing the collected data, students defined a problem within a particular supply chain. Supply chain and logistics professionals from various companies collaborated with students in seminars to discuss their last-mile logistic operations and approaches to addressing COVID-19 disruptions. These professionals provided insights into pandemic impacts and unanswered issues, allowing students to make sense of the study situation, and completing the reflective observation (RO) stage of the experiential learning cycle.

In the third stage, students related identified problems to potential solutions using provided theories, methods, tools, and practical knowledge from professionals, completing the abstract conceptualization (AC) stage of experiential learning. Consequently, students designed last-mile strategies to enhance supply chain resilience and flexibility, applying their disciplinary knowledge and skills in operations, logistics, and supply chain management to propose viable solutions to presented problems.

For each case, students received additional training on specific methods and tools, if necessary, such as optimization modelling, simulation, GIS software, and statistical analysis, among others. Students were to analyze collected data using descriptive and inferential statistics. The main findings of the analysis were described in four main ideas:

- Significant effects on products: Product price, assortment, and quality variation.
- Changes in consumption patterns and requirements.
- Retail landscape transformation and consumption preferences by socioeconomic level.

- Disruption level of logistics and supply chains: Changes in availability, accessibility, affordability and purchasing opportunity.

Finally, stakeholders, including academic partners and professionals in supply chain management and logistics, evaluated students' proposals. Students presented their findings and proposals to experts and teachers, receiving feedback from both an academic and practical perspective. As part of the learning outcomes, student teams delivered a final report and presentations, completing the active experimentation (AE) stage of the experiential learning cycle. The assessment included individual evaluation of transdisciplinary outcomes in follow-up sessions by the teacher and collective assessment of disciplinary learning outcomes during the final presentation by the teacher and stakeholders. Evaluation criteria considered the relevance, pertinence, and quality value of their proposals. Key results focused on:

- Preventing food chain disruptions, utilizing strategic tools to anticipate potential disruptions like the bullwhip effect, reinforcing traditional and short supply chains, and supporting vulnerable supply chain echelons such as producers and vulnerable consumers.
- Designing and reconstructing resilient supply chains, including inclusive models for specific communities, and addressing nutritional deserts.

The learning experience provided students with diverse perspectives on study problems, enabling them to generate creative solutions to overcome limitations, challenges, and barriers related to improving warehousing operations, optimizing last-mile deliveries, and redesigning distribution strategies, among other aspects.

4.3 Learning assessments and achievements

The assessment framework for the learning experience comprised three key components. First, students' performance (i.e., final marks) was evaluated through a formative exam (20% of the total mark) and

TABLE 1 Experiential learning stages and activities.

Experiential learning	Activities description
Concrete experience (CE)	<ul style="list-style-type: none"> • Collect and tabulate quantitative data regarding food supply at home with family members and acquaintances during the COVID-19 crisis using a pre-designed survey over social networks; • Collect and classify qualitative data (i.e., observations and reports) about household food supply practices over time regarding product assortment, quality, delivery times, accessibility, availability, and affordability of food items; • Examine key variables affecting food supply practices concerning order size, purchase amount, product categories, retail format and location, delivery times, service times, service level, and household location;
Reflective observation (RO)	<ul style="list-style-type: none"> • Analyze the aggregated survey database using descriptive and inferential statistics to identify the variables' patterns, correlations, and relationships; • Identify a problem or issue of concern about food supply during the pandemic regarding the quality, delivery times, accessibility, availability, and affordability of food items; • Relate the problem or issue of concern to supply chain management and logistics theories and methods.
Abstract conceptualization (AC)	<ul style="list-style-type: none"> • Design and propose logistic changes in food chains to overcome the existing disruption crisis.
Active experimentation (AE)	<ul style="list-style-type: none"> • Summarize and defend a proposal based on the leverage points to overcome the situation; • Write up a research report.

TABLE 2 Key study variables of the learning situation.

Section	Category	Purpose	Questions
1	Location	Learn the surveyed location	Bolivia: State and city
2	Consumer Profile	Explore the consumer's profile, socioeconomic level, and access to transportation	Gender
			Age
			Civil status
			Household size
			Average income
			Vehicle ownership
3	Characterization before the pandemic	Explore consumer purchasing preferences previous to the COVID-19 pandemic	Preferred retail channel and reason
			Purchase method
			Purchase frequency
			Food accessibility
			Food availability
			Food opportunity
4	Characterization during the pandemic	Explore consumer purchasing preferences during the COVID-19 disruptive situation	Preferred purchase channel and reason
			Purchase method
			Purchase frequency
			Food accessibility
			Food availability
			Food purchasing opportunity
5	Effects of the pandemic	Explore perception changes in the availability and consumption of food during the pandemic	Scarcity perception
			Availability time
			Price variation
			Consumption preferences variation
			Perception of food quality consumption change

a comprehensive final report (80% of the total mark). Second, the assessment covered both disciplinary ABET and transdisciplinary learning outcomes. This assessment is not considered in the students' marks as it provides information for pedagogical improvement and program accreditation purposes. Third, the overall course and learning experience were evaluated using student surveys conducted at the beginning and end of the course, focusing on student interest, motivation, and perceived relevance of learning activities. This assessment provided feedback for pedagogical improvement.

Participation in this learning experience involved thirteen undergraduate students in industrial engineering, guided by one faculty member, spread across twenty-four sessions delivered over five weeks. Adherence to prevailing academic regulations was ensured throughout the course by not changing any course specifications or overseeing any academic policies concerning student attendance or participation.

It's essential to note that demographic factors like gender, age, background, and attendance were not considered during data collection, promoting an inclusive environment. That is, students did not have to disclose any personal information, avoiding any individual questioning or judgment during the learning experience. All students had equal opportunities to voluntarily engage in learning activities, assessments, and data collection processes, eliminating the need for sampling or random selection. Additionally, students participated voluntarily and

anonymously in surveys, leading to varying response rates. Importantly, despite the challenges posed by the COVID-19 pandemic, participants reported minimal disruptions to their engagement.

Furthermore, this study intentionally refrained from including illustrations of student assignments or detailed learning outcomes, as these aspects fell outside the study's specific scope. Student assignments involved proposals and discussions regarding solutions to improve the food supply chain and logistics operations, not focusing on the learning experience. The variables defining "how-to-assess learning" achievements and the learning experience are summarized in [Table 3](#).

Given the limitation in the number of students who enrolled in this topic (13 students) and the absence of a control group, a descriptive analysis of the results has been chosen. The detailed results and findings are presented in [Tables 4–7](#), which show descriptive statistics such as means, standard deviations, medians, modes, quartiles, minimum and maximum values, and ranges. Finally, non-parametric methods such as the Mann–Whitney test were used. These types of tests do not assume normality in the distribution of data, which is an advantage in small samples where the assumption of normality may not necessarily be met. Moreover, it is crucial to remember that, with small samples, the ability to generalize results is limited. Therefore, the studies and analysis are more focused on exploration and description rather than inference.

TABLE 3 Study variables of the learning experience.

Variables	Scale	Instrument
Final course mark (individual)	0–100	Weighted mark calculation
Exam (individual)	0–100	Mark calculation
Report mark (group work)	0–100	Rubric
Attainment level in learning outcomes (disciplinary and transdisciplinary)	1–4	Rubric
Level of interest (initial and final)	1–5	Survey
Level of motivation (initial and final)	1–5	Survey
Level of relevance of the learning experience (initial and final)	1–5	Survey
Level of ability to create committed, sustainable and supportive solutions for cities and communities (initial and final)	1–5	Survey

TABLE 4 Students' marks.

Marks	N	Mean	StdDev	Min	Q1	Median	Q3	Max	Range	Mode
Final	13	88	4	75	86	89	90	91	16	89
Exam	13	84	11	50	83	88	91	93	43	91
Report	13	89	1	87	87	90	90	90	3	90

Among the noteworthy outcomes, all students achieved a 100% passing rate in the course evaluation. Furthermore, 77% of students met the minimum acceptable level in ABET student outcomes (1), (2), and (6), while creativity and innovation witnessed a 100% achievement at the minimum acceptable level, with critical thinking at 69%. These statistics provide a comprehensive overview of the student's academic performance and perceptions of the learning experience.

5 Discussion

5.1 Results discussion

This study delves into the implementation of experiential learning in a higher education course focused on the disruptions of food supply chains during the COVID-19 pandemic, aiming to assess its effectiveness in improving students' interest, motivation, and learning relevance. The case study not only sheds light on the academic outcomes but also explores students' perceptions of the learning activities. Furthermore, the results illustrate the learning experience in terms of a rich picture and purpose statement highlighting two complementary views of the COVID-19 pandemic impact, that is, teaching within a structure of experiential learning and constructive alignment while students learn in a collaborative, engaging and practical immersive and relevant situation.

Despite limitations, the case study showcases students' ability to apply learning to real-world challenges under uncertain situations, especially during the COVID-19 crisis. The successful translation of a contextual uncertain situation into a study situation and pedagogical design, using constructive alignment and experiential learning principles, highlights the adaptability of active learning activities to real-world challenges.

Accordingly, the case study illustrates an enhancement of the intended learning outcomes under remote learning conditions. The disruptive uncertain situation leveraged "what-to-learn" in the course by providing learning relevance and disciplinary pertinence

to existing real-world challenges during the pandemic. In this sense, intended learning outcomes turn as dynamic rather than static definitions to enrich instructional designs. Moreover, despite the disruptive uncertain situation constrained teaching and learning activities because of the remote learning conditions, experiential learning activities were deployed to maintain "how-to-learn" through a cycle of reflective and practical activities that kept students motivated and engaged. Regarding "how-to-assess-learning," the disruptive and uncertain situation offered the possibility of developing novel assessment methods beyond exams and considering their opinion on the learning experience concerning their motivation, interest, learning relevance, and learning outcome development.

Results from the case study indicate substantial progress in course passing rates, project marks, and learning outcome achievements, demonstrating the positive results of this learning experience. The assessment methods employed reveal higher mean and median project marks compared to exams, suggesting a positive impact on student performance (see Tables 4, 5). Despite notable achievements, there is room for improvement in attaining expected levels of learning outcomes (median value above 3), particularly in critical thinking in which the Q1 result is 2. Moreover, student opinion surveys (see Tables 6, 7) consistently reflect a high regard for the learning experience, with scores of 5 in the final survey for relevance, interest, and motivation. The positive impact of learning activities on citizenship commitment ability, as indicated by a median score of 4 in the final survey, further reinforces the success of the experiential learning approach.

Statistical analysis using the Mann–Whitney test affirms the stability of student opinions throughout the learning experience (Nachar, 2008). Referring to relevance, interest, and motivation (see Tables 6, 7), the p values of the Mann–Whitney two-tailed test (0.35238, 0.60306 and 0.60306) indicated that the null hypothesis could not be rejected because $p > \alpha = 0.05$ in all cases. This result means that the medians of the two groups of survey answers were not different ($H_0: \theta_x = \theta_y$, $H_1: \theta_x \neq \theta_y$, where θ_x is the median of the first group and θ_y is

TABLE 5 Learning outcomes assessment.

Learning outcomes	N	Min	Q1	Median	Q3	Max	Range	Mode	N Mode
ABET student outcome 1: "An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics"	13	2	3	3	4	4	2	4	3
ABET student outcome 2: "An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors"	13	2	3	4	4	4	2	4	3
ABET student outcome 6: "An ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgement to draw conclusions"	13	2	3	3	4	4	2	3	3
Creativity and innovation: "An ability to generate new ideas and solutions, novel, original and different, aimed at solving problems or needs in different situations or contexts, to create value sustainably, within the reach and disposal of the society"	13	3	3	3	4	4	1	3	8
Critical thinking: "An ability to question, analyze, interpret, synthesize, assess and make reasoned judgments about complex situations with an open, reflective and constructive attitude, seeking to gain a deep understanding of the facts and develop knowledge, behaviors or attitudes that are adapted to these situations or the transform. Likewise, accessing scientific knowledge by applying their methods, to objectively approach reality and obtain or reject scientific results"	13	2	2	3	4	4	2	3	5

TABLE 6 Students' opinion survey of the learning experience (initial results).

Question	N	Min	Q1	Median	Q3	Max	Range	Mode	N Mode
1. How RELEVANT is doing the food supply activities in this course to your studies and professional practice?	11	3	4	4	5	5	2	5	5
2. What level of INTEREST do you get from doing the food supply learning activities in this course to benefit your future professional practice?	11	4	4	5	5	5	1	5	7
3. What level of MOTIVATION do you get from this course's food supply learning activities?	11	4	4.5	5	5	5	1	5	8
4. How do you now consider the level of development of your ability to create committed, sustainable, and supportive solutions to social problems and needs through strategies that strengthen democracy and the common good?	11	1	2	3	3.5	5	4	2	4

the median of the second group). We could interpret this as students maintaining a high level of recognition during the learning experience. In the case of citizenship commitment, $p < \alpha = 0.05$ ($p = 0.01174$); therefore, the null hypothesis was rejected. While there was no significant difference in medians for relevance, interest, and motivation, citizenship commitment witnessed a significant increase. It is crucial to note the limited data records used for this test, emphasizing the need for a larger participant pool in future cases.

Overall, the favorable assessment of the learning experience suggests that the high level of student interest, motivation and learning relevance positively influenced their engagement and participation, and consequently, the student learning outcome achievements and performance results. This claim is consistent with previous research

on the effectiveness of active methods, highlighting similar benefits (Aji and Khan, 2019). Therefore, the experiential learning approach presented in this work, suggests having achieved its expected results.

Considering the research process, discussions about reliability, transferability, and validity emerge (Vahl, 1997). Survey reliability is compromised by an 84.61% participation rate (Singh and Masuku, 2014). According to the Yamane simplified formula of proportions for survey answers, these results represent a level of precision (e) or sampling error of 11.82%. These calculations assume a confidence level (P) of 95%, population (N) of 13, and sample size (n) referring to the answers gathered (11) in each survey. Moreover, the transferability of this work is contingent on researchers developing further instances of learning experiences to exemplify its use. Concerning validity, the single

TABLE 7 Students' opinion survey of the learning experience (final results).

Question	N	Min	Q1	Median	Q3	Max	Range	Mode	N Mode
1. How RELEVANT was doing food supply activities in this course to your studies and professional practice?	13	4	4	5	5	5	1	5	8
2. What level of INTEREST did you get from doing food supply learning activities in this course to benefit your future professional practice?	13	4	5	5	5	5	1	5	10
3. What level of MOTIVATION did you gain from conducting food supply learning activities in this course?	13	3	4	5	5	5	2	5	8
4. How do you consider the development of your ability to create committed, sustainable, and supportive solutions to social problems and needs through strategies that strengthen democracy and the common good in the Sustainable Cities and Communities learning activities in this course?	13	3	4	4	5	5	2	4	6

case study limits claims about the generalizability of observations to other instances, necessitating additional cases for robust inferences.

Summing up, the study illustrates the positive outcomes of applying constructive alignment and experiential learning in logistics education. It not only shows the effectiveness of this approach in enhancing students' skills and performance but also demonstrates its adaptability to learning during disruptive uncertain situations. The case study serves as a model for future work for integrating real-world disruptive challenges into pedagogical designs, emphasizing the significance of constructive alignment, experiential learning and teaching-based research with undergraduate students. However, further exemplifications are required to test and validate the propositions of this work in other instances or situations.

5.2 Main findings

This work introduces an approach to active learning in HE by using constructive alignment and experiential learning during disruptive uncertain situations, particularly focusing on SCML education. The framework addresses the impact of supply chain disruptions during the COVID-19 pandemic and its use for educational purposes, specifically to seamlessly enrich the conceptualization of experiential learning activities during uncertain situations. The case study demonstrates the relevance of this type of uncertain situation to enhance a constructive alignment of ILOs, TLAs and ATs with a positive impact on student achievements.

Surveys indicate that students perceived the learning experience positively, and the study suggests a positive relation between the effectiveness of the learning experience and learning outcomes, although a detailed statistical analysis is lacking. In conclusion, the findings support the effectiveness of experiential learning in promoting sustainability and student engagement, offering valuable insights for educators seeking to create meaningful and motivating learning experiences.

Moreover, the study highlighted the social dimension of supply chains concerning the effects of the COVID-19 pandemic on food supply, social inclusion, and equity for disciplinary learning purposes. The uncertain COVID-19 pandemic situation allowed for demonstrating the disciplinary value of SCML beyond medical or sanitary aspects to increase students' learning relevance. Nevertheless, further examples are needed to broaden disciplinary topics.

Finally, the use of rich pictures and purpose statements represents a new application for this type of appreciative tool to unveil people's views and understandings of a situation. The tools allowed for supporting a reflective teaching practice in which the contextual conditions of learning experiences can be systematically addressed for teaching and learning purposes. Accordingly, the incorporation of uncertain situations within the structure's constructive alignment and the use of rich pictures and purpose statements represent the main contribution of this work.

5.3 Limitations

Despite its contributions, this work and the associated learning experience have limitations. The selection of constructive alignment and experiential learning as pedagogical approaches represent a limitation, as other methods like challenge-based or problem-based learning could be considered in future efforts. The use of a single case study restricts conclusions to that specific instance, making it challenging to generalize findings. Ethical considerations also arise, as offering different uncommon learning experiences to students may not be enriching for all. Survey results are dependent on student perspectives, and the limited number of participants hinders comprehensive statistical analysis. Future instances should aim for increased participant numbers and tailored assessment instruments. Despite these limitations, the study indicates the positive impact of engaging learning experiences on students' motivation and interest in sustainable supply chains, emphasizing the importance of meaningful learning during uncertain situations and the potential of integrating research activities for professional development. However, the additional workload for instructors in designing, planning, executing, and evaluating such experiences may pose challenges for widespread adoption and replication by other academics.

5.4 Future work

Further implementations of new learning experiences are essential to enhance the design and evaluation of research results. Future efforts should focus on creating diverse instances for data collection, analysis, and the development of statements, conclusions, contributions, and use. This includes exploring various study situations, topics, and

disruptive scenarios across disciplines and academic programs, incorporating both undergraduate and postgraduate levels to enrich learning experiences. Additionally, there is a need to investigate the effectiveness of learning experiences in improving student learning, requiring the adoption, adaptation, or development of new data collection instruments for in-depth variable analysis.

Additionally, new explorations should delve into the connection between logistics, supply chains, and their impact on food supply for educational purposes. For example, examining how logistic operations and efficiency affect food accessibility, availability, and affordability could contribute to conceptualizing challenges and identifying relevant scenarios for novel learning experiences in the discipline.

6 Conclusion

Despite challenges in remote learning, active learning experiences can be leveraged to create innovative learning activities during disruptive uncertain situations, ensuring the development of intended learning outcomes for students. This work proposes a methodology, grounded in constructive alignment and experiential learning, to design learning experiences for SCML education during such situations. Considering contextual conditions like social distancing and limited access to resources, the methodology integrated tools like the rich picture and purpose statement to align “what-to-learn,” “how-to-learn,” and “how-to-assess-learning.”

A case study exemplified these concepts, offering insights into creating relevant learning experiences focused on food supply and supply chain operations during the COVID-19 pandemic. While the case study provides valuable information, further cases are needed to validate and refine the formulations and statements of this work, ensuring its contribution to enriching students' learning.

Data availability statement

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

Ethics statement

Ethical review and approval was waived for this study as it was deemed “Research without risk”. The studies were conducted in

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Author contributions

DES-N: Conceptualization, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing, Project administration. EP-V: Formal analysis, Funding acquisition, Software, Supervision, Writing – review & editing, Validation. ACS-O: Data curation, Investigation, Validation, Visualization, Writing – original draft, Resources.

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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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