

Seeing What Was Invisible: Journaling, Stockfinder, and the Emergence of Systemic Thinking in Organizational Change Education

Francisco Araujo, ARBA Dynamics Lab, hello@pacoaraujo.com



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Abstract:

*Developing systemic thinking in non-technical audiences remains a persistent challenge in System Dynamics education. Traditional approaches often rely on formal modeling techniques that can limit accessibility and early engagement. This paper presents a pedagogical innovation that integrates **structured journaling** with a simple physical cognitive artifact—the Stockfinder—to support the development of systemic thinking in undergraduate business students.*

*The intervention was implemented over four weeks in an Organizational Change course. Students engaged in repeated cycles of observation, reflective journaling, peer review, and progressive exposure to System Dynamics concepts, including stocks, behavior over time, endogenous and exogenous variables, and feedback loops. The design emphasized cultivating a foundational capability: the ability to **notice and articulate accumulation and change in everyday contexts** before formal modeling.*

Results show heterogeneous levels of engagement, with a subset of students demonstrating clear progression from isolated observations to integrated representations of system structure. A key finding was the emergence of a shared pattern across multiple students: the accumulation of stress, anxiety, and fatigue. This

emergent structure—identified through journaling rather than predefined examples—was subsequently modeled in a dedicated session, revealing reinforcing and balancing feedback dynamics grounded in students' lived experience.

*The findings suggest that structured journaling can serve as both a **learning tool and a sensing mechanism for emergent system structures**, thereby enhancing accessibility and connecting System Dynamics concepts to real-world contexts. The paper argues that cultivating the habit of observation may be a critical precursor to Systems Thinking and proposes integrating **emergent, phenomenon-driven sessions** as a key enhancement to experiential System Dynamics education.*

Keywords:

System Dynamics Education, Reflective Journaling, Experiential Learning, Feedback Loops, Mental Models

Introduction:

One of the central challenges in System Dynamics education is enabling students to move from **event-based thinking** to **structural and dynamic thinking** (Meadows, 2008; Senge, 1990). While formal modeling tools provide rigor, they often require a level of technical proficiency that may hinder early engagement, particularly among non-engineering students. As a result, learners may struggle to connect abstract system structures with their everyday experiences.

This challenge is particularly evident in business education, and especially in Organizational Change courses, where students tend to interpret change as a sequence of decisions, actions, or external disruptions, rather than as the result of underlying feedback structures. Such interpretations limit their ability to design effective interventions, as they focus on events rather than the systems that generate them.

While formal modeling remains the dominant approach to teaching System Dynamics, alternative pedagogical strategies have explored the role of **writing as a pathway to understanding dynamic systems**. Notably, Joy (2003) introduced notebooks as a central learning tool, emphasizing the integration of writing and modeling to develop conceptual understanding. His work demonstrated that structured writing practices can foster dynamic thinking by enabling learners to externalize and refine their mental models.

Building on this foundation, the present study proposes a shift in emphasis: from using writing primarily to understand predefined system structures to using journaling to **discover system structures embedded in lived experience**. To support this shift, the study integrates structured journaling with a physical cognitive artifact—the *Stockfinder* (Araujo, 2025)—and a lightweight peer-review process designed to expose students to multiple perspectives.

The underlying premise of this approach is that **the ability to see system structure precedes the ability to model it**. Rather than beginning with formal representations, the intervention focuses on cultivating the habit of observing and articulating accumulations, changes, and relationships in everyday contexts. As students engage in repeated cycles of observation and reflection, more complex System Dynamics concepts—such as flows, feedback, and behavior over time—are introduced progressively.

This paper examines the extent to which this approach can enhance systemic thinking skills in undergraduate business students, while also enabling the emergence of meaningful system structures from their own lived experiences.

Hypothesis:

The hypotheses of this study are grounded in the premise that systemic thinking can be developed through **experience-based reflection and iterative sensemaking** (Kolb, 1984; Schön, 1983), supported by conceptual scaffolding that gradually introduces system structure (Senge, 1990). In this view, learning does not begin with formal modeling, but with the ability to observe, articulate, and refine interpretations of dynamic phenomena.

Building on this foundation, the study proposes that **the development of systemic thinking is preceded by the cultivation of perceptual and reflective capabilities**—specifically, the ability to recognize accumulation, change over time, and underlying structure in everyday contexts.

Accordingly, the central hypothesis is:

The integration of structured journaling practices with a physical cognitive artifact (*Stockfinder*) enhances students' systemic thinking skills, as evidenced by their ability to identify stocks, describe behavior over time, and differentiate between endogenous and exogenous drivers of system behavior.

In addition, the study explores a secondary hypothesis:

Reflective journaling, when sustained over time and supported by peer interaction, can surface emergent system structures from students' lived experiences, which can be leveraged as meaningful learning opportunities within the classroom.

Method:

The intervention was implemented in an undergraduate course on **Organizational Change**, part of the academic unit *Strategic Opportunity Detection*. The course focuses on developing students' ability to understand and design change processes within organizational contexts.

The instructional design of the intervention was informed by principles of **experiential learning and reflective practice** (Kolb, 1984; Schön, 1983), as well as **habit formation theory** (Clear, 2018). Rather than emphasizing the immediate mastery of System Dynamics concepts, the approach prioritized the development of a consistent observational practice.

The underlying assumption guiding the intervention was that **the ability to perceive and articulate system-relevant observations precedes the ability to formally model them**. Accordingly, students were encouraged to repeatedly observe and record accumulations in everyday contexts. Through this process, more complex insights—such as flows, feedback relationships, and system structure—were expected to emerge progressively through reflection and iteration.

Journaling Design and Procedure

Figure 1 – Student Journaling Notebook

Figure 1. Example of the physical notebook provided to students for the journaling practice. Each notebook was personalized and used consistently throughout the intervention to record observations, reflections, and evolving representations of system structure.

Students were provided with a **personalized physical notebook** (see Figure 2), intended to support continuous use throughout the intervention, and a **3D-printed**

Stockfinder (Araujo, 2025), designed as a cognitive artifact to facilitate the identification of accumulations and their dynamics (see Figure 2).

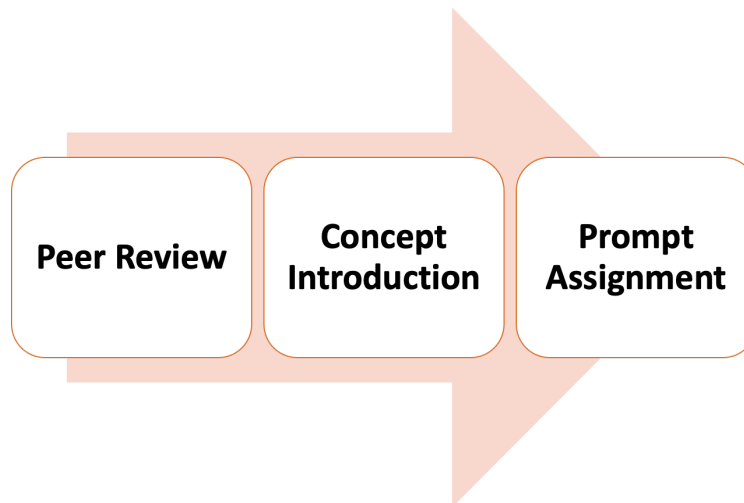
Figure 2 – Stockfinder Cognitive Artifact

Figure 2. The *Stockfinder* is a 3D-printed cognitive artifact designed to support the identification of accumulations (stocks) and reflection on their dynamics. The tool was used by students to frame observations and explore how quantities change over time.

Over a four-week period, students engaged in:

- 20 journaling opportunities,
- 9 peer-review cycles, and
- a final notebook evaluation.

Each session followed a consistent instructional sequence:



This structure created a recurring learning loop in which students first engaged with peer perspectives, then incorporated new conceptual lenses, and finally applied them through guided observation.

The journaling prompts were designed as a **scaffolded sequence** that progressively introduced key System Dynamics concepts. Short, conceptually aligned definitions, consistent with the *System Dynamics Glossary* (Ford, 2019), were included on the slides to anchor interpretation without constraining observation. The sequence moved

from identifying accumulations to exploring their drivers, dynamics, and feedback structures (see Appendix A).

Conceptual Progression

The instructional sequence followed a structured progression:

- **Session 1:** Identification of stocks through environmental observation
- **Session 2:** Endogenous and exogenous variables
- **Session 3:** Invisible accumulations (e.g., purpose, stress, motivation)
- **Session 4:** Flows and accumulation mechanisms
- **Session 5:** Manifest and latent structures (informed by system archetypes)
- **Session 6:** Behavior over time and reference modes
- **Session 7:** Reinforcing feedback loops
- **Session 8:** Balancing feedback loops
- **Session 9:** Integrative review of student notebooks
- **Session 10:** General feedback and closing reflection

This progression moves students from **concrete observation to structural reasoning**, enabling a gradual transition from noticing system elements to understanding their dynamic interactions.

Prompt Design

Each session incorporated a structured prompt that translated the conceptual focus into guided observation and reflection. Prompts were designed to move students from identifying observable accumulations toward articulating flows, patterns, and feedback structures.

Representative prompts are included in the main text, while the complete set—along with their conceptual alignment and learning objectives—is provided in **Appendix A**. Selected concept introduction slides used to activate observation with the Stockfinder are presented in **Appendix B** to support transparency and replicability.

An example prompt used in the initial session is shown below:

Example Prompt (Session 1 – Stocks):

Observe your immediate environment (e.g., classroom, campus, street, or home).

1. Identify three things that are accumulating (i.e., resources that can increase or decrease over time).
2. For each one, describe:
 - What is accumulating?
 - Why can it grow or shrink?
3. Select one and reflect:
 - What might cause it to increase?
 - What might cause it to decrease?

Students were encouraged to write freely, focusing on observation rather than correctness.

Peer Review Mechanism

At the beginning of most sessions, students exchanged notebooks with a nearby peer. The peer reviewed the most recent entry and provided brief feedback, either in written form or through simple symbolic reactions (e.g., emojis).

This process served multiple purposes:

- reinforcing consistency in journaling practice,
- improving clarity of expression, and
- exposing students to alternative perspectives.

Through repeated exposure to others' observations, students were encouraged to expand their own interpretations and refine their mental models.

Data Collection and Analysis

Data for this study consisted of **final notebook submissions** and **in-class observations of student engagement** throughout the intervention.

At the end of the four-week period, students were invited to submit their notebooks voluntarily. A total of **25 out of 28 notebooks** were collected and analyzed. Due to the personal nature of the reflections, notebooks were returned after evaluation, and no copies were retained.

The analysis followed a **qualitative, interpretive approach**, focusing on three dimensions:

- **Consistency of engagement**, assessed through the frequency and completeness of entries,
- **Depth of reflection**, based on the level of detail and elaboration in observations, and
- **Evidence of systemic thinking** is identified through the use of concepts such as stocks, flows, behavior over time, and feedback structures.

Rather than applying a formal coding scheme, the analysis emphasized the identification of **recurring themes across student reflections**, particularly those appearing in multiple notebooks, which were interpreted as indicators of shared systemic structures.

Additional insights were drawn from **peer-review interactions and classroom discussions**, which provided context for how students interpreted and applied the concepts over time.

This approach aligns with the exploratory nature of the study, focusing on how structured journaling supports the **emergence of systemic thinking** in a non-technical learning environment.

Results:

Participation and Engagement

A total of 28 undergraduate students participated in the intervention, of whom **25 submitted notebooks** for final review.

Engagement varied in both **depth and consistency**, and can be grouped into three levels:

- **High Engagement (n = 2):**
Students demonstrated sustained participation, deep reflection, and creative expression (including visual elements). Their entries showed clear integration of System Dynamics concepts and evolving structural thinking.
- **Moderate Engagement (n = 5):**
Students consistently followed the prompts and demonstrated an emerging understanding of key concepts, though with limited elaboration or integration across sessions.

- **Partial or Minimal Engagement (n = 18):**

Students showed irregular participation or produced brief entries, in some cases limited to keywords, constraining the depth of analysis.

Across these groups, variation was observed in **reflective discipline, conceptual understanding, and the ability to connect system elements over time.**

Development of Systemic Thinking Skills

Students with higher engagement demonstrated clear progression in their ability to:

- identify and describe **stocks (accumulations)**,
- recognize **patterns of change over time**,
- connect observations across sessions, and
- articulate early forms of **system structure**, including flows and feedback relationships.

These students transitioned from isolated observations toward more integrated representations of systems, suggesting the emergence of **structural thinking**. This progression supports the study's central hypothesis that repeated observation and reflection can foster systemic thinking capabilities.

Emergent Systemic Patterns

A key finding was the emergence of a recurring pattern across more than one-third of participants (n > 10): the accumulation of **stress, anxiety, and fatigue**.

Students described:

- increasing academic workload,
- time management challenges, and
- sustained emotional pressure from multiple commitments.

From a System Dynamics perspective, students implicitly framed **stress as a stock variable**, influenced by multiple inflows (e.g., workload, commitments, deadlines) and constrained outflows (e.g., rest, recovery, time management strategies).

Importantly, this pattern was **not part of the original instructional design** but emerged organically through the journaling process. This indicates that the practice enabled students to surface meaningful system structures grounded in their lived experience.

The recurrence of this pattern across multiple students suggests a **shared systemic structure**, highlighting how common experiences can be reframed as dynamic systems when appropriate observational tools are applied.

This finding provides preliminary evidence that structured journaling can function as a **mechanism for detecting shared systemic structures within a learning cohort**.

Discussion

The findings reinforce and extend prior work on writing-based approaches to System Dynamics learning (Joy, 2003). While earlier studies emphasized notebooks as tools for conceptual understanding, this study suggests that journaling can also function as a **sensing mechanism for emergent system structures**, particularly when combined with peer interaction and progressive conceptual scaffolding.

The structured sequence of prompts effectively supported the shift from **event-based to structural and dynamic thinking**, enabling students to recognize accumulations, drivers of change, and feedback relationships in everyday contexts. However, a key insight is that the intervention's effectiveness depended less on the complexity of the concepts introduced and more on the **consistency of the observational practice**.

In line with habit formation theory (Clear, 2018), repeated cycles of observing and writing played a central role in enabling systemic thinking. Rather than requiring immediate mastery of formal constructs, the intervention prioritized developing a foundational capability: the ability to **notice and articulate what accumulates**. Once this perceptual habit was established, more advanced concepts—such as flows, feedback loops, and behavior over time—were more readily internalized. This suggests that systemic thinking may emerge not only from conceptual instruction but from the **progressive cultivation of attention and reflection**.

The emergence of stress as a shared systemic structure further illustrates how systems can remain hidden until appropriate conceptual lenses are applied (Meadows, 2008). Students identified stress as an accumulating variable shaped by multiple interacting factors, implicitly revealing reinforcing dynamics and constrained balancing mechanisms. This demonstrates the potential of everyday experience as a valid entry point for systemic analysis.

Additionally, the peer review process supported the expansion of **mental models** (Senge, 1990) by exposing students to alternative perspectives, enabling them to move beyond initial interpretations.

A key limitation of the study was the delayed evaluation of notebooks, which restricted the ability to identify patterns early and respond in real time. From a System Dynamics perspective, this represents a **missing feedback loop** in the instructional design.

This limitation highlights an important implication: **reflective practices require embedded feedback loops to fully realize their potential**. When present, these loops enable emergent patterns to be surfaced, modeled, and explored collectively.

Accordingly, this study proposes integrating **emergent intervention sessions**, in which patterns identified in student reflections are brought into the classroom as shared systems. This approach closes the loop between observation, modeling, and intervention, strengthening both learning outcomes and practical relevance.

Conclusions

This study extends the tradition of writing in System Dynamics education (Joy, 2003) by demonstrating that journaling is not only a learning tool but also a **mechanism for revealing system structures embedded in lived experience**.

The findings suggest that journaling, when supported by simple cognitive artifacts and structured interaction, can:

- enhance accessibility to System Dynamics concepts,
- support the transformation of mental models, and
- connect abstract systemic principles to everyday contexts.

More fundamentally, the study proposes that the development of systemic thinking depends less on the direct teaching of complexity and more on cultivating a foundational habit: **learning to see accumulation, change, and structure in the world**. Once this habit is established, more advanced System Dynamics concepts can emerge naturally from experience.

Future work should explore integrating **real-time sensing and feedback mechanisms** to enable earlier detection of emergent patterns and more adaptive instructional responses. This would align the learning process itself with core System Dynamics principles of feedback, adaptation, and continuous learning.

References:

Araujo, P. (2025). *Stockfinder: A physical cognitive tool for identifying stocks and flows in everyday systems*. Presented at the International System Dynamics Conference (ISDC), Boston, USA.

Clear, J. (2018). *Atomic habits: An easy & proven way to build good habits & break bad ones*. Avery.

Joy, T. (2003). *Writing and modeling: Using a notebook to learn about system dynamics*. The Creative Learning Exchange.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice-Hall.

Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea Green Publishing.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.

Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. Doubleday.

Structured Abstract

Introduction (30–70 words)

Developing systemic thinking in non-technical audiences remains a challenge in System Dynamics education, as formal modeling approaches can limit accessibility. Prior work highlights writing as a pathway to learning. This study builds on that foundation by proposing a journaling-based approach that emphasizes developing observational capabilities as a precursor to understanding system structure.

Approach (30–70 words)

The intervention was implemented over four weeks in an Organizational Change course. Students engaged in iterative cycles of peer review, concept introduction, and journaling, supported by observation-driven slides and a physical cognitive artifact (Stockfinder). Concepts included stocks, flows, drivers, behavior over time, and feedback loops. Data (n = 25 notebooks and class observations) were analyzed qualitatively.

Results (30–70 words)

Engagement varied, with some students demonstrating progression from isolated observations to structured representations of systems. A recurring pattern across multiple students was the accumulation of stress, anxiety, and fatigue. This emergent structure, not predefined in the design, was later modeled in class, revealing reinforcing and balancing dynamics grounded in students' lived experience.

Discussion (30–70 words)

Findings suggest that structured journaling can function as both a learning tool and a sensing mechanism for emergent system structures. Developing the habit of observation may be a critical precursor to systemic thinking. Integrating emergent, phenomenon-driven sessions can strengthen experiential learning by connecting System Dynamics concepts to real-world contexts.