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A Proposed Experiential Case Study for Teaching Data Visualization Through Process-Generated Data: A LEGO®-Based Simulation

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Abstract

This proposal presents a four-week experiential teaching exercise that addresses a persistent gap in business analytics education: the reliance on sterile, pre-cleaned datasets that obscure the messy reality of data generation. In the exercise, students will construct physical LEGO® aircraft under real-time constraints within an agile operational environment. This simulated production process generates operational metrics, such as cycle times, throughput, bottlenecks, and defects, which students will then clean, model to validate statistical and operational principles, and transform into dashboards applying Nussbaumer Knaflic's storytelling principles. This paper presents the conceptual design, assessment rubrics, and an interdisciplinary foundation combining action research pedagogy and Ken Bain's "Super Course" system as a constructivist framework. The objective of this proposal is to present the pedagogical design to the information systems and analytics education community to solicit peer feedback. Following refinement, the exercise will be deployed as analytics teaching exercise under a formal classroom action research methodology to empirically measure its impact on student mental models and data literacy.

Keywords: LEGO® Simulation, Pedagogical Proposal, Action Research, Data Visualization, Lean Operations, Storytelling with Data.

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1. INTRODUCTION

Data visualization courses often rely on precleaned datasets, which can unintentionally obscure the messy, emergent nature of real organizational data. This exercise reframes visualization as a downstream interpretive act rooted in process behavior. Students experience firsthand how data is created, distorted, and shaped by operational systems. This proposed exercise builds on McManus et al.’s (2007) work at MIT using LEGO® simulations to teach Lean principles, demonstrating that tactile, team-based construction tasks create rich opportunities to learn about flow, variability, and waste. It also aligns with Bain’s (2004) concept of a “super course,” in which students engage deeply with authentic problems, develop intrinsic motivation, and experience learning as a process of discovery rather than compliance. The classroom environment of the “super course” is recognized as a Natural Critical Learning Environment (NCLE). This proposal outlines the theoretical foundations, instructional design, assessment strategy, and action research methodology supporting the exercise. The manuscript combines several elements intentionally to suggest the variety and flexibility the case can exemplify, LEGO® simulation, Lean operations, Scrumban, data engineering, Little’s Law for inventory and cycle time; analytics dashboards, storytelling, and Bain’s Natural Critical Learning Environment. The case differentiates itself from previous analytics research in those domains in the application of LEGO® Serious Play® for the analytics space, particularly the tangible, constructivist application of data management.

1.1 Theoretical Foundations

Hands-on simulations have been used to teach Lean concepts such as flow, bottlenecks, takt time, and waste elimination in undergraduate, professional development, and graduate engineering business and information systems classes (McManus et al., 2007; Murman et al., 2002; Womack & Jones, 1996). These concepts may not be applicable to all classes, and students may not be aware of the operational and supply chain terms, Appendix A gives detailed explanation and application of terms. LEGO®-based simulations provide a low-cost, high-engagement medium for illustrating how operational systems behave under constraints and variability (Salas, et al., 2009; Stainton, et al., 2010). LEGO®-based simulations have increasingly been recognized in the academic literature as a robust pedagogical medium capable of supporting deep learning, conceptual understanding, and professional skill development. Research in higher education demonstrates that LEGO® activities, particularly those using the LEGO® Serious Play methodology, promote high engagement, critical thinking, and collaborative problem-solving, while offering instructors a flexible tool for illustrating complex systems and abstract concepts (Henderson & Shipway, 2026).

Systematic reviews further show that LEGO®-based interventions enhance learners’ spatial reasoning, creativity, and methodological skills, making them effective for both formal and nonformal educational contexts (Chasanidou & Raikou, 2024). LEGO® Serious Play® research highlights its strong grounding in constructivist learning theory, and participatory design, underscoring its value as a multimodal, experiential approach for helping learners understand how systems behave under constraints, variability, and uncertainty (Chew et al., 2025). Simulation-based learning enhances engagement, improves retention, and supports the development of managerial judgment (Salas et al., 2009; Stainton et al., 2010). The LEGO® build creates a microenvironment where students must coordinate, communicate, and adapt mirroring real organizational dynamics.

Prior ISCAP research reinforces these points. Scialdone and Connolly (2021) demonstrate that LEGO® Serious Play can surface communication breakdowns inherent in requirements engineering, noting that “transferring ideas (namely requirements) between individuals is no simple task, but rather, demands

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intentionality and even strategic planning" (p. 2). Their study shows that semi-abstract LEGO® builds create ambiguity that mirrors real-world systems analysis challenges, making communication failures visible and discussable. Similarly, Jones and McCarthy (2018) show that LEGO®-based team-building simulations cultivate collaboration, decision-making, and project management awareness in IS capstone courses. As they explain, "even though it is a relatively short activity, it can simulate many properties of a full project" (p. 1), including resource constraints, coordination demands, and emergent team dynamics. Their findings align with broader literature showing that LEGO® activities promote high engagement, critical thinking, and collaborative problem-solving, particularly when grounded in the LEGO® Serious Play methodology (Henderson & Shipway, 2026).

1.2 Bain's Super Course Framework

Bain (2004) argues that transformative learning environments, which he later formalizes as "super courses" (Bain, 2021), place students in situations where they must grapple with authentic, consequential problems rather than passively receive information. In such environments, students are expected to generate their own data, confront ambiguity, make sense of imperfect information, and communicate insights to real or simulated decision-makers. This proposed LEGO®-based experiential exercise embodies that ethos by situating learners within a dynamic operational system where the data they later visualize emerges directly from their own actions, decisions, and coordination behaviors.

Equally powerful in Bain's (2021) articulation of super courses are the common themes that emerge across exemplary learning designs. The most significant of these is the intentional relinquishing of control over learning from the educator to the student. Bain contends that meaningful learning occurs when instructors shift from being the subject matter expert to the coach and guide, creating conditions in which students take ownership of inquiry, experimentation, and sense-making. This shift requires educators to design learning environments that encourage students to learn by doing through activities that involve teaching others, practicing skills, reflecting on performance, and receiving timely, constructive feedback.

A LEGO® data visualization exercise aligns with Bain's (2004, 2021) principles by requiring students to collaboratively build a physical model, generate operational data, and then transform that data into managerial insights. Students must diagnose system behavior, identify bottlenecks, interpret variability, and construct an executive narrative grounded in evidence. In doing so, they experience the kind of active, student-centered learning Bain (2021) describes, where agency, curiosity, and responsibility for learning are placed squarely in the hands of the learner.

1.3 Visualization as Student Self-Assessment

To fully manifest Bain's (2004, 2021) mandate for a "natural critical learning environment," the physical architecture of the proposed lab must allow operational failures and system dynamics to become immediately visible to the learners without instructor intervention. This will be achieved by embedding a physical whiteboard (from Scrumban) tracking system directly into the workspace layout drawn from Agile Project Management (Cobb, 2015). Using a localized, whiteboard-mounted or poster-board matrix populated with color-coded Post-it Notes will require student teams to manage their physical supply chain, assembly steps, and data logging tasks in real time. Data will be captured on the Post-it notes and serve two critical pedagogical functions within the NCLE:

- Externalization of Distributed Cognition**:** Grounded in cognitive design principles, the movement of physical sticky notes across distinct workflow columns (Backlog, Data Preprocessing, Active Assembly, Quality Assurance, Visual Analysis) will serve as a shared cognitive support. It will reduce individual coordination overhead and enhance team situational awareness (Bourdeau et al., 2020).
- Safe Failure and Immediate Feedback Loops: In alignment with Bain's focus on intrinsic discovery, the Post-it board acts as a real-world indicator of system health. When a bottleneck occurs, such as a data-logging delay in Class 2 or an inventory imbalance, the rapid accumulation of sticky notes in a single column creates immediate visual feedback (Cobb, 2015).

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1.4 Learning Objectives

By the end of the exercise, students will be able to:

1. Explain how operational processes generate data and how variability, bottlenecks, and human behavior shape datasets. As Richardson (2024) emphasizes, business analytics begins with understanding the context in which data is generated. Similarly,
2. Transform and Categorize Raw, Messy, Real-Time Data into structured datasets suitable for visualization. Richardson (2024) notes that a core competency is converting unstructured data into analyzable form. Students practice this by sorting pieces, assigning part numbers, and developing a Bill of Materials (BOM), which are a foundational artifact in enterprise systems.
3. Apply Lean and Flow Concepts. Schroeder and Goldstein (2021) identify key flow metrics foundational to understanding operations management: Cycle Time, Throughput, Work-in-Process (WIP), Defects, Rework, and Bottlenecks.
4. Construct Executive-Level Insights. Richardson (2024) emphasizes that analytics must support managerial judgment. Students apply Nussbaumer Knaflic's (2015) Storytelling with Data framework to transform quantitative findings into clear, audience-centered communication.
5. Appendix

2. EXERCISE OVERVIEW AND METHODOLOGY

The four-week curriculum is structured around a business case wherein student teams are hired as cross-functional analytics consultants for a struggling aircraft component factory. The framework operates as a Scrumban system, combining the time-boxed sprint structure of Scrum with visual data monitoring (Cobb, 2015).

2.1 Case Narrative: The Falcon Aero Components Crisis

Falcon Aero Components is a mid-sized manufacturer supplying sub-assemblies for regional aircraft. For the past six quarters, the company has missed delivery targets, frustrated customers, and absorbed rising rework costs. The plant manager, Dana Ruiz, has been tasked with diagnosing the problem before the next board review. She believes the issue is not simply "slow workers" or "bad data," but a deeper misalignment between the physical production process and the digital analytics systems used to monitor it.

To test this hypothesis, Falcon Aero hires your student team as cross-functional analytics consultants. Your assignment is to observe, measure, and improve a simulated production line that mirrors the real factory's workflow. The simulation uses a LEGO® aircraft kit to represent Falcon Aero's product, allowing you to experience the messy, real-time generation of operational data.

Dana's challenge to your team is simple:

"Our dashboards look clean. Our factory floor does not. I need you to show me what the data *really* says about how we work, and how we can work better."

Your team will:

- Build the aircraft under time pressure
- Capture cycle times, defects, bottlenecks, and throughput
- Diagnose operational constraints
- Redesign the workflow using Lean and Agile principles
- Validate improvements using Little's Law
- Present an executive dashboard and recommendation to Falcon Aero's leadership

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The simulation is intentionally imperfect. Parts will be misplaced. Data will be messy. People will make mistakes. The goal is not to build the fastest aircraft. It is to understand how operational systems generate the data that managers later visualize, interpret, and act on.

2.3 Materials and Team Roles

Materials: LEGO® Creator 31160 Race Plane, stopwatch, data capture sheets, and visualization tools (Tableau, Excel or Power BI are commonly used).

Team Roles (6–8 students per team): Builders, Quality Inspector, Timer, Observer/Data Recorder, and Project Manager.

2.4 Weekly Curriculum Breakdown- Detailed Class Timeline is in Appendix C

Class 1: Data Engineering & Pre-Production Inventory Schema (A complete list of terms and definitions is in Appendix A)

Teams establish categorical schemas, assign standardized alphanumeric Part IDs, and create a Bill of Materials (BOM). Intentionally, this is a simplified Engineering Bill of Material. Students execute a data-driven ABC Inventory Classification Analysis to segment components (Schroeder & Goldstein, 2021). ABC Inventory analysis looks for 10% of the high value parts as “A”, 20% of medium value parts as “B” and “C” as the 70% of low value parts; establishing as a categorization and tracking method.

After the instructor provides the overall explanation of the exercise, students will begin by engaging with the LEGO® kit as an analogy for the earliest stage of organizational data generation. Students first read the instructions and visualize the completed model, establishing a mental representation of the system they will build. They then will empty the LEGO® box onto the table, encountering what Richardson (2024) describes as *unstructured data*: a collection of heterogeneous, unlabeled, and unorganized elements that lack immediate analytical meaning. In this initial state, the LEGO® pieces represent the raw, unprocessed inputs that data scientists and operations analysts must routinely wrestle with before any meaningful analysis or visualization can occur.

The next task requires students to sort the pieces and assign part numbers, illustrating a foundational principle in both analytics and operations management: numbers often function as categorical identifiers rather than quantitative values. Richardson (2024) emphasizes that data categorization is a critical early step in transforming unstructured inputs into structured datasets, enabling downstream processes such as aggregation, filtering, and relational modeling. By assigning part numbers, students learn that classification is not merely a technical step but a conceptual one, an act of imposing structure on operational reality.

Once the pieces are sorted and categorized, students will develop a Bill of Materials (BOM), a structured list of all components required to assemble the final product. Schroeder and Goldstein (2021) identify the BOM as a foundational artifact in Material Requirements Planning (MRP) and Enterprise Resource Planning (ERP) systems. The BOM serves as the bridge between physical operations and digital information systems, enabling organizations to coordinate procurement, inventory management, production scheduling, and cost estimation. By constructing a BOM from the sorted LEGO® components, students experience first-hand how operational data is combined, standardized, and integrated into the hierarchical structures that underpin modern ERP systems (Salas, et al, 2009; Stainton, et al., 2010).

This step serves as a scholarly and practical introduction to the data lifecycle: students move from unstructured inputs to categorized components, and finally to a structured, relational artifact that mirrors the logic of enterprise systems (Richarson, 2024). It provides a conceptual foundation for understanding how operational data is generated, organized, and transformed long before it becomes the basis for visualization, analysis, or managerial decision-making.

Class 2: Descriptive Operations, Metric Extraction, and Bottleneck Detection

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Teams construct a baseline production line to build ten LEGO® aircraft. Back in the analytics environment, students generate a Pareto Chart to identify the system's exact bottleneck and apply the TIMWOOD framework to isolate waste (McManus et al., 2007). TIMWOOD is the classical categories of operational waste: Transportation, Inventory, Motion, Waiting, Overproduction, Overprocessing, and Defects. Schroeder and Goldstein (2021) identify these flow metrics as foundational to understanding operations and supply chain analytics. Students will learn to define, measure, and interpret each concept within the context of the LEGO® build:

- Cycle Time: Total time required to complete one unit.
- Throughput: Number of units completed per time interval.
- Work-in-Process (WIP): Units started but not finished.
- Defects: Errors or missing/incorrect components.
- Rework: Time spent correcting defects.
- Bottleneck: The slowest step limiting throughput.

By analyzing these metrics, students develop the ability to diagnose system constraints, identify sources of variability, and propose improvement strategies grounded in Lean thinking.

Class 3: System Optimization, Structural Modularity, and Predictive Modeling

Teams redesign the assembly path into flexible, modular sub-assemblies. By moving to reduce inventory part number amounts, or Work-in-Process (WIP) with sub-assemblies, the cycle time for production is reduced in a linear fashion, given Little's Law (Goldratt & Cox, 2014). Students construct a Scatter Plot mapping WIP levels against Lead Time to provide empirical, statistical proof of Little's Law (Richardson, 2024).

Class 4: Dashboard Showcase and Executive Storytelling

The curriculum culminates in a corporate executive board presentation where exploratory charts are transformed into explanatory narratives applying Nussbaumer's (2015) Storytelling with Data framework. Each student group will deliver a ten-minute executive pitch supported by an interactive Tableau (or other data visualization system) dashboard portfolio. The narrative must avoid simply listing technical metrics, focusing instead on establishing a clear, context-driven narrative arc: defining the operational tension (the baseline bottlenecks), demonstrating the data-driven intervention (the modular process redesign), and presenting a definitive "so-what" recommendation for permanent organizational improvement (Nussbaumer 2015).

3. HOLISTIC ASSESSMENT AND EVALUATION STRATEGY

To measure educational efficacy, the exercise implements a multi-layered evaluation methodology spanning technical proficiency, conceptual synthesis, and communication rigor. A complete rubric is found in Appendix B.

3.1 Quantitative Technical Evaluation (35% Total Weight)

Focuses on the structural accuracy of database schema design, analytical application prowess (ABC Inventory and Pareto cumulative percentages), and predictive validation via regression models.

3.2 Conceptual Operations Synthesis (35% Total Weight)

Ensures analytical outputs tie back to physical behaviors, including Lean diagnosis of the "7 Wastes", Theory of Constraints bottleneck analysis, and operational validation of Little's Law.

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3.3 Visual Narrative & Rhetorical Delivery (30% Total Weight)

Aligned with executive visual communication requirements: cognitive load optimization, strategic attention redirection via pre-attentive attributes, and a cohesive executive narrative arc.

4. CONTRIBUTION TO TEACHING PRACTICE

This proposed teaching exercise offers a distinct contribution to business analytics, information systems, and operations management education. The curriculum provides an innovative mechanism for integrating experiential process simulation with formal data analytics instruction, thereby correcting a prevalent pedagogical reliance on synthetic, pre-cleaned datasets. In traditional classroom settings, data is frequently introduced as an historical, sterile artifact, which shields learners from the critical upstream realities of data engineering (Richarson, 2024). By requiring students to actively operate a physical value stream, this exercise demonstrates how digital data natively emerges from complex human behaviors and volatile operational environments (McManus et al., 2007; Richardson, 2024). It builds a tangible cognitive bridge that connects structural data anomalies (such as missing values or misclassifications) to physical system realities (such as defect production or material inventory mismatches).

While many business analytics simulations require expensive proprietary software licenses or specialized computing infrastructure, this simulation leverages tactile manipulatives paired with foundational visualization ecosystems, like Tableau (Salas, et al., 2009; Stainton, et al., 2010). Grounded in constructivist education theory, this design encourages student engagement by transforming lectures into a laboratory setting, accelerating the developmental velocity of student mental models regarding data pipelines and performance metrics (Bourdeau et al., 2020; Salas et al., 2009).

This work contributes a roadmap for the cross-disciplinary synthesis of quantitative analytics, business and operations management methodologies. Rather than siloing Lean Six Sigma mechanics, queueing theory, data management, and visual communication into independent courses, this exercise unifies them within a single opportunity (McManus, et al., 2007). Students observe firsthand how operational constraints govern system capacity, utilize statistical modeling (linear regression) to empirically validate mathematical operational laws (Little's Law), and translate these mathematical realities into corporate insights using visual communication frameworks (Goldratt & Cox, 2014; Nussbaumer, 2015; Schroeder & Goldstein, 2021).

The curriculum directly operationalizes Ken Bain’s (2004, 2021) "Supercourse" and Natural Critical Learning Environment (NCLE) frameworks within the constraints of standard higher education schedules. By structurally transferring classroom control from the instructor to the student cohort, the exercise creates a learning laboratory for instructor and students. The integration of a visual work tracking board allows student teams to experience operational failure safely, identify systemic constraints through visual data cues, and self-correct their learning in real time (Cobb, 2015). This approach moves analytics instruction away from passive compliance-driven software tutorials and toward an authentic environment of data-driven managerial discovery.

5. PROPOSED CLASSROOM ACTION RESEARCH METHODOLOGY

To ensure continuous instructional improvement, a formal Classroom Action Research (CAR) study will be implemented upon institutional review board (IRB) approval (Norton, 2018). This study will operationalize the action research spiral cycle established by Kemmis and McTaggart, which guides the researcher through a continuous, iterative pipeline of planning, acting, observing, and reflecting (as cited in Siregar, 2025).

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- Planning Stage**:** The initial cycle is represented by this current design proposal. Formative feedback collected from peers during the presentation of this paper at the conference will be integrated to refine the scoring rubrics, simulation metrics, and data collection instruments.
- Acting Stage**:** The refined four-week curriculum will be formally deployed within an undergraduate business analytics course section.
- Observing Stage: The instructor will step into the dual role of educator and embedded researcher, systematically gathering a robust array of qualitative and quantitative data tracking artifacts to evaluate student comprehension.
- Reflecting Stage: The data collected will be analyzed to pinpoint where students encountered cognitive bottlenecks, how effectively they applied the storytelling principles, and how the physical layout influenced learning outcomes. The insights gleaned from this reflection will immediately feed into the "Planning" phase of Cycle 2 for the subsequent academic term.

5.1 Research Questions

The CAR study will be guided by two primary research questions:

1. How does participating in an active, physical data-generation simulation impact student understanding of upstream data engineering challenges compared to learning through static, pre-cleaned datasets?
2. To what extent does a tactile, physical environment reduce software learning challenges and encourage self-directed workflow improvement among students using analytics?

5.2 Proposed Mixed-Methods Data Collection

Following Norton's (2018) methodology for action research in university settings, a mixed-methods data collection matrix will be deployed to triangulate student learning outcomes:

- Pre- and Post-Test Concept Inventories: Prior to Class 1, students will complete a baseline diagnostic assessment testing core concepts in database schemas, statistics, operational flow metrics, and data visualization best practices. This exact inventory will be re-administered following Class 4 to quantitatively measure statistical gains in conceptual mastery.
- Artifact Rubric Analysis: Student-generated Bills of Materials, linear regression scatter plots, Pareto analysis and interactive Tableau dashboards will be graded utilizing the rubrics outlined in Appendix C.

Reflective Student Focus Groups: Upon completion of the four-week sequence, students will journal reflecting on key moments. The qualitative transcripts will be analyzed via thematic coding to capture student perceptions of working through operational problems, experiencing safe failure, and developing analytical skills within Bain's Natural Critical Learning Environment Framework.

6. CONCLUSIONS

The LEGO® Data Visualization Exercise provides a comprehensive, process-driven approach to teaching analytics, operations management, and executive communication. By transferring agency to students within a Natural Critical Learning Environment, this scalable framework bridges the gap between operational reality and analytical insight, cultivating the managerial judgment required in contemporary data-driven organizations.

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APPENDIX A

Instructor's Glossary of Integrated Operations and Agile Terminology

Concept / Jargon	Framework	Operational Definition in the LEGO® Context
Bill of Materials (BOM)	Operations / Lean	The structured, hierarchical list of all raw components, colors, and unique part numbers required to assemble one finished LEGO aircraft.
ABC Inventory Classification	Logistics / Supply Chain	A method of tiering inventory by value or scarcity. Class A parts (e.g., plane windshields) require strict control, while Class C parts (e.g., standard pegs) are managed with low oversight.
Sprint	Agile / Scrum	A fixed, time-boxed iteration (modeled as an in-class laboratory hour) during which a cross-functional team must deliver a functional project increment.
Scrumban	Project Management	A hybrid framework utilizing the administrative structural timeboxes of Scrum Sprints alongside the visual workflow and WIP controls of Lean.
Work-in-Process (WIP)	Operations Management	The total number of LEGO(r) sub-assemblies or aircraft units that have entered the assembly pipeline but are not yet completed.
Cycle Time	Operations / Lean	The granular, empirical duration required for a single workstation or operator to complete their assigned steps on a single unit.
Manufacturing Lead Time	Operations / Lean	The total elapsed time from when an aircraft model begins initial sorting or assembly to when it successfully clears final quality inspection.
Bottleneck	Theory of Constraints	The specific manufacturing station or process step with the lowest capacity that limits the ultimate throughput of the entire production line.
TIMWOOD (7 Wastes)	Lean Six Sigma	The classical categories of operational waste: Transportation, Inventory, Motion, Waiting,

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Concept / Jargon	Framework	Operational Definition in the LEGO® Context
		Overproduction, Overprocessing, and Defects.
Little’s Law	Queueing Theory	The mathematical relationship proving that system Lead Time is directly determined by the volume of Work-in-Process divided by operational Throughput (LT=WIP/TH).
Pre-attentive Attributes	Data Visualization	Visual cues (such as color saturation, size, and orientation) that the human brain processes instantly before conscious thought, used to guide a dashboard user's focus.

APPENDIX B

Assessment Rubrics for Proposed Student Deliverables

Technical & Conceptual Analytics Deliverable Rubric

Criteria	Exemplary (90–100%)	Proficient (75–89%)	Developing (Below 75%)
Data Schema & Normalized BOM	Bill of Materials (BOM) is perfectly structured with unique, logical Alphanumeric Part IDs. Categorical variables (color, dimensions) are cleanly separated from numeric metrics.	BOM is structured but features minor inconsistencies in key naming convention or data types. Primary categorization is mostly functional.	BOM lacks clear schema normalization; duplicate records or mixed data fields obscure relational analysis.
Operational Metric Accuracy & Logic	ABC Inventory tiering, Pareto calculations, and process cycle times perfectly match physical production realities. Bottlenecks are accurately flagged via cumulative data.	Minor mathematical or configuration errors in formulas (e.g., mismatched cumulative Pareto lines). Primary metrics remain identifiable.	Critical operations concepts (WIP, Cycle Time) are calculated incorrectly or fail to align with raw logs.
Empirical Modeling & Little’s Law	Scatter plot perfectly pairs WIP against Lead Time. Linear regression line features accurate slope and R2 values, yielding a flawless mathematical interpretation of Little’s Law.	Scatter plot handles variables correctly, but interpretation of the regression slope coefficient or R2 variance lacks full analytical precision.	Variables are plotted on incorrect axes, or regression modeling fails to prove the underlying queuing theory constraint.

2. Executive Visual Narrative & Showcase Presentation Rubric

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Criteria	Exemplary (90–100%)	Proficient (75–89%)	Developing (Below 75%)
Cognitive Load Optimization	Flawless application of decluttering principles. All non-essential gridlines, redundant axis titles, and chart-junk are eliminated to optimize readability.	Visualizations are clean, but retain 1–2 elements of unnecessary clutter or redundant labeling that distract from core insights.	Dashboards are overcrowded, dense walls of unfiltered charts, severely impeding immediate human interpretation.
Strategic Focus (Pre-attentive Attributes)	Color saturation, size contrast, and visual hierarchies are used intentionally. Primary colors exclusively highlight operational tensions (e.g., bottlenecks), while context is muted.	Visual hierarchies exist, but color choices are occasionally over-applied or inconsistent across separate dashboard sheets.	Arbitrary color schemes or default software palettes fail to direct the viewer's cognitive focus toward key anomalies.
Executive Narrative Arc & "So-What"	The presentation delivers a crisp narrative arc: introducing the baseline operational tension, showing the data-driven process pivot, and delivering an actionable, ROI-focused recommendation.	The pitch explains the data and process fixes, but relies too heavily on technical jargon instead of framing a strategic "so-what" for management.	The presentation is merely a chronological reading of class tasks, lacking a unified narrative structure or clear call to organizational action.

APPENDIX C

Four-Week Instructional Pacing for Two-Hour Sessions

Class Session	Time Allocation	Physical Simulation	Data Analytics
Class 1: Data Engineering & Pre-Production Inventory Schema	00–45 min	Review project process and objectives. Establish cross-functional consultant teams.	Review data types and ABC Inventory classification. Review raw LEGO(R) ® component kits.
	45–90 min	Unpack physical LEGO(R) ® models. Manually sort pieces by color, size, structural role, and scarcity.	Log attributes into spreadsheets. Construct a relational database schema and a normalized Bill of Materials (BOM).
	90–120 min	Populate initial Scrumban Board inventory cards and sprint goals.	Perform an ABC Inventory Classification Analysis to segment components by operational criticality.
Class 2: Descriptive Operations, Metric Extraction, &	00–30 min	Brief teams on baseline production sprint criteria.	Prepare real-time digital logging sheets and set up Scrumban Board.
	30–90 min	Run a baseline production sprint to construct 10 aircraft under real-time	Capture granular Cycle Times, Throughput, Work-In-Process

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Class Session	Time Allocation	Physical Simulation	Data Analytics
Bottleneck Detection		constraints. Log timing on Post-it notes. Set up a physical Scrumban board.	(WIP), and defect counts per workstation.
	90–120 min	Observe physical accumulation of Post-it notes at congested workstations on the board.	Clean messy runtime logs. Generate a Pareto Chart of step times and apply the TIMWOOD framework to isolate waste.
Class 3: System Optimization, Modularity, & Predictive Modeling	00–30 min	Teams re-engineer assembly flows into modular sub-assemblies to resolve identified bottlenecks.	Re-configure tracking board metrics to mirror the new modular workflow layout.
	30–75 min	Execute a second production run with varied WIP levels and modified assembly paths.	Capture dynamic runtime data across varying WIP levels and calculate total Manufacturing Lead Times.
	75–120 min	Clear physical assembly floor and shift completely to analytical modeling environments.	Construct Scatter Plots mapping WIP against Lead Time. Fit linear regression models to empirically validate Little's Law.
Class 4: Dashboard Showcase & Executive Storytelling	00–20 min	Finalize interactive dashboards in the data analytics environment.	Apply Nussbaumer's Storytelling Framework: eliminate clutter, leverage pre-attentive attributes, and build narrative arc.
	20–105 min	Teams present their analytical findings and strategic process recommendations to the class.	Deliver a cohesive narrative arc that includes inciting incident, climax, and resolution.
	105–120 min	Final de-briefing on physical data generation versus synthetic dataset analysis, process redesign, and communication impact.	Complete post-exercise concept inventories and Classroom Action Research reflective focus group assessments.

Appendix D
Mapping Learning Objectives to Assessment

Learning Objective	**Class Activity**	**Student Deliverable**	**Assessment Criterion**	**Evidence**
Data generation & variability	LEGO dump → sorting	BOM	Accuracy of schema	BOM table
Data engineering	Assign Part IDs	ABC analysis	Correct cumulative %	ABC table
Lean flow metrics	Production run	Pareto chart	Correct bottleneck	Tableau chart
Predictive modeling	WIP vs Lead Time	Regression plot	R^2, slope	Scatterplot
Executive storytelling	Dashboard build	Executive pitch	Narrative clarity	Final dashboard
Social Skills	LEGO Build	Process Improvements	Professor Team Assessment	Professor Observation