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A project-based learning approach to supply chain mapping education

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ABSTRACT

Although recent disruptions have revealed the importance of supply chain mapping, there is a lack of academic content in this domain. This is evident because supply chain management textbooks and pedagogical articles offer limited practical guidance on developing supply chain maps. Neither do Harvard Business Publishing and the Case Center cases. The main reason for this scarcity is the challenge of integrating supply chain mapping into the course curriculum. To address this and enrich academic content, we introduce a Supply Chain Mapping Project based on a Project-Based Learning approach to instruct undergraduate business students in fundamental mapping skills and raise awareness of the complexities involved in producing high-quality maps. The project is implemented in two upper-level undergraduate courses. The project's effectiveness is assessed through the post-project survey responses. Results indicate that students were actively engaged throughout the project. Similarly, survey results from one of the similar courses offered in the subsequent semester validate the effectiveness of the project. Given the rising demand for supply chain talent within the management domain, this project will enhance the management/supply chain management curricula at business schools. The benefits and challenges of the proposed approach are discussed in the paper.

1. Introduction

Supply Chain Mapping (SCMp) is a real-time spatial representation of the supply network that enhances supply chain visibility (Gardner & Cooper, 2003). Despite its importance, academic content for developing SCMp skills remains scarce (Ritchie et al., 2023). This is concerning since business schools are expected to equip students with the knowledge needed for corporate success (Symonds et al., 2011).

The lack of SCMp content within supply chain management (SCM) curricula can be attributed to multifaceted challenges faced by the educators when attempting to incorporate this complex topic into their curriculum. For instance, integrating SCMp requires extensive time commitment to teach students the necessary foundational knowledge. Additionally, instructors may face the challenge of shifting from traditional lectures to incorporate active learning, often necessitating curriculum redesign. Obtaining the most recent

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data for real-world products can also be challenging, hindering efforts to motivate students by connecting theoretical aspects to practical applications. Such challenges contribute to the lack of SCMp content, highlighting the need for innovative methods of instruction.

We propose Project-Based Learning (PBL) as a promising approach to address these challenges and effectively integrate SCMp into the classroom. Embracing the design principles of PBL, we develop and introduce a Supply Chain Mapping Project (SCMp-P) designed to immerse management students in the practical application of SCMp. Specifically, students are asked to work in teams and create a three-tier supply chain map for a real product via commercially available mapping software. The project helps students acquire fundamental SCMp skills and knowledge, while also providing them with the experience of going through the rigorous process of designing maps.

To assess the effectiveness of the project, we implemented it in two upper-level SCM courses at a state university in the northeastern United States (U.S). Empirical evidence demonstrated the effectiveness, with students achieving high scores on project deliverables, showcasing their grasp of theoretical and practical SCMp skills. Moreover, a post-project survey revealed high student satisfaction with SCMp-P. To ensure consistency, a follow-up survey in the subsequent semester showed no significant difference in satisfaction levels, validating the initial findings. These results collectively suggest the effectiveness of PBL in enhancing students' SCMp knowledge.

Given the constraints in available resources to teach SCMp and the limited coverage of this topic in existing SCM courses and textbooks (Birou et al., 2022), our study underscores the critical importance of SCMp. In addition, we identify and discuss challenges that hinder the integration of SCMp in SCM curricula. By presenting a PBL-driven SCMp-P, we build upon and extend the research of Ritchie et al. (2023), shifting the perspective of SCMp from merely an optimization challenge to a much broader strategic problem that requires access to contemporary data along with state-of-the-art commercially used mapping software.

In the remainder of this paper, we provide an overview of the relevant literature, describe the development and implementation of the SCMp-P, provide empirical support regarding the SCMp-P's effectiveness, and present conclusions.

2. Background

2.1. Supply chain mapping

SCMp refers to creating a comprehensive picture of the key participants and activities across all levels of the supply chain (Norton & Conlon, 2019). Mubarik et al. (2021) defines SCMp as the "*process of engaging across companies and suppliers to document the exact source of every material, every process and every shipment involved in bringing goods to market*" (p.3). Gardner and Cooper (2003) describe SCMp as "*a representation of the linkages and members of a supply chain, along with some information about the overall nature of the entire map*" (p. 46).

SCMp is crucial as it enables the identification of potential bottlenecks that could disrupt the flow of goods (Jabbour et al., 2020). Its value lies in the ability to track components or materials that might be delayed due to incidents affecting supplier locations (Vakil, 2021). Consequently, firms that invest in SCMp are significantly more resilient, capable of swiftly implementing avoidance and mitigation strategies (Linton & Vakil, 2020). These companies can assess network vulnerabilities, leverage collaborative relationships, and integrate processes and information in a timely manner (Choi et al., 2020; Mubarik et al., 2021).

Despite the critical importance of SCMp, many corporations remain hesitant to map their supply chains (Choi et al., 2020). This became particularly evident during the COVID-19. A survey conducted by Resilinc found that 70% of firms had not invested in SCMp, and hence had no visibility beyond their second-tier suppliers (Choi et al., 2020). Similarly, Mubarik et al. (2021) reported that 20% of companies sourcing globally had no visibility beyond their immediate suppliers. As a result, many organizations were forced into disorganized responses (Mubarik et al., 2021). Choi et al. (2020) and Mubarik et al. (2021) consider limited interest in SCMp as a key factor contributing to firms' struggles in sourcing alternative suppliers during the pandemic.

While COVID-19 was a major disruption in recent years, the importance of SCMp extends far beyond this event and has long been emphasized in other domains, particularly sustainability. Over the past few decades, companies across all industries have faced increasing pressure to comply with environmental, economic, and social responsibilities (Jayaratne et al., 2012, pp. 131–148). Despite these expectations, many firms have been criticized for engaging in unsustainable supply chain practices. For example, in 2010, Nestlé faced accusations of sourcing palm oil linked to the destruction of orangutan habitats in Indonesia (Sheffi, 2018). Similarly, companies such as Walmart, Mars, Nestlé, and Hershey have been implicated in modern slavery within their upstream supply chains (Balch, 2021; Han et al., 2022). In many cases, this is due to a lack of visibility into supply chains, which hampers firms' ability to identify and address unethical practices.

For this reason, SCMp is crucial, as it provides the necessary transparency across supply networks and should be the initial step for any business aiming to enhance sustainability performance (Jayaratne et al., 2012, pp. 131–148). By utilizing SCMp, firms can

Table 1
Practitioner participants.

ID	Position	Total Experience	Industry	Location
P.1	President	40 years	Manufacturing	Rhode Island
P.2	Procurement Specialist	3 years	Healthcare Technology	Georgia
P.3	Procurement Specialist	2 years	Information Technology	North Carolina
P.4	Supply Chain Specialist	2 years	Healthcare Technology	Rhode Island

visualize their supply chains, gaining deeper insights into the flow of goods, supplier practices, and processes, while identifying any sustainability-related issues (Bateman & Bonanni, 2019; Villena & Gioia, 2020).

SCMp has undeniably emerged as a critical activity for firms operating within the increasingly complex and dynamic global supply chain landscape (Choi et al., 2020; MacCarthy et al., 2022). This perspective was reinforced during our in-depth interviews with four SCM practitioners, each possessing expertise to provide valuable insights into the importance and necessity of SCMp. The details of the participants are summarized in Table 1.

All participants acknowledged the critical role of SCMp in improving visibility within their firms' supply chains. One participant highlighted:

"One of the first things that were talked about during the pandemic was transparency in our supply chain and the struggle that we are still facing to really understand who our suppliers are down the line, and how we have never done that before."

The participants' responses aligned with findings from a Gartner survey, which identified SCMp as the top technological investment priority for firms (Brown, 2021). As such, there is consensus among researchers and practitioners that a key success factor for building sustainable and resilient supply chains lies in firms' ability to "*reconceptualize who is in the supply chain*" (Busse et al., 2017, p. 22), thereby emphasizing the need for SCMp.

2.2. The gap between practice and curriculum

The growing emphasis on SCMp has also spurred demand for professionals skilled in SCMp, prompting calls for business schools to adapt their curricula to meet corporate needs (Ritchie et al., 2023). According to the Council of Supply Chain Management Professionals, equipping undergraduate and graduate students with supply chain skills enables firms to hire employees with the potential to manage complex tasks, such as SCMp. For this reason, corporations place significant value on classroom education, as it prepares students to meet the demands of prospective employers (Campbell & Skoog, 2004). This sentiment also echoed in our interviews with SCM professionals, who stressed the importance of teaching SCMp and how this expertise can serve as a key differentiator for students entering the job market. One participant noted:

"I think it [SCMp skill] is something that makes students an attractive candidate for a job because it's just an extra legit, hard skill that they have."

However, despite the rising interest in SCMp, a review of 227 SCM syllabi from 121 universities by Birou et al. (2022) revealed a significant gap in SCM education, with SCMp seldom covered as a key topic. For this reason, Ritchie et al. (2023) argue that SCM curricula are not keeping pace with the industry's shift towards mapping. We searched Harvard Business Publishing and the Case Center's website using the keyword "*Supply Chain Maps*" to verify this. Our search revealed no SCMp teaching resource. Additionally, we reviewed prominent SCM textbooks -compiled with the input from multiple SCM academics - but found no practical guidance on SCMp. While these textbooks mention 'maps' in various operational or quality management related contexts such as value stream maps, process maps, optimization maps etc., they do not offer instructions on SCMp (see Table 2).

Table 2
Prominent textbooks in SCM and the mentioning of maps.

Text Books	Author(s)	Supply Chain Maps	Process Maps	Value Stream Maps	Optimization Maps	Other types
Supply Chain Management: Strategy, Planning, and Operation	Sunil Chopra and Peter Meindl (Chopra & Meindl, 2016)	X	X	X	✓	X
Operations and Supply Chain Management (ISE HED IRWIN OPERATIONS/DEC SCIENCES)	F. Roberts Jacobs and Richard B. Chase (Jacobs & Chase, 202)	X	✓	✓	X	✓
Operations and Supply Chain Management (MindTap Course List)	David A. Collier and James R. Evans (Collier & Evans, 2020)	X	✓	✓	✓	X
Principles of Supply Chain Management: A Balanced Approach	Joel D. Wisner, Keah-Choon Tan, and Keong Leong (Wisner et al., 2015)	X	✓	✓	X	✓
Purchasing and Supply Chain Management	P. Fraser Johnson, and Anna E. Flynn (Johnson & Flynn, 2015)	X	✓	X	X	X
Purchasing and Supply Chain Management	Robert M. Monczka, Robert B. Handfield, Larry C. Giunipero, and James L. Patterson (Monczka et al., 2015)	X	✓	✓	X	✓
Supply Chain Logistics Management	Donald Bowersox, David Closs, and M. Bixby Cooper (Bowersox et al., 2012)	X	✓	X	X	✓
Supply Chain Management: A Global Perspective	Nada R. Sanders (Sanders, 2020)	X	✓	✓	X	X
Operations and Supply Chain Management for MBAs	Jack R. Meredith and Scott M. Shafer (Meredith & Shafer, 2019)	X	✓	✓	X	✓
Supply Chain Management: A Logistics Perspective	John J. Coyle, Robert A. Novack, C. Brian Gibson, and John Langley (Coyle et al., 2017)	X	✓	X	✓	X

In addition, an extant review of prominent pedagogical journals from 2000 to 2023 (*using keywords "Supply Chain Mapping', "Mapping," "Maps")* within the management domain yielded only one article, i.e., Ritchie et al. (2023). This lack of SCMp educational content within the SCM curricula is concerning and raises a fundamental question: *Why are the SCM educators not integrating SCMp in their courses despite its immense value*?

The answer to this question may be rooted in the complexity of teaching SCMp, which presents significant challenges for educators when it comes to incorporating it in the classroom. The section below discusses some of the considerable challenges of integrating SCMp in SCM courses.

2.3. Challenges in supply chain mapping education

Despite the growing popularity of active learning methods like the beer distribution game and SCM simulations in SCM education, lecture-based teaching remains dominant (e.g., Swaim et al., 2022; Yousef, 2012). This traditional approach hinders the effective integration of SCMp into the curriculum. Relying solely on PowerPoint slides risks trivializing this complex and crucial topic for students (Scholten & Dubois, 2017). Passive listening during lectures makes it difficult for them to grasp the intricate process and effort involved in developing the maps (Camps, 2017). Without practical experience, visualizing and understanding SCMp concepts can be challenging (Burke & James, 2008). Consequently, this can lead to poor course evaluations, potentially discouraging educators from incorporating SCMp (Swaim et al., 2022).

Scholten and Dubois (2017) argue that students decide whether to engage in surface learning or deep learning based on the environment created by the instructor. If the environment is based on "teacher as expert' (i.e., lecture-based approach), students adopt surface learning. On the contrary, if the instructor enables an environment based on "teacher as facilitator of learning" (i.e., active-learning approach), students adopt deep learning and engage in complex tasks with the sense of responsibility to complete the tasks appropriately and meaningfully. Since most SCM instructors adopt the 'teacher as expert' role (Scholten & Dubois, 2017), it becomes challenging to integrate SCMp into the curriculum effectively.

Another challenge in teaching SCMp lies in the considerable demands on time, resources, and dedication. Learning SCMp requires students to grasp various components, including data access and analysis, software utilization, map visualization, interpretation, and decision-making for contingency plans, etc. (MacCarthy et al., 2022). These diverse elements are time-consuming and require dedication from both students and instructors. Condensing SCMp into one or two lab sessions fails to equip students with a comprehensive understanding of the concept. Furthermore, teaching SCMp concepts alongside software training necessitates additional time and resources, potentially requiring curriculum adjustments (Camps, 2017; Swaim et al., 2022). This might deter instructors from incorporating the topic altogether.

Adding to the challenges, instructors constantly grapple with finding up-to-date and relevant data for each semester. While hypothetical data can be a temporary solution, it often lacks real-world context, potentially hindering student engagement (Ritchie et al., 2023). Additionally, students who do not participate in data gathering miss out on experiencing the process' rigor, potentially undervaluing the significance of SCMp (MacCarthy et al., 2022).

Furthermore, modern SCMp practices leverage state-of-the-art mapping tools (MacCarthy et al., 2022). These tools enhance map creation and equip students with valuable skills (Perera & Rupasinghe, 2015, pp. 3548–3556). However, integrating these tools presents a hurdle, as most students likely hail from business management backgrounds and may lack prior technical experience (Perera & Rupasinghe, 2015, pp. 3548–3556). This leads to another significant challenge for instructors i.e., determining the appropriate complexity level for introducing SCMp in the classroom. SCMp can range from basic conceptual diagrams to intricate digital maps depicting multi-tiered suppliers (MacCarthy et al., 2022). While detailed maps offer deeper insights, they risk overwhelming students, especially with limited instructional time. Hence, instructors must delicately balance complexity with educational value (Camps, 2017). Overwhelmed students who lack guidance may drop the course or provide unfavorable evaluations. This, in turn, can further disincentivize instructors from incorporating SCMp altogether (Scholten & Dubois, 2017; Willging & Johnson, 2009).

Our review of the existing literature highlights the absence of a definitive approach to teaching SCMp. While the research by Ritchie et al. (2023) offers valuable insights and techniques applicable to teaching "location analytics," it does not directly translate to the broader context of SCMp instruction. Location analytics involves analyzing geographical data to understand spatial patterns and address problems related to space and time (Ritchie et al., 2023). It is predominantly operational, with a focus on optimizing delivery routes, managing inventory, and identifying optimal locations for key sites such as factories, warehouses, and assembly units (Harmon, 2023). In contrast, SCMp emphasizes a holistic visualization of the supply chain, considering various components, activities, and relationships that are essential for understanding the network's flows and overall performance. Unlike location analytics, which is often more geographical data-driven, SCMp requires an in-depth, qualitative analysis of the entire network. This comprehensive evaluation involves real-world data (including geographical data) and requires a more time-intensive mapping process, which integrates both analysis and research.

Moreover, management programs are not always centered on analytical proficiency, and students may lack familiarity with advanced analytical tools. This makes the instruction of location analytics more challenging in such contexts, as it necessitates additional training. Despite these differences in scope, objectives, and methodologies, location analytics and SCMp complement one another by providing critical insights into supply chain visibility (Ritchie et al., 2023). Thus, while the focus of Ritchie et al. (2023) is primarily on location analytics, we view their work as a foundational step for SCMp. Their research lays the groundwork for mapping practices, and our study aims to build upon this foundation by addressing the specific instructional needs of SCMp.

To achieve this, we propose Project-Based Learning (PBL) as an effective approach to teaching SCMp. We posit that PBL, with its inherent characteristics, can address the key challenges hindering effective SCMp integration in the classroom.

2.4. Project-based learning

PBL advocates for *"student-centered and experiential approaches to education that* support *"deeper learning" through active exploration of real-world problems and challenges"* (Condliffe, 2017, p. 2). Positioned within active learning, PBL promotes a learning environment where students significantly engage in the planning, investigating, and executing projects motivated by real-world events (Domínguez & Jaime, 2010). Research has shown that PBL facilitates superior student learning outcomes along with enhanced creativity, enthusiasm and engagement among students compared to traditional instructional methods (Daun et al., 2016; Thompson & Beak, 2007). This enhanced learning is credited to the learners' active involvement in the process (Özpolat et al., 2014). In recent years, PBL has increasingly been embraced in primary and secondary education (e.g. Biazus & Mahtari, 2022; Kokotsaki et al., 2016), while several scholars in management education have recommended incorporating the approach into business curricula to enhance students' learning experiences (e.g. Kanigolla et al., 2014; Marnewick, 2023; Terrón-López et al., 2020; Özpolat et al., 2014).

An attribute of PBL, which makes it highly effective, is its initiation with a driving topic or concept that holds real-world significance (Veselov et al., 2019). Parker et al. (2013) contend that the subject matter should be authentic and pertinent to real-world contexts and furnish students with skills or knowledge bearing real-world implications. To facilitate the development of such projects, PBL mandates a semester-long engagement, allowing enough time for students to acquire foundational concepts essential for the successful completion of the project (Thomas, 2000; Daun et al., 2016; Revelle et al., 2020). Consequently, PBL necessitates that instructors design curricula embedding topics relevant to the project (Singer et al., 2000; Revelle et al., 2020). Specifically, Drain (2010) proposes a two-phase approach to PBL, consisting of (i) aiding students in knowledge acquisition pertinent to the project, followed by (ii) independent project execution. Authors like Thomas (2000) and English and Kitsantas (2013) argue that for the effective implementation of PBL, the project should be central to the curriculum. This centrality enables instructors to introduce greater complexity into project details, thus fostering deep rather than surface learning.

Another attribute of PBL is its encouragement of a shift from traditional lecture-based teaching methods to a more active, student-centered learning approach (Grant, 2011). PBL positions instructors as facilitators rather than subject matter experts, promoting a pedagogy where students construct knowledge through active engagement, with instructors guiding the learning process (Thomas, 2000; Grant, 2011). This model grants students the autonomy to delve into topics directly, actively seeking solutions rather than passively receiving information from the instructor (Condliffe, 2017). Moreover, PBL empowers students to shoulder the responsibility for complex tasks, including data collection, technological training, and information gathering (Krajcik & Shin, 2014). The extended duration of PBL projects affords students sufficient time to engage in such intensive activities (Ravitz, 2010), alleviating the instructor's burden of repetitively managing such tasks every semester. Nonetheless, the instructor's role in facilitating these activities remains paramount. Research suggests that students' degree of autonomy and responsibility should correlate with their proficiency in independently undertaking these tasks (Condliffe, 2017). Therefore, instructors may adjust the level of task difficulty based on their assessment of students' preparedness and skill levels.

Another critical attribute of PBL is the role of technology, though not a requirement but highly recommended, to augment student learning and the quality of the final product (Condliffe, 2017). Technology is a significant support in PBL, enabling students to accomplish challenging tasks independently, which might otherwise be beyond their capability (Krajcik & Shin, 2014). The PBL approach also emphasizes the importance of providing multiple opportunities for self-reflection and feedback throughout the project. This allows students to contemplate their learning process and understand the rationale behind their learning activities (Krajcik & Shin, 2014). Given these characteristics, we propose PBL as a suitable approach to impart the skill of SCMp to students.

Further, PBL has been widely used in management domain, thereby supporting its application in this study. Educators have leveraged PBL to raise awareness and impart practical skills related to real-world issues that are often inadequately addressed through traditional lecture-based methods. For instance, Terrón-López et al. (2020) applied PBL in teaching Sustainable Development Goals, demonstrating how PBL allows students to engage with organizations committed to sustainability, fostering real-world awareness and hands-on experience. Similarly, Fini et al. (2017) used PBL to teach transportation engineering students about sustainability concepts and their application, reinforcing the argument that complex real-world challenges, like sustainability, are difficult to convey through lectures alone. A similar approach was taken by Özpolat et al. (2014), who introduced a Humanitarian Logistics Project—akin to SCMp—to teach students the importance of humanitarian logistics, a growing global need due to the increase in natural disasters. The project enabled students to develop civic awareness by designing donation advertisements for a prominent humanitarian organization.

Beyond addressing real-world problems, PBL has been employed to equip students with realistic competencies aligned with their future careers. For example, Maddi et al. (2013) used PBL to create a competition where students developed skills in design, development, and supply management by working on a new motorcycle model. This allowed students to gain technical expertise in 3D software and acquire knowledge in business discipline, which is crucial for launching new products. Similarly, Kanigolla et al. (2014) applied PBL to help students solve Lean Six Sigma problems in collaboration with local companies, and Giambatista and Hoover (2009) empirically demonstrated PBL's effectiveness in developing business skills in an MBA course.

These studies demonstrate that PBL is highly effective in achieving educational goals that traditional lecture-based approaches often fail to meet, such as fostering deep engagement with real-world issues and developing practical competencies. Furthermore, research in management education has consistently shown that PBL enhances student engagement and knowledge retention compared to traditional methods (e.g., Belohlav et al., 2004; Özpolat et al., 2014). Therefore, the body of literature supports PBL for a topic like SCMp, which has significant real-world implications and requires active student participation and skill development. To our knowledge, PBL has not yet been applied to SCMp instruction. This paper aims to fill this gap by presenting a Supply Chain Mapping Project (SCMp-P) developed based on PBL principles.

3. Planning and implementing the SCMp-P

3.1. SCMp-P overview

The SCMp-P presents a hypothetical scenario in which students, in teams, are asked to assume the role of global SCM managers for Patagonia. They are presented with a scenario where one of the company's Asian cotton t-shirt suppliers has been blocked due to unsustainable labor practices. As global SCM managers, students are tasked with securing a new first-tier supplier and identifying second and third-tier suppliers to mitigate potential supply chain disruptions in the future. This approach reflects a growing trend where firms increasingly take responsibility for managing their entire supply chains, moving beyond traditional reliance on first-tier suppliers for upstream information. To ensure manageability, the project focuses on a single raw material: cotton fibers. Student teams begin their research by visiting Patagonia's website to identify strategic suppliers for the chosen product. The final artifact is a report to the Patagonia board of directors containing the supply chain map created using a commercially used mapping software. The project document is detailed in Appendix A.

Why Patagonia: Patagonia is chosen for the following reasons: i) the company is amongst the major apparel brands in the U.S. that is highly dependent on its suppliers in Asia, thereby, widening the scope of the exercise to many possibilities where student research and creativity are enabled; ii) the company advocates sustainable sourcing and works with suppliers that adhere to social and environmental standards, thereby, emphasizing the visibility and sustainability connection to the value of the mapping exercise; and (iii) the company provides information regarding their 1st tier suppliers on its website that is available to all the customers, thereby, making the initial data available to the students. Further, Patagonia's commitment to environmental/social activism aligns with the values of undergraduate students (Petro, 2021; Versace & Abssy, 2022; Wood, 2022).

SCMp Tool: We selected Starboard Navigator® (https://www.starboardcorp.com/) – acquired by Logility, Inc in 2022 - as the mapping tool based on the following criteria.

1. Free of charge for students;
2. Compatible with all types of computers;
3. Cloud-based, interactive and user-friendly;
4. Adequate customer support with troubleshooting assistance;
5. Availability of training and skill-developing resources.

Starboard Navigator is a cloud-based tool for designing real-world supply chain maps. This commercially used tool offers several features crucial for experiential learning, such as students can visualize and compare different scenarios and foster informed decision-making. Additionally, built-in tools facilitate efficient map creation and revision. Furthermore, cloud technology allows for faster data integration and collaborative work, eliminating the constraints of lab schedules and enabling remote access. By enabling these functionalities, Starboard Navigator directly supports the core principle of PBL, i.e., active learning. While we selected Starboard Navigator, instructors can also evaluate tools like Llamasoft, Strategic Analysis of Integrated Logistics Systems (SAILS), Sourcemap, Resilinc, etc.

3.2. SCMp-P implementation

SCMp-P was implemented in two senior-level SCM courses. To maintain anonymity, the courses are referred to as SCM-Course 1 (Fall 21′) and SCM-Course 2 (Spring 22′). SCM-Course 1 addressed fundamental principles of global SCM, including key topics such as global sourcing, manufacturing, logistics, buyer-supplier relationships, sustainability, and technology adoption. SCM-Course 2 focused on distribution management, covering essential aspects of designing and optimizing distribution networks. Both 3-credit-hour courses were chosen because they aligned with SCMp-P's learning objectives. Also, replacing an existing semester project in both courses minimized disruptions to the overall curriculum. In total, 88 students were enrolled in both courses (*N = 38 SCM-Course 1; N = 50 SCM-Course 2*)

On the first day of class, students were introduced to SCMp project (Appendix A document shared) and given one week to

Table 3
Topics covered during the two courses.

Topics Required for SCMp-P	Lectures in SCM-Course 1	Lectures in SCM-Course 2
Transportation modes and lead times	Global Logistics & International Transportation	Introduction to Distribution Networks
Risk Management	Risk Management in Global Supply Chains	Supply Chain Performance; Case Study: Contingency Analysis
Supplier Importance	Case Study: Supplier Relations	Case Study: Contingency Analysis; Case Study: Sensitivity Analysis
Impact of COVID-19 and Mapping Significance	Case: COVID-19 and potential markets	Assigned WSJ articles
Data sourcing	Industry 4.0: Artificial intelligence and machine learning: applications to SCs; Blockchain and the "TradeLens" shipping solution by Maersk & IBM	Data Collection and Analysis through Microsoft Excel
Map visualization	Introduction to Starboard Navigator	Introduction to Starboard Navigator

communicate any questions, concerns, or expectations to the instructor. During this initial week, student teams were also formed based on individual preferences. Studies suggest that when students can choose their teams, they tend to demonstrate greater commitment (e.g., Chen & Gong, 2018).

The first six weeks of the semester focused on building foundational knowledge through diverse learning methods (see Table 3). Lectures, case studies, newspaper articles, worksheet analyses, and other approaches were employed to engage students and cater to various learning styles. Additionally, a dedicated session introduced students to the Starboard Navigator software, highlighting its core features and practical applications. The software's developers also offered weekly training sessions, available on an as-needed basis, to further support student proficiency.

By the end of week-6, a mid-term exam was conducted covering the basic concepts of SCMp and the mapping tool. While a diverse range of scores was observed, particular attention was given to students who scored less than 90%. Extra office hours were conducted for these students. It became apparent that the lower-performing students were missing specific course materials. Consequently, instructors supplied the necessary resources and facilitated a concise multiple-choice questionnaire based on the mid-term exam questions. Following this, all students achieved scores above 90% on the questionnaire, enabling them to proceed with their project work.

To make sure that balanced progress is made throughout the second half of the semester, progress was monitored using four milestones (see Table 4).

The first milestone deliverable was a three-page report delineating the student teams' approach to executing the SCMp-P, including identifying data sources, evaluating vital mapping software functionalities, and explaining the project's importance to Patagonia. Overall, the purpose of this deliverable was to emphasize the SCMp's value to the students, encouraging early engagement and familiarity with the project's resources, and to foresee any potential obstacles in executing the project.

The second milestone was a mapping sample exercise to evaluate the students' understanding of the mapping tool's key features. Students were asked to design a basic supply chain map on Starboard Navigator covering the following points.

1. Position a manufacturing plant in New York City
2. Position three warehouses:
a. Warehouse I in Wuhan, China
b. Warehouse II in Dhaka, Bangladesh
c. Warehouse III in Sialkot, Pakistan
3. Link the nodes in a sequence i.e., Warehouse III (consider third-tier supplier) → Warehouse II (consider second-tier supplier) → Warehouse I (consider first-tier supplier) → Manufacturing plant (consider customer).

The third milestone involved a group presentation covering areas like data sources, mapping strategies, functionalities of the mapping tool employed, and an initial draft of the maps. The milestone's key purpose was to offer the teams constructive feedback on their preliminary project drafts before the final submission. The instructors ensured that the feedback was dispensed in a supportive and non-threatening atmosphere (Thompson & Beak, 2007).

The final milestone, and primary deliverable, was a comprehensive 10-page report. Along with this milestone, students were also required to complete a post-project feedback survey.

Table 5 below outlines the criteria and standards required to achieve top score for each milestone.

During the second half of the semester, the instructors overall maintained a facilitative role, encouraging independent exploration by students (Thomas, 2000). However, they remained attentive to monitoring project progress, ensuring adherence to milestone deadlines, and providing timely, constructive feedback.

While the allocation of weight for each milestone is at the instructors' discretion, it is our recommendation that the final report should receive the highest weight, reflecting its importance as the final artifact of the project. Further, integrating the SCMp-P grade into the overall course grading schema is also at the instructor's will. In our courses, we allocated a 35% weight to the SCMp-P. The remaining portion of the course grade was distributed among two examinations (mid-term and final exam), class participation, and quizzes. This balance ensured that while the SCMp-P is a central component of the course, other components also contribute meaningfully to the student's overall grade.

3.3. Students' performance and major challenges

In this sub-section, we detail the main challenges students encountered during milestone submissions, along with an overview of their performance for each milestone. Although these challenges may vary across instructors, sharing our observations may assist

Table 4
SCMp-P milestones.

Milestone	Deadline	Deliverable
1	7th week	3-page report
2	8th week	Mapping sample exercise
3	10th week	Classroom Presentation
4	12th week	Final Report

Table 5
Grading Criteria and Expectations for an A grade.

Milestone	Deliverable	Grading Criteria	Expectations for top score
1	3-page report	Project approach	Clear, well-structured outline of the approach to project completion, demonstrating a full understanding of deliverables.
		Significance of Supply Chain Mapping	Articulates the importance of supply chain mapping with relevant examples.
		Data sources	Detailed identification of data sources used for supplier information.
		Relevance to Patagonia	Provides a well-reasoned explanation of the project's importance for Patagonia and discusses Starboard Navigator features, reflecting a solid understanding of the tool.
		Anticipated challenges	Identifies expected challenges and presents thoughtful strategies for addressing them, demonstrating proactive problem-solving.
2	Sample Exercise	Map features	Accurately positions the manufacturing facility and Warehouses I, II, and III, along with the correct sequence of all lanes, demonstrating effective use of Starboard.
		Formatting	Proper labeling of all nodes. Map screenshot includes date and time for verification
3	Group Presentation	Introduction to the topic	Effectively contextualizes the topic, explaining the underlying problem, relevance connection to GSCM.
		Layout, style and typos	Organized layout with clear visuals (images, videos), error-free writing, and polished presentation with no typos.
		Content	Comprehensive coverage, including research methods, data collection, supplier selection, and Starboard Navigator usage with proper citations.
		Engagement	Connects topic to class materials (lectures, cases, research), showing relevance and depth.
		Delivery	Professional handling of audience questions; smooth technical setup (slides prepared and ready, no technical issues).
		Conclusion	Clear summary of key points.
		Presentation style (individual)	Uses hand notes without reading directly from slides; maintains eye contact; adheres to business formal dress code.
4	Final Report	Introduction	Clear overview of the problem, motivation, significance for Patagonia's sustainability, and research approach.
		Research	Detailed selection process, explaining each supplier's role and impact on Patagonia's network sustainability and resilience. Reliable and relevant data sources clearly listed.
		Map	Accurate map on Starboard Navigator with visible three-tier suppliers, correct lane sequences, and proper labeling.
		Conclusion	Clearly outline challenges faced and strategies for future improvements.
		Formatting	Report includes title page, table of contents, captions, and professional language. Conforms to the page limit with specified font, spacing, and includes references (may exceed the page limit).

instructors in proactively identifying and addressing similar issues.

Milestone 1: A prevalent challenge reported by most of the teams in their 3-page report was the difficulty in sourcing information about second and third-tier suppliers. To address this, the instructors compiled a resource document to assist the teams in locating the necessary information. The document advised students to begin with the company's website as the primary data source and then to explore other public resources. Recommended platforms included SourceMap, SCM Globe, Geography Realm, Kaggle, and Alibaba, with each source accompanied by direct links and descriptions of the types of data available, along with potential advantages and limitations of using each platform. While not exhaustive, the modifiable document provided a valuable starting point for students. Aside from the data sources, no other significant challenges were reported. None of the teams expressed concerns about Starboard Navigator and felt comfortable using it. Overall, all the teams effectively presented a clear research plan, demonstrating a thorough understanding of the project's requirements. They also showed a solid grasp of the deliverables and explained the specific features of Starboard Navigator to be used in the project. Consequently, all submissions were deemed 'satisfactory' as they effectively met the criteria outlined in the rubric.

Milestone 2: Minor errors, such as variations in zip codes, spelling mistakes, and wrong file names, were observed in the submissions. However, minor errors were not penalized by the instructors, and teams that accurately mapped all nodes and their links, i.e., the connection between the facilities in the correct sequence, received full credit. No significant challenge was observed during this milestone, suggesting that the teams had a good grasp of the tool features needed for designing the maps.

Milestone 3: During the oral presentation, the teams received feedback from a panel comprising instructors, guest faculty, and their peers. A recurring theme across most presentations was the insufficient detail about the suppliers within the network. Although the teams successfully identified and pinpointed the suppliers' locations, they struggled to articulate the rationale behind each supplier's specific positioning within the network—specifically, the reasons for a supplier being in an n-tier rather than an n+1-tier. Additionally, there was a noticeable lack of information regarding the characteristics of the countries where the suppliers are based, including cultural, political, and economic factors. This type of contextual information is needed to identify credible and high-performing suppliers, thus enhancing the overall efficacy of the supply network. The students were encouraged to gather more data about the suppliers. It's worth noting that the visual aspects of the mapping received no negative comments, indicating that the maps were effective.

Milestone 4: The final artifact, i.e., the final report, was the most critical indicator of student learning since it synthesizes all the

feedback and knowledge provided. As mentioned above, the report required students to research the focal firm and analyze its supply chain. Additionally, students were expected to create a visual map using Starboard Navigator, testing their practical application of mapping software and SCMp knowledge. These elements also align with Gardner and Cooper (2003)'s criteria for effective maps. Reports meeting these criteria indicate the successful acquisition of essential skills and knowledge for map creation. Upon reviewing the final reports, it was observed that teams from both sections received high scores. Specifically, the average final report score for SCM Course 1 was 69 out of 75 (92%), and for SCM Course 2 was 68.25 out of 75 (91%), thus suggesting that the students did acquire the necessary skills and knowledge.

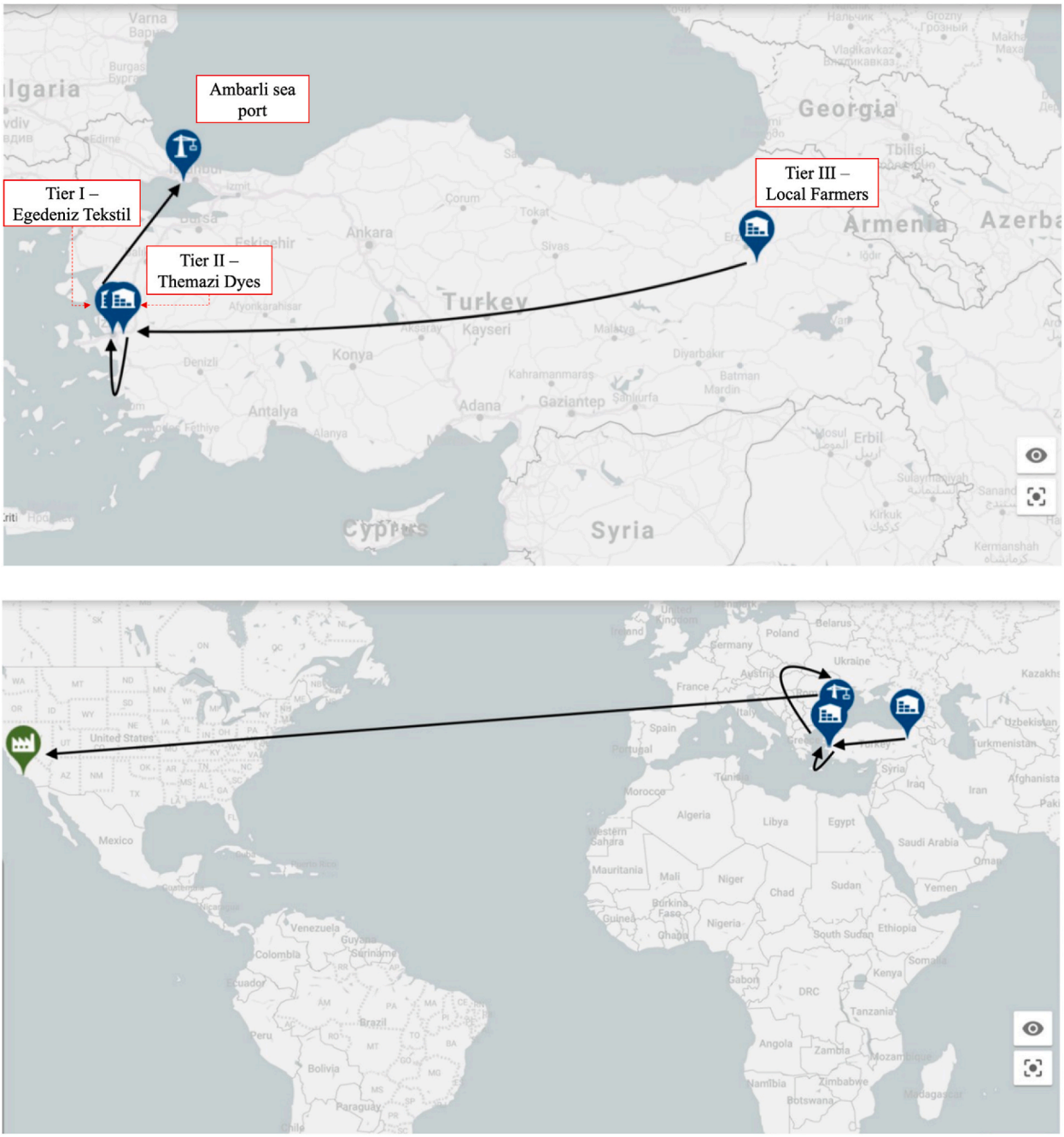

Fig. 1. *Top*: Close-up of Tier III suppliers (local farmers) in eastern Türkiye supplying materials to Tier II suppliers (Themazi Natural Dyes) in southwest Türkiye, which in turn supply Tier I supplier (Egedeniz Tekstil) in Izmir, Türkiye. The final product is transported to Ambarli sea port for shipment to the US. *Bottom:* Overall map view. The shipment is delivered to the Patagonia warehouse in Los Angeles, U.S. (green node) via intermodal transport. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Fig. 1 below shows a sample of the map (created on Starboard Navigator) submitted by a team that scored maximum credit in one of the courses. Using the mapping tool, the team effectively mapped three tiers of suppliers: Tier I supplier (Egedeniz Tekstil) in Izmir, Türkiye; Tier II supplier (Themazi Natural Dyes) in southwest Türkiye; and a Tier III supplier (local cotton farms) in eastern Türkiye. The team also proposed a shipping route to deliver the final product to the U.S. via intermodal transportation using Ambarli sea port in Türkiye. Their final report detailed recommended transportation modes, data sources, sustainability initiatives by n-tier suppliers, potential supply chain risks, and proposed mitigation strategies.

4. Evaluation of effectiveness

To assess the effectiveness of SCMp-P, survey data was collected from both courses at the end of week 12. The survey included one open-ended question alongside nine items adapted from Kwon et al. (2021). Open-ended question asked the students for the key takeaways from the project, whereas the nine-items Likert scale questions assessed students' experience with the SCMp-P.

Sixty-four complete responses were analyzed. Quantitative responses were measured on a 5-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). A reliability analysis conducted in SPSS demonstrated strong reliability for the scale (Cronbach's Alpha: 0.83). [1] Table 6 summarizes student responses, indicating the percentage who agreed or strongly agreed with each statement. The results show that most students were satisfied (90.6%) and gained valuable experience as they attempted SCMp-P (94.3%). These students believed that the project helped them in bridging the academia-industry gap (94.4%), as they were able to apply their classroom knowledge to a real-world problem (86.8%), thus making the project extremely relevant to the course (98.1%). Also, students felt that the project provided them with a significant challenge (96.2%), which was among the primary objectives of the SCMp-P. Overall, the results from the survey questionnaire indicated that students found attempting SCMp-P a valuable experience that improved their understanding of the SCM concepts in general and SCMp concepts in particular.

5. Discussion of qualitative findings

PBL proved highly effective for integrating SCMp-P into the curriculum, as its core attributes directly address key challenges in teaching SCMp, such as time commitment, technology integration, shift from traditional lecture-based formats, and alignment with real-world applications. Qualitative results highlighted students' positive reception of SCMp-P in enhancing SCMp education.

Thematic analysis approach outlined by Braun and Clarke (2006) was used to analyze the qualitative responses. Two coders independently reviewed the data and generated initial codes using an inductive approach to identify key takeaways. Since no pre-existing coding framework existed, similar codes were grouped into higher-order categories and further condensed into over-arching themes. NVivo-12®, a qualitative data analysis software, assisted with the coding process. Any disagreements were resolved by clarifying contextual information, achieving one hundred percent inter-rater agreement at each stage (Miles & Huberman, 1994).

To ensure reliability, several steps were taken. First, student responses were selected from two different courses, guaranteeing diversity. Second, multiple coders participated in the coding process. Throughout the process, codes and categories were compared, discussed, and merged into themes through consensus. Finally, the coding results were verified by researchers who were not part of the coding process. The qualitative analysis revealed five primary themes: *the rigor involved in project execution, the importance of engaged scholarship, the critical role of sustainability, the significance of supplier relationships,* and *the value of learning about new countries*. Table 7 presents the key takeaway themes along with illustrative quotes for each category.

Particularly, PBL's strong connection to real-world issues, as highlighted by Veselov et al. (2019), resonated with students, who frequently emphasized the project's engaged scholarship aspect. They reported that the project allowed them to apply classroom knowledge to practical contexts, bridging the gap between theoretical learning and real-world application. By learning and applying a professional tool to address a real-world challenge, students gained confidence in their career preparedness. One student commented, "*This knowledge will help me in my future career*," underscoring the project's relevance and its perceived impact on their professional development. In fact, the instructors observed that some students who attempted SCMp updated their LinkedIn profiles and added keywords such as "*Supply Chain Mapping*", "*Starboard Navigator*", "*Supply Chain Planning*", "*Strategic Planning*" etc. under their skills and knowledge tab. Similar keywords were also used to boost up their resumes as well.

Further, sustainability issues – a key motivator of SCMp – also emerged as a major theme in students' responses. By selecting a real-world company known for its sustainability practices, the project fostered a hands-on understanding of how mapping can support

Table 6
Student responses on a 5-point Likert scale (N = 64).

Item	1	2	3	4	5	4 + 5	Mean
I am satisfied with the project.	0%	0%	9.4%	39.6%	51%	90.6%	4.41
I gained valuable experience from the project.	0%	0%	5.6%	28.3%	66%	94.3%	4.60
Doing the project improved my understanding of the research topic.	0%	0%	5.6%	30.3%	64%	94.3%	4.56
Doing this project was useful for retaining the knowledge I learned in the course.	0%	0%	7.5%	28.3%	64.2%	92.5%	4.57
The project helped me to learn real-time Supply Chain issues.	0%	3.8%	9.4%	28.3%	58.5%	86.8%	4.42
This project helped me to learn more than doing projects in other courses.	1.9%	3.8%	15%	45.3%	34%	79.3%	4.05
The project was relevant to the course.	0%	0%	1.9%	13.1%	85%	98.1%	4.83
The project provided me with a challenge.	0%	0%	3.8%	35.8%	60.4%	96.2%	4.56
The project helped me bridge classroom knowledge with real-world supply chain issues.	0%	0%	5.6%	37.7%	56.7%	94.4%	4.49

Table 7
First and second-order codes from project takeaways using NVivo-12®.

Second-order code (theme)	First order code (category)	Illustrative quotations example	Relative frequency
Rigor Involved	a Effort in research	*"My greatest takeaway from this is the amount of research needed to find second and third tier suppliers."*	33%
	b Work needed in mapping	*"A lot more work than anticipated goes into mapping the supply chain for just one product."*	
	c Identifying suppliers	*"Being able to do research to find all the different tier suppliers and even with such a transparent company it was not as easy as I thought it would have been."*	
Engaged Scholarship	a Bridging academia and industry	*"This provided me with the opportunity to apply what we've been learning this semester to a real-world scenario"*	25%
	b Help in career	*"This knowledge will help me in my future career"*	
Significance of Sustainability	a Connection with sustainability	*"I enjoyed researching sustainable companies and suppliers, so I enjoyed that that this project was based around Patagonia"*	16.6%
	b Acknowledging sustainability in mapping	*"How much effort Patagonia puts in to ensure that their suppliers are also sustainable"*	
Significance of Suppliers	a Supplier attributes	*"Suppliers do small things differently to try to set itself apart from the rest of the group"*	16.6%
	b Supplier Selection	*"The greatest takeaway would be learning how to find suppliers and researching about them."*	
Learning about new countries	a Trade regulations	*"What countries have free trade with other countries"*	8.3%
	b Geography	*"Learning how to connect a supply chain to geography."*	

sustainability initiatives, a process central to PBL's experiential approach (Özpolat et al., 2014). For example, one student noted,

"*I enjoyed researching sustainable companies and suppliers, so I appreciated that this project was based around Patagonia.*"

This insight is particularly relevant as the current generation demonstrates heightened concern for sustainability, evidenced by shifting purchasing habits (Wood, 2022), increased activism for safety (Petro, 2021), and more sustainable investment choices (Versace & Abssy, 2022). By focusing on a company with strong sustainability credentials, the project enabled students to connect SCMp with broader environmental goals.

Students similarly expressed appreciation for researching suppliers aligned with Patagonia's vision, recognizing that mapping extends beyond creating visuals; it involves understanding suppliers' attributes and assessing operational practices that could impact the company's reputation. One student reflected on this insight, noting, "*Suppliers do small things differently to try to set themselves apart from the rest of the group*." This demonstrates students' recognition of SCMp as a critical analytical tool for evaluating suppliers' practices, ensuring alignment with corporate values and minimizing potential risks to the brand.

Further, the extended nature of the project, which is integral to PBL (Thomas, 2000; Daun et al., 2016; Revelle et al., 2020), allowed students to explore the cultures and policies of supplier countries, enriching their mapping decisions with contextual insights. This depth of understanding, unachievable in single-session projects, was further supported by PBL's structured curriculum attribute, which enabled instructors to incorporate topics directly relevant to the project (Singer et al., 2000; Revelle et al., 2020). Notably, the most significant takeaway from the SCMp-P experience for students was the rigor required in mapping N-tier suppliers. One student reflected, "*My greatest takeaway from this is the amount of research needed to find second and third-tier suppliers*." This aligns with Farris (2010), who highlights the exponential increase in complexity when examining suppliers beyond tier one. The project successfully achieved our objective of fostering this critical awareness in students.

In summary, SCMp-P, grounded in PBL principles, effectively addressed the challenges instructors encounter when integrating SCMp into classroom instruction. The student feedback from both sections indicate the high effectiveness of SCMp-P in enhancing student engagement and learning outcomes.

5.1. Potential challenges

While SCMp-P offers significant benefits, careful project design and clear guidelines are crucial. Undergraduate students may have limited experience with SCMp concepts and software tools. The project's goal should be to provide a rigorous learning experience without overwhelming or demotivating students. Technological issues, data availability, and the number of deliverables can frustrate instructors and students. To mitigate these, instructors should assess students' technical skills and mapping knowledge, tailoring the project accordingly. Furthermore, compatibility issues with mapping tools due to varied operating systems among students' laptops, such as Windows or Mac, underscore the need for selecting cloud-based tools to ensure accessibility for all.

Similarly, product selection also requires consideration. Students' diverse backgrounds may lead to varying judgments based on sustainability, politics, or human rights. One approach is allowing students to choose a product they connect with. To validate the effectiveness of this approach, the project was reimplemented in SCM-Course 2, offered in Fall 2022, with another instructor who was not involved in the research project. While the overall course curriculum and SCMp-P content remained the same, the instructor permitted students to select any product. In Week 12 of the semester, a survey was administered, and 22 out of the 30 enrolled students provided complete responses. The results, detailed in Table B1 in Appendix B, showed consistent outcomes with those from the initial implementation. However, scores were marginally higher for students in the original SCMp-P, suggesting that students might benefit from having a product assigned by the instructor rather than selecting one independently. Therefore, instructors should carefully select

products to avoid offending any student (or group).

Additionally, the requirement for consistent feedback can be daunting for the instructors. Developing well-defined milestones with clear rubrics can help manage this. However, providing qualitative feedback may still be challenging. Therefore, while class sizes can vary, we recommend SCMp-P for classes of 40 or fewer students (Thompson & Beak, 2007). However, large classes could be feasible with support from a teaching assistant.

Finally, SCMp-P is best suited for upper-division undergraduate courses where students already possess some basic SCMp knowledge and are motivated by real-world projects as they approach the job market.

6. Conclusion

Recent disruptions, such as those triggered by COVID-19 and various sustainability-related controversies, have highlighted the critical importance of SCMp. In the past, firms deprioritized SCMp due to the considerable resources it demands, yet the recent disruptions have shifted the perspective, underscoring SCMp as essential for both operational resilience and sustainability. Despite its growing importance, SCM programs fall short in equipping undergraduate students with adequate training in SCMp. This gap is evident not only in curricula but also across pedagogical research, SCM textbooks, and case studies, where in-depth coverage of SCMp remains limited. This study addresses this gap by introducing SCMp-P, a project that leverages the principles of PBL, to enhance student learning and address key challenges in SCMp education.

This paper makes several contributions to Management pedagogical research – particularly in the SCM domain. First, it contributes to the SCM education by introducing a mapping project – built upon Ritchie et al. (2023) foundational work - with real-world significance, particularly in high demand after COVID-19 and ever-increasing sustainability issues. However, it is a topic currently underrepresented in SCM educational resources. SCMp-P responds to this need, furthering engaged scholarship by bridging the divide between academia and industry (Van de Ven, 2007). Second, this study contributes to the PBL literature in the SCM domain as, to our knowledge, it is the first to apply a PBL approach for teaching the vital skill of mapping in SCM. Research has shown that working in realistic scenarios, as offered in PBL, enables students to develop a comprehensive and realistic set of competencies, positively impacting their professional growth (Maddi et al., 2013). The learning outcomes, as evidenced by student survey responses, demonstrate the positive impact of SCMp-P on students. Third, the paper responds to the industry's call for business schools to develop skill sets in SCM students that meet current industry demands (van Hoek et al., 2020). Past research has shown that companies benefit from hiring graduates who possess skills in supply chain tools. While working on SCMp-P, students develop skills that are currently in-demand within the SCM domain. For example, Supply Chain Game Changer (2023) Magazine outlines several skills expected of SCM professionals (refer to Appendix C), many of which are covered in this project.

The project's skill focus can be adjusted by instructors based on their program's preference. Analytically intensive programs can require students to collect and analyze data using tools like SPSS, Python, or R Studio. Conversely, in less analytical programs, instructors could provide students with organized data while focusing on developing skills such as risk management, strategic thinking, and global mindset. Thus, SCMp-P offers flexible guidance, adaptable to various teaching preferences, while instilling skills beneficial for students' future careers. Also, while SCMp-P uses Starboard Navigator, the features learned are transferable to other mapping software, as confirmed by practitioners. Features like data organization and import, node and link allocation, and the selection of facilities and transportation carriers are generally applicable in nearly all SCMp software tools such as SAILS, Llamasoft etc.

Like any project, the SCMp-P design has certain limitations and can be improved in several ways. First, while our project is inspired by real-world issues, students currently rely on publicly available online data sources. We recommend that instructors aiming to integrate SCMp-P into their courses consider developing industry partnerships to provide students with access to proprietary data from corporate firms, where feasible. This would allow all students or teams to work on similar mapping challenges under the guidance or supervision of industry professionals. Such collaboration would not only make the project feel more authentic but would also motivate students to engage more deeply, foster professional connections, and potentially create networking opportunities that could support future career development. Second, our design of SCMp-P involves Starboard Navigator as the mapping tool. We recommend that educators try other mapping software in the classroom, such as Llamasoft, Oracle, SAP, SAILS, etc., and see how the students perform on them. Third, the effectiveness of SCMp-P was assessed using students enrolled in a U.S. university. However, it is important to consider the varying levels of access to technology, software, and related resources in universities outside the U.S. A follow-up study that includes input from universities in other countries would provide valuable insights. Similarly, we recommend that future researchers analyze the impact of demographics on student learning outcomes. Differences in ethnicity, academic program, or even school affiliation may influence learning outcomes, offering useful insights for refining the project accordingly. Last, we advise future researchers to investigate the potential emergence of undesirable online resources, like cheat sheets, that could impact PBL studies like ours. We suggest they examine the implications of such risks and identify mitigation strategies.

Lebovitz (2021) projects a shortfall of approximately 2.4 million supply chain positions between 2018 and 2028, attributed to increased retirements and a decrease in skilled workers entering the industry. Delgado and Mills (2018) emphasize the need for firms to invest in skilled labor to fill up the soaring number of positions. However, new entrants in the job market often lack the practical skills necessary to fill these positions. As a result, firms encounter talent attraction and retention challenges, especially amidst post-COVID-19 market pressures and rising supply chain complexity (Ashraf et al., 2022; van Hoek et al., 2020). In such circumstances, our paper is timely and in line with the SCM industry expectations from the business schools.

Note(s):

1. To assess the dimensionality of the scale, we conducted an Exploratory Factor Analysis (EFA) using SPSS. The scree plot and factor loadings revealed that 8 out of 9 items loaded strongly on the first component, suggesting the scale is largely unidimensional. Additionally, an ANOVA was conducted to examine whether there were significant differences in the mean responses. The ANOVA results (N = 86) showed only one item having a significantly different mean compared to the other items - while all other 8 items had no significant differences in their means.

CRediT authorship contribution statement

Muhammad Hasan Ashraf: Writing – review & editing, Writing – original draft, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Koray Özpolat:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Methodology, Conceptualization. **Mehmet G. Yalcin:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Piyush Shah:** Writing – review & editing, Visualization, Supervision, Methodology, Formal analysis, Data curation, Conceptualization.

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Declaration of competing interest

None.

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Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijme.2024.101128.

Data availability

The data that has been used is confidential.

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