Extended Abstract

Do Causal Loop Diagrams Stimulate the Use of Information and Systems Thinking?

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System Dynamicists primarily rely on model diagrams to convey findings to clients. Despite their significance, there has been limited examination of the effectiveness of such diagrams. This study employed a mixed-method design with two sequential presentations (CLD/Text or Text/CLD) to examine the impact of causal loop diagrams (CLD) on professionals' (N=14) ability to engage in systems thinking and information utilisation. Through a case study on juvenile crime, utilising a think aloud method, police and municipal professionals were prompted to articulate their understanding of the problem's causes and the potential impact of an intervention. Additionally, we explored the correlation between the concepts of self-efficacy, response-efficacy, and the need for cognition with systems thinking. Findings suggest that presenting a CLD following textual information enhances information utilisation and systems thinking. We discuss implications for the discipline and potential directions for future research.

Introduction
Persistent societal problems are often characterised by dynamic complexity, including interconnectedness and circular causation. Such challenges appear across various domains such as crime, healthcare, and energy. Public professionals, including city officials, social workers, and police officers, encounter these problems daily and must understand their structure and behaviour to devise effective policies. Systems thinking, characterised by a holistic, broad, long-term, and dynamic view, enhances understanding and problem-solving in such contexts. System Dynamics (SD) supports professionals in tackling dynamic complexity, as people generally struggle to learn and act effectively in complex situations. Misperceptions of dynamic behaviour, omission of information, and failure to account for feedback loops often hinder effective decision-making.

Model diagrams are integral to the SD method, used to elicit, analyse, and communicate the causal structure underlying complex problems. However, the efficacy of diagrams in supporting systems thinking has received limited experimental research attention. This study assesses how causal loop diagrams (CLD) influence systems thinking and information use, focusing on systems thinking skills and psychological constructs such as self-efficacy, response-efficacy, and the need for cognition.

Systems thinking, lacking a single encompassing definition, is recognised as a worldview or cognitive paradigm. It involves perceiving the world as a dynamic system of interacting parts, requiring a broad and holistic perspective to understand system behaviour. Richmond's (1993, 1997) proposed set of systems thinking skills—dynamic thinking, system-as-cause thinking, forest thinking, operational thinking, closed-loop thinking, quantitative thinking, and scientific thinking—provides a comprehensive framework for assessing systems thinking.

This study seeks to address the following research questions:

1. Do causal loop diagrams stimulate the use of systems thinking skills?
2. Do causal loop diagrams lead to more information being used?
3. Do people with a higher need for cognition display more systems thinking?

4. Do people with a higher sense of self-efficacy and response efficacy regarding systems thinking display more systems thinking?

Method

A mixed-design experiment was conducted, involving police and municipal professionals (N=14) familiar with juvenile crime. Participants were presented with two consecutive stimuli: a textual analysis and a CLD, in varying orders. The think aloud method was used to assess systems thinking and information use during two assignments related to juvenile crime. The first assignment was related to describing the causes of rising youth crime in a neighbourhood. The second assignment asked participants to reason about the effects of an intervention. Both assignments were conducting in each of the two conditions (text, diagram). Participants' responses were coded and analysed for their use of systems thinking skills, as measured on Richmond's thinking skills, and information utilisation, as measured by participants reference to model variables.

Results

Overall, participants used relatively little system thinking skills and information. Analysis showed that participants did use more systems thinking skills and mentioned more variables when presented with a CLD after the text (T1D2 condition) compared to the text after the CLD (D1T2 condition). Within-subject analysis confirmed significant increases in systems thinking skills and information use in the T1D2 condition, but not in the D1T2 condition. Correlation analysis revealed a strong relationship between the use of systems thinking skills and information utilisation. However, no significant correlations were found between systems thinking and the psychological constructs of need for cognition, self-efficacy, and response efficacy. The results were inconclusive with regard to the benefits of solely being exposed to a diagram compared to only having read a text. Put differently, being exposed to a CLD with minimal instruction is as effective as receiving case information in a plain text.

Discussion

The findings indicate that CLDs enhance systems thinking and information use when presented after textual information. This suggests that information organized in a CLD adds value for public professionals beyond the same information captured in a text. The limited use of systems thinking skills among professionals highlights the need for further training or support from SD professionals. The results also indicate that, although CLDs improve systems thinking and information use, their use by professionals remains limited. Both the use of diagrams and the definition and measurement of systems thinking can be improved to facilitate their measurement and enhance improvement.

Conclusion

This study contributes to understanding the effectiveness of CLDs in supporting systems thinking and information use. These preliminary results suggest that CLDs, when used appropriately, can enhance the analytical capabilities of professionals dealing with complex societal problems. Deepening our insight into personal characteristics that influence systems thinking can aid in tailoring SD support to professionals. Unfortunately, this study found no relation between performance and NfC, RE nor SE. Future studies should investigate the role of diagrams in different contexts and by different users, the effects of various levels of instruction, visualisation techniques and the benefits of enhanced systems thinking on decision-making and policy outcomes.