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Received: 23 June 2024 | Accepted: 11 August 2025

DOI: 10.1111/dsji.70016

DECISION SCIENCES
JOURNAL OF INNOVATIVE EDUCATION

EMPIRICAL RESEARCH

Preparing for tomorrow's supply chain leaders today in the Industry 4.0 era: Student perceptions on learning modes

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Abstract

Preparing for tomorrow's supply chain leaders today involves an understanding of how students perceive the educational value of classroom learning approaches. To better understand how to prepare our students for the Industry 4.0 era, we surveyed current and former students on their perceptions of pedagogical methods that contributed to their learning and preparation to enter the workforce as supply chain management professionals. Results from former students, who are working in the supply chain management field, indicate that real-world teaching methods have a higher impact on learning than methods that are not as real-world. However, both groups rated guest speakers as the most effective learning method and lectures as the least effective. We offer an exploratory study motivated by students' informal post-discussion of learning via Zoom during COVID-19. This article offers insights into how teachers should deliver supply chain content based on the student's perception of learning, an approach that will prepare students for supply chain management careers in the Industry 4.0 era.

KEYWORDS

pedagogy, supply chain management, teaching style, undergraduate education

> If we teach today's students as we taught yesterday's, we rosssb them of tomorrow.
>
> ~John Dewey

1 | INTRODUCTION

The COVID-19 pandemic required a methodical change in teaching approaches due to the nationwide suspension of in-person instruction, which resulted in the shift to emergency remote distance learning via Zoom (Wong et al., 2023) or other remote platforms such as Microsoft Teams. Since the COVID-19 crisis, and to some extent beforehand, a noticeable change in student learning preference prompted a needed change in the way effective teaching strategies align with the students' perceived approach to classroom learning. Recent studies have focused on a variety of pedagogical approaches, from asynchronous versus synchronous (Bradley-Dorsey et al., 2022; Wong et al., 2023), "in-person" to "virtual" using learning management systems like Canvas and BlackBoard, to "hybrid" (Albert et al., 2021; Cheng et al., 2022), and curriculum design for knowledge, skills, and abilities (KSAs) (Nikookar & Yanadori, 2022; Stek & Schiele, 2021). While these and other studies have provided contributions to pedagogical research, we did not identify any studies that considered how students learn or perceive learning. Hence, we seek to bridge this gap in our study. Today's effective teaching strategy and methods employed should focus on having the student approach solutions to problems that are more real-world. Likewise, the learning approach should enable students to develop skills to analyze situations that may have multiple practical solutions instead of using cookie-cutter solutions (Zhao & Watterston, 2021).

Pointing to the fourth industrial revolution (termed Industry 4.0) that has recently gained attention in the operations

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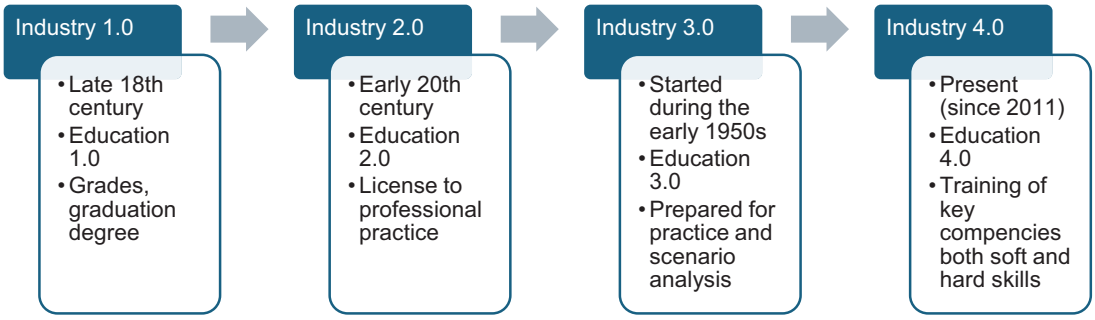


FIGURE 1 Transition from Education 1.0 to Education 4.0
Source: Miranda et al. (2021); Reyes et al. (2020).

and supply chain domain, Reyes et al. (2020) suggest that, from a managerial perspective, we are victims or beneficiaries of a multitude of converging technologies that are changing the way business is conducted in the global supply chain. This Industry 4.0 era, which features digital technologies like the Internet of Things, cloud computing, big-data analytics, and cyber-physical systems, along with other advances, is fundamentally changing the conventional business processes (Mahmood & Mubarik, 2020), and there is a growing need for students to learn its applications (Ellahi et al., 2019). As such, this new technology-driven business environment necessitates a transformation in the delivery of supply chain management (SCM) education.

As with each industrial revolution, there has been a transition of approaches for educating the workforce, as depicted in Figure 1. As such, this Industry 4.0 era has created the Education 4.0 paradigm in determining the needed toolkit of KSAs for the Industry 4.0 era. The learning outcomes in the present Education 4.0 era have transitioned to the training of both transversal (soft) and disciplinary (hard) key competencies (Miranda et al., 2021; Reyes et al., 2021). This model recommends that students be taught these competencies through challenge-based learning, problem-based learning, and learning by doing.

This article identifies effective teaching strategies that align with the student's learning approach specific to those students majoring in supply chain management, though our findings could be applied to other disciplines. In this article, we investigate how students perceive the usefulness of different modes of learning to facilitate the development of the KSAs that supply chain professionals expect students to have. Several studies have reported on needed KSAs for supply chain professionals, which will be reviewed in the next section. As educators, it is important to help students develop the necessary KSAs that are valued for entry-level supply chain management professionals in the Industry 4.0 era and the transition to the digital supply chain. How we do this in the classroom is the crucial question we need to address.

In the next section, we provide a brief review of the pedagogical supply chain literature and a discussion of pedagogical approaches. Next, we present our research methodology and survey results. We then discuss the implications of our research for educators and conclude with a summary of our work and suggestions for future research.

2 | SUPPLY CHAIN EDUCATION LITERATURE AND APPROACHES

A comprehensive review of the supply chain education literature and teaching approaches is well beyond the scope of this article. Hence, we briefly discuss how the supply chain education literature has evolved and focus on more recent papers. We follow a similar methodology for supply chain education approaches.

2.1 | Supply chain education literature

The supply chain management education literature has rapidly evolved over the past few decades. Reck et al. (1992) reported on functional areas specific to the skills and competencies for purchasing and materials management that called for an increased focus on analytical and technical skills. Carter and Vellenga (1993) surveyed practitioners and academics to rank the quality of academic purchasing programs, confirming the importance of an integrative approach to problem-solving. Large and Giménez (2006) noted the increased importance of oral communication capabilities, while Gravier and Farris (2008) describe the evolution of pedagogy from a functional to an integrated supply chain educational paradigm from a logistics discipline perspective.

Previous research has focused on hard technical skills and soft interpersonal skills. Hard technical skills refer to those supply chain management practices based on quantitative, technical, and methodological approaches (Durach & Machuca, 2018; Escrig-Tena et al., 2018; Söderlund & Maylor, 2012; Stek & Schiele, 2021). Soft interpersonal supply chain management skills are based on interactions with other people (Tatham et al., 2017; van Hoek et al., 2020).

There is an abundance of KSAs and competencies studies in the field of supply chain education (Bals et al., 2019; Helfat & Martin, 2015; Nikookar & Yanadori, 2022; Stek & Schiele, 2021; van Hoek, 2021; Visich et al., 2021). However, several scholars have emphasized the need to explore focus

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areas within supply chain management education such as the required talent/skills for entry-, mid-, senior- and executive-level supply chain management jobs (Sinha et al., 2016), the role of managers and supply chain talent (van Hoek, 2021), and management level skills that address supply chain resilience (Nikookar & Yanadori, 2022).

2.2 | Supply chain education approaches

Compared to traditional lectures and exam-based assessments, active learning methods are becoming increasingly popular in operations management and supply chain management classes (Robbins, 2019). Active learning approaches include games and simulations, where students work independently or in groups and learn by applying course content to identify solutions and make decisions (Reyes, 2007a,b; Stewart et al., 2011; Visich & Salmani, 2023). Simulations have also been recognized as an effective way to enhance transferable learning (Scherpereel et al., 2022).

Problem-based learning (PBL) originated in the 1950s in medical training at McMaster University in Canada (Barrows, 1996). In a supply chain course, students work on an authentic problem as part of the learning sequence. The problem-solving activity drives the acquisition of new knowledge (Bayley et al., 2021). The PBL approach requires students to work in small groups to first identify the business problem that needs to be solved and then engage in self-directed learning. The PBL Goals consist of problem-solving skills, self-directed learning, team collaboration skills, and critical thinking skills. The students receive practice with quantitative, qualitative, and logical analysis tools that reinforce critical thinking and provide immediate relevant skills (Miller et al., 2016).

Engaging students with business case studies as a consulting exercise helps students in a team environment gain interest in the content application and an understanding of the problem-solving process. Students can be exposed to the complexity and diversity of a variety of contributing factors in a real-world situation (Erzurumlu & Rollag, 2013). Case studies can also help students develop a managerial process for critical thinking and decision-making. Another PBL approach are empirical projects where students work in teams to solve problems for local and regional companies. Roethlein et al. (2021) found that empirical projects provide students with an integrative, multidisciplinary experience that better prepares them for their careers. Since students must communicate frequently with client company managers, the projects facilitate the development of a variety of interpersonal skills.

3 | RESEARCH METHODOLOGY

The motivation for this study was based on an overheard discussion of students' comments on the COVID-19 pivot to online learning and their return to in-person courses. A further informal discussion of the students' likes and dislikes of distance learning via Zoom exposed questions about how students' approaches to the perception of learning have changed and how faculty should present and deliver the supply chain management content material to students. This then led to a discussion of pedagogical methods on how faculty should prepare future supply chain professionals and leaders for the Industry 4.0 era. These methods were identified by the students as (1) Simulations, (2) Case Studies, (3) Group Activities/Projects, (4) In-Class Activities, (5) Off-Campus Site Visits, (6) Traditional Lectures, (7) Guest Speakers from Industry, and (8) Consultancy for "live" cases.

To gain insights into student perceptions of learning, we conducted a survey that measured student and alumni perceptions. Our intent was not to assess teaching effectiveness, but rather the effectiveness of the methodology based on students' perception of learning. Of particular interest is how the different pedagogical approaches might impact the learning experience.

We used a Likert scale to measure student response scores for teaching methodologies, with 7 as "very important," 4 as "neither important nor unimportant," and 1 as "not important." The eight teaching methodologies investigated in this research are those used by the lead author for teaching supply chain management to undergraduates. Before the first week of the spring 2022 semester, a pilot study of the survey instrument was conducted with ten former supply chain management students who offered suggestions. After editing the survey questions, the survey was administered in Qualtrics to two groups of students during the spring 2022 semester. Group 1 was comprised of senior-level undergraduate students ($n = 49$) who were majoring in supply chain management at Baylor University and enrolled in the required capstone course. The current students enrolled in the global supply chain management capstone course completed the prerequisite courses (i.e., distribution management and procurement and materials management). They completed the survey at the end of the semester.

Group 2 consisted of students who belonged to Baylor University's supply chain management major alumni group on LinkedIn and were recent graduates with 2–5 years of working experience as supply chain professionals. The alumni group all followed the same supply chain curriculum (and the same professors). The survey link was sent to 100 alumni during the semester, with seventy-one alumni responding ($n = 71$). As Theall and Franklin (2021) pointed out, the students are competent to judge their learning experiences and can judge the effectiveness of factors. Responses from Group 1, the current students, are based on their perception of how they learn best. Responses from Group 2, the alumni, are based on a reflection and perception of what contributed to their learning. The overarching objective of the study was to gain insight into students' perceptions of learning to facilitate a curriculum redesign.

4 | SURVEY RESULTS

The survey instrument consisted of eight pedagogical methods that are used for teaching to facilitate student learning.

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These methods were: (1) Simulations, (2) Case Studies, (3) Group Activities/Projects, (4) In-Class Activities, (5) Off-Campus Site Visits, (6) Traditional Lectures, (7) Guest Speakers from Industry, and (8) Consultancy for "live" cases. The simulations, case studies, group activities/projects, in-class activities, and traditional lectures were consistent for both groups. The traditional production-distribution game (aka *The Beer Game*) is played at the start of the semester in the traditional "board game" and 100% paper (i.e. no computer software) to gain an understanding of the various processes in the supply chain. Then, during the final one-third of the semester, students engaged in the LINKS simulation working in teams of 4–5 making the various decisions for each round (10 rounds total). The two supply chain case studies with analytics have been consistently used over the years as a consulting exercise to help students in a team environment identify the business question (problem), identify possible solutions, and make actionable decisions.

Each semester, the three in-class group activities are active learning approaches applied to specific course content. The semester begins with the Puzzle Game (Fawcett & McCarter, 2006) with a few modifications to demonstrate the complexities of a global supply chain. The students make a paper football (Brau et al., 2019) to get a hands-on learning experience applying Deming's PDSA methodology for process improvement. This is followed by Using a Rubber Band to Teach the Management of Quality (Reyes, 2007a,b) which focuses on process improvement utilizing Six Sigma tools.

The off-campus site visits and guest speakers from industry are organized by the student Association for Supply Chain Management (ASCM) chapter. Each semester, the students organize two guest speakers and one off-campus site visit. These are typically during the evening hours, and the students are incentivized to attend via extra credit (and, of course, pizza). Consultancy for "live" cases is an infrequent activity. However, when requested, we follow the Roethlein et al. (2021) model to provide students with an integrative, multidisciplinary experience. We believe that this "live" case experience better prepares the students for their future professional careers. The students must communicate frequently with the company managers, facilitate data collection, and develop a short written report and a 10-min PowerPoint presentation. This activity also adds to the development of a variety of interpersonal skills.

4.1 | Differences within each group

We first conducted paired *t*-tests to see if there were significant differences between the learning methodologies within each group. Table 1 shows the learning methodologies ranked by their mean for each group, as well as the standard deviation and the paired *t*-test results for methods that were statistically different when $p \leq 0.05$. Group 1, current students, rated both Guest Speakers and Simulations significantly more important than Off-Campus Site Visits and Traditional Lectures. Group 2, alumni, had more significant differences between the learning methods. Guest Speakers, Group Activities/Projects, Site Visits, and Consultancy were very close in importance and were all statistically significantly different from In-Class Activities, Case Studies, Simulations, and Lectures. One difference that stands out is that alumni rated their top seven learning methods as statistically more important than Traditional Lectures. Interestingly, both groups rated Guest Speakers as the most important and Traditional Lectures as the least important.

4.2 | Differences between groups

To understand if there were differences in the perceptions of the importance of the learning methods between the two student groups, we conducted a two-sample *t*-test. Table 2 lists the group means, the Levene's test *p*-value, and the *p*-value from the two-sample test. We conducted a two-sample variance test to determine if we could pool the variances since the two-sample *t*-test is slightly more powerful when it can be assumed that the variances of the two samples are equal. For the two-sample variance test, we did not base the test and confidence intervals on the normal distribution because all the data was skewed left, as shown in the box plot comparisons of learning approaches (Figure 2). We report the Levene's test *p*-value since the sample sizes are not equal. A *p*-value ≤ 0.05 indicates the variances cannot be pooled. Except for Simulations, Levene's test *p*-values are > 0.05; hence, we were able to pool our variances for seven of the eight two-sample *t*-tests. Our two-sample *t*-test results show that the only learning method that had a significant difference between the two groups was for Off-Campus Site Visits. Alumni perceived Off-Campus Site Visits to have a higher degree of importance for learning than current students with a *p*-value = 0.019.

4.3 | More Real-World versus Less Real-World

When we looked at the paired *t*-test results in Table 1 for the alumni we noticed a clear difference between the top four teaching methods and the bottom four teaching methods, where the top four were all significantly different in learning importance than the bottom four. After a discussion on how strongly or weakly the teaching methods represented a practitioner's work environment, we labeled the top four in the More Real-World category (MRW: Guest Speakers, Group Activities/Projects, Site Visits, and Consultancy) and the bottom four in the Less Real-World category (LRW: In-Class Activities, Case Studies, Simulations, and Lectures). We then conducted *t*-tests to see if there were any differences in importance between the two categories of learning methods. We compared the following: Test 1—Group 1 MRW versus Group 1 LRW; Test 2—Group 2 MRW versus Group 2 LRW; and Test 3—Groups 1 and 2 MRW versus Groups 1 and 2 LRW. For Tests 1 and 2, the samples are from the same population, and therefore, we conducted a paired *t*-

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TABLE 1 Paired *t*-test within each group.

Group 1—current students			
Teaching method	**Mean**	**SD**	**Significantly different from if $p \leq 0.05$ (p-value)**
Guest Speakers	5.55	1.39	Site Visits (0.010), Lectures (0.017)
Simulations	5.51	1.12	Site Visits (0.042), Lectures (0.028)
Group Activities/Projects	5.49	1.52	–
Case Studies	5.37	1.38	–
Consultancy	5.35	1.49	–
In-Class Activities	5.27	1.51	–
Site Visits	5.04	1.63	–
Lectures	5.02	1.68	–
Group 2—alumni			
Teaching method	**Mean**	**SD**	**Significantly different from if $p \leq 0.05$ (p-value)**
Guest Speakers	5.72	1.33	In-Class (0.022), Case Studies (0.031), Simulations (0.025), Lectures (0.000)
Group Activities/Projects	5.68	1.38	In-Class (0.021), Case Studies (0.025), Simulations (0.009), Lectures (0.0000)
Site Visits	5.66	1.23	In-Class (0.014), Case Studies (0.027), Simulations (0.022), Lectures (0.0000)
Consultancy	5.65	1.48	In-Class (0.038), Case Studies (0.050), Simulations (0.035), Lectures (0.000)
In-Class Activities	5.28	1.44	Lectures (0.001)
Case Studies	5.24	1.61	Lectures (0.006)
Simulations	5.16	1.48	Lectures (0.040)
Lectures	4.66	1.24	–

TABLE 2 Group means, Levene's test, and two-sample *t*-test between each group.

Method	**Current students mean***	**Alumni mean***	**Levene's test p-value**	**Pool variances**	**Two-sample p-value**
Simulations	**5.51**	5.16	0.027	No	0.157
Case Studies	**5.37**	5.24	0.938	Yes	0.633
Group Activities	5.49	**5.68**	0.737	Yes	0.487
In-Class Activities	5.27	**5.28**	0.722	Yes	0.952
Site Visits	5.04	**5.66**	0.164	Yes	**0.019**
Lectures	**5.02**	4.66	0.066	Yes	0.181
Guest Speakers	5.55	**5.72**	0.849	Yes	0.507
Consultancy	5.35	**5.65**	0.682	Yes	0.278

*Higher mean value between groups indicated in bold.

test. For Test 3, the samples are from different populations (current students vs. alumni); hence, we conducted a two-sample *t*-test.

For Test 1 (Group 1 MRW vs. Group 1 LRW), the paired *t*-test resulted in a p-value = 0.523, indicating that current students did not perceive any differences in importance between MRW and LRW teaching methods. This is not surprising given the results in Table 1 for current students, where there were few significant differences between the learning methods, and the rankings for MRW and LRW were mixed.

For Test 2 (Group 2 MRW vs. Group 2 LRW), the paired *t*-test had a p-value equal to 0.000, indicating alumni placed a higher level of importance on learning methods that were MRW. These results support the alumni results in Table 1, where each MRW learning method was given a significantly higher level of importance than each of the LRW learning methods.

For Test 3 (Groups 1 and 2 MRW vs. Groups 1 and 2 LRW), we first conducted a two-sample variance test to determine if we could pool the variances in the two-sample *t*-test. Since the data were skewed heavily to the left, we did not use test and confidence intervals based on the normal distribution. And, because of the skew, we used the Levene's test results rather than the Bonett test results. The Levene's test p-value was equal to 0.924, denoting we could pool the variances in the two-sample *t*-test, which had a p-value equal to 0.000. From this, we can conclude that current students and alumni gave a significantly higher level of importance

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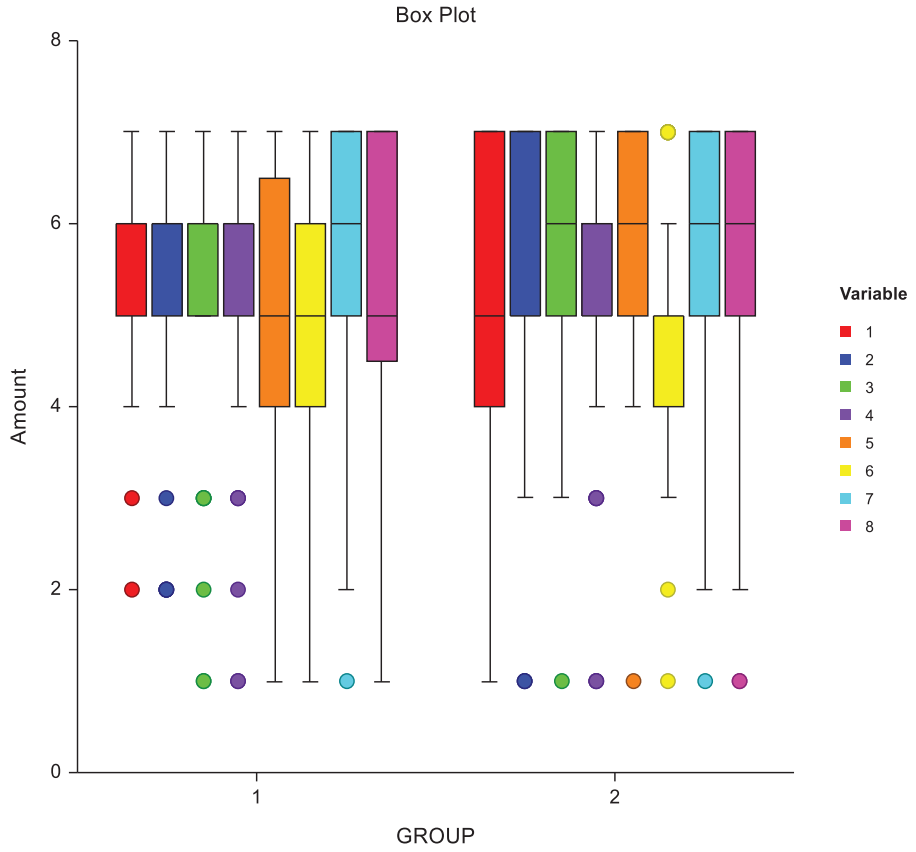


FIGURE 2 Box plot comparisons of learning approaches.

to MRW learning methods than to LRW learning methods. However, these results could be influenced by the larger sample size of the alumni group ($n = 71$) compared to the current student group ($n = 49$).

5 | EDUCATOR IMPLICATIONS AND PROPOSITIONS

In this section, we discuss how our research findings have educational implications. We then make propositions on the pedagogical impact of the teaching methods to help students attain the needed knowledge, skills, and abilities for the Industry 4.0 era.

5.1 | Simulations

Two simulations are used in the capstone class. The traditional *Beer Game* is played during the first week of classes and is used to introduce the complexity of supply chain management. The simulation is played as a traditional board game without the use of computers. The second simulation, LINKS as a computerized supply chain simulation, is played at the end of the semester with eight rounds of decisions where the students apply course concepts and make supply chain operational decisions. Key decision inputs involve forecasting, finished goods inventory management, purchasing, distribution, and channel management. The primary learning objective is to see how operational KPIs (key performance indicators) impact financial KPIs and customer service KPIs.

Current students rated Simulations as second in importance, while alumni rated Simulations as seventh. Though Simulations were the only teaching method where the variances could not be pooled in the two-sample *t*-test, current students and alumni did not score them as significantly different. Simulations can be considered a subset of games where students are immersed in a dynamic business environment and make decisions using specified rules and a limited set of data. The objective of most simulations is to help students understand system effects and how different functional areas are impacted by the decisions made. An issue we have found with using simulations in the classroom is the learning curve students go through to understand game play, the usefulness of the given data, and the tools needed to make decisions. The trade-off with simulations is that while complex scenarios are more realistic than simple scenarios, complexity usually entails a steeper learning curve. The steeper the student learning curve, the less likely the student is to fully engage with the simulation. We make the following proposition concerning Simulations:

Proposition 1. *Simulations that are both complex and have a shallow learning curve will better prepare students for the Industry 4.0 era than Simulations that are both simplistic and have a steep learning curve.*

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5.2 | Case Studies

Average importance scores for Case Studies were close for current students (5.37) and alumni (5.24) and were not significantly different (Table 2). Case Studies are a classic method of teaching and can focus on an array of business scenarios including event analysis, operational or tactical decision-making, and strategic planning. Case Studies often are based on historical data to create the presented business environment, and the given data can be quantitative and or qualitative. Though it is highly expected that Industry 4.0 will be digital and data-driven, we make the following proposition regarding Case Studies:

Proposition 2. *Case Studies that have a blend of quantitative and qualitative data will better prepare students for the Industry 4.0 era than Case Studies that are primarily either quantitative-based or qualitative-based.*

5.3 | Group Activities

Group Activities was ranked third by current students and second by alumni, indicating they are an important learning method in preparing students for Industry 4.0. Group Activities should focus on a significant and relevant issue related to the course content, where students need to make a feasible recommendation that addresses the issue at hand. Students need to schedule meetings, allocate work, meet deadlines, and strive for excellence. Collaboration is key, and Group Activities mimic the work environment students will encounter when they graduate. Prior to the kickoff of a significant Group Activity, instructors should prepare students for teamwork. This will help the team to set group norms and expectations and mitigate conflict. See the Team Labs exercise by Williams and Anderson (2008) for an example of preparing students to work collaboratively on a team. We make the following propositions regarding Group Activities:

Proposition 3a. *Group Activities that address relevant issues within the course content will better prepare students for the Industry 4.0 era than Group Activities that do not address relevant issues within the course content.*

Proposition 3b. *Group Activities that utilize a pre-activity team-building exercise will better prepare students for the Industry 4.0 era than Group Activities that do not utilize a pre-activity team-building exercise.*

5.4 | In-Class Activities

In-Class Activities scored low for both current and former students and were included in our Less Real-World category. In-class activities are a good teaching method to engage students in a team environment where they can facilitate learning between themselves. They are also an effective way to break a long class into blocks of learning methods. However, In-Class Activities need to have a clear pedagogical objective to maximize their learning impact and cannot be seen as a way for the instructor to fill class time. In-Class Activities should connect theory and concepts to practice, thereby making them empirical. We make the following proposition concerning In-Class Activities:

Proposition 4. *In-Class Activities that connect theory and concepts to practice will better prepare students for the Industry 4.0 era than In-Class Activities that do not connect theory and concepts to practice.*

5.5 | Site Visits

Site Visits had the only significant difference between current and former students. This was a surprising result because Site Visits get the students out of the classroom and allow them to see how the work is done. Upton and Macadam (1997) identified three categories of facility tours: Learning, Assessment, and Teaching. For a Learning Tour, the objective is to learn how the facility operates. They recommended that during a Learning Tour, visitors should keep an open mind and focus on practices, not numbers. Since current students have limited knowledge of how businesses operate, we recommend that students be prepared before they go on a Site Visit. Before the visit, the instructor should brief the students on the company's background, business processes, what the students should expect to see, and any procedures and safety requirements they will need to follow. In addition, the tour should include a question-and-answer session with the tour guide(s). To close the loop, during the class that follows the tour, the instructor should conduct a post-tour debrief on what the students observed and learned. For Site Visits, we make the following three propositions:

Proposition 5a. *Site Visits that include a pre-tour brief will better prepare students for the Industry 4.0 era than Site Visits that do not include a pre-tour brief.*

Proposition 5b. *Site Visits that include a question-and-answer session will better prepare students for the Industry 4.0 era than Site Visits that do not include a question-and-answer session.*

Proposition 5c. *Site Visits that include a post-tour debrief will better prepare students for the Industry 4.0 era than Site Visits that do not include a post-tour debrief.*

5.6 | Traditional Lectures

Traditional Lectures were the lowest-scoring teaching method for both current and former students with averages

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of 5.02 and 4.66, respectively. From these results and our own observations in the classroom over the past 20+ years, it is obvious that students do not like Lectures. With the widespread use of cell phones and laptops in the classroom, students are easily distracted when presented with PowerPoint and podium-style lectures. Based on these results we make the following proposition for Lectures:

Proposition 6. *A course curriculum that has low levels of lecturing will better prepare students for the Industry 4.0 era than teaching methods that have high levels of lecturing.*

5.7 | Guest Speakers

Both current students and alumni ranked Guest Speakers as the most important teaching method, indicating that faculty should strive to bring Guest Speakers to the classroom. During the class before the Guest Speaker's arrival, the instructor should distribute the speaker's bio to the students and then discuss how the speaker's experience aligns with the content of the course. The instructor should also inform the Guest Speaker about the course content and the student level, so the Guest Speaker can tailor their presentation to the subject matter. The most effective Guest Speakers not only tell a captivating story but also convey useful industry knowledge that enhances student learning. Based on this discussion we make the following proposition regarding Guest Speakers:

Proposition 7. *Guest Speakers who tell a captivating story and convey useful industry knowledge that is aligned with course content will better prepare students for the Industry 4.0 era than Guest speakers who only tell a captivating story.*

5.8 | Consultancy

Consultancy as a learning method was ranked in the middle by both current students and alumni; however, it was part of the more real-world category for alumni. Consultancy projects require industry partners and, therefore, a high level of coordination between the instructor, the student teams, and the employee contacts at the organization. Project deliverables need to be realistic so the project can be completed by the end of the academic semester, but they should also have an appropriate level of rigor. Impactful projects require data and a strong commitment to the past of the company's contacts. Finally, instructors should plan for the signing of non-disclosure agreements and security clearances so students can access the organization's computer systems. Roethlein et al. (2021) provided a detailed discussion on a global supply chain management consultancy capstone course, where they conclude: "In sum, requiring a multidisciplinary empirical course has succeeded in enabling our students to put their supply chain skills to use in solving real-world, multifaceted problems. We are highly confident that our students are better prepared for the challenges they will face throughout their careers in supply chain management or on whatever career path they choose to follow" (p. 127).

We make the following propositions for Consultancy:

Proposition 8a. *Consultancy projects that solve real-world problems will better prepare students for the Industry 4.0 era than Consultancy projects that do not solve real-world problems.*

Proposition 8b. *Consultancy projects that are multifaceted will better prepare students for the Industry 4.0 era than Consultancy projects that are not multifaceted.*

5.9 | Real-World

Compared with current students, alumni placed a higher level of importance on learning methods that are More Real-World than those that are Less Real-World. Since alumni are working in the field of supply chain management and applying their supply chain knowledge, skills, and abilities, they are in a better position to judge the effectiveness of the teaching methods in preparing students for the Industry 4.0 era. Based on these alumni results we make the following proposition:

Proposition 9. *Teaching methods that are More Real-World will better prepare students for the Industry 4.0 era than teaching methods that are Less Real-World.*

6 | CONCLUSION

Our results show that both groups rated guest speakers as the most effective learning method and lectures as the least effective learning method. Group comparisons for current students only showed significant differences between Site Visits and Lectures; hence, they did not perceive differences in importance between the other six methods. However, results from former students working in the supply chain management field indicate that teaching methods that are more real-world have a higher impact on learning than methods that are not as real-world. When comparing the importance of teaching methods between current and former students, the only significant difference occurred for Site Visits, which alumni rated higher. Overall, this case study adds important insights that can help educators in supply chain management provide a more enriching classroom learning experience in the era of Industry 4.0.

The primary limitation of our exploratory research on the perceived importance of learning methods is the small samples of 49 current students and 71 former students. A larger sample from both groups might yield different insights into the differences in perception of learning methods. Hence, future research could sample more current students and a larger alumni base. Future research could also request detailed demographic data for each group as follows. For

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Group 1, current students, questions could be asked about the number of supply chain management courses they have taken, the number of internships they have completed, grade level, and work experience. For Group 2, alumni, data could be collected on years of work experience, professional certifications attained, graduate school coursework completed, and type of position they obtained when they entered the workforce. Since we are asking students about their perceptions on the importance of learning methods, it is possible that there could be a memory effect on the part of alumni who are likely to favorably remember the more real-world aspects of learning rather than the less real-world methods. This could also be due to the lower frequency of usage of the more real-world methods over the course of a semester. Also, real-world methods often have a greater level of time commitment for the students (Group Activities, Consultancy) or a higher sensory impact (Guest Speakers, Site Visits).

Students can no longer be considered a work-in-progress, and ultimately a finished good for the end customer, organizations that hire our students. Instead, students need to be directly involved in an empirical learning process, where they engage with their professors, classmates, and industry practitioners to address real-world issues and the needs of Industry 4.0.

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How to cite this article: Reyes, P.M., & Visich, J.K. (2025) Preparing for tomorrow's supply chain leaders today in the Industry 4.0 era: Student perceptions on learning modes. *Decision Sciences Journal of Innovative Education*, 23, e70016. https://doi.org/10.1111/dsji.70016

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