Characteristics of Complex Problems

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Many of the social challenges we care about feel like messy, wicked knots (or a pile of tangled headphones). When we pull on a thread in one place, we create new, tighter knots elsewhere. The messy nature of these challenges is due to, among other things, their complexity. Understanding key features of complex problems helps us understand why problems in education can be especially resistant to change. The purpose of this brief is to share (some) characteristics of complex problems, and introduce system dynamics as a set of tools for managing this complexity.

+(Some) Characteristics of complex problems in education

- **Changing over time (dynamic)** - The problems we are solving today look different than they did yesterday, and will look different tomorrow. Students learn; staff are hired and leave; parents’ priorities change; policies are enacted and revised; curriculum is introduced and replaced; and communities grow and change. All components of education systems change over time, so we must think about these factors as dynamic rather than static.

- **Multiple stakeholders with different goals whose decisions and actions impact each other** – Administrators, teachers, students, parents, and teachers are experiencing systems differently, therefore have different incentives and motivations. The district's goal in mandating a school-wide curriculum to improve test scores may conflict with the teacher's goal to meet the individual needs of each student.

- **Time delays between action and result** – Despite our desire to see instant results, there is a lag time between our actions and their impacts. An investment in early childhood education will take years to improve graduation rates. An investment in a relationship with a child today won't instantaneously transform the school's culture. Often funding or buy-in is gone long before an initiative can demonstrate impact.
Feedback effects causing unintended or unanticipated consequences of actions – When we can’t see or understand the system as a whole, our well-intentioned actions may have side effects that make the problem worse in the long-run. Let’s say our district has low test scores, so we double down on time spent preparing for standardized tests. In the short term, test scores may improve. But there is an unintended consequence: with the added pressure on testing, teachers become burnt out and students become less engaged in learning. Ultimately, the test scores drop further.

Accumulations and history dependence – The behavior of a system is not only influenced by what is going on right at this moment, but the history of accumulated experiences of people in that system. A high school parent outreach coordinator may initiate large scale listening sessions and free brunches to build relationships with parents, but parents’ perceptions and experience of the school may be influenced by the accumulated positive and negative experiences over years of interacting with the school -- both as a parent but also as a student themselves.

System dynamics offers tools for working with complex problems

Traditional program design tools, such as logic models, help us develop, negotiate, and communicate our change efforts in a clear, linear way (i.e. Resources --> Activities --> Outputs --> Outcomes --> Impact). However, these tools can fail to account for the characteristics of complex problems, causing our best plans to fail or lead to surprising results.

System dynamics is the use of causal maps and computer simulation models to engage with this complexity and understand system behavior from a feedback perspective. Visual tools for mapping and modeling such as causal loop diagrams and stock and flow diagrams help us create simplified representations of complex systems, allowing us to identify places to intervene, test out our ideas, and anticipate their consequences. System dynamics tools help us to consider the behavior of the “whole” rather than fixating on the “parts” when addressing complex problems.
Because system dynamics is especially suited for gaining insight into complex problems, it is not the right method for every situation. Sometimes what’s actually needed is a simple calculation (i.e. Which program is more cost effective?), a survey (i.e. What do people think about this new policy?), or even just a meeting between stakeholders. Sometimes the path forward is obvious, or a decision has to be made immediately. As former Changing Systems Fellow with the Social System Design Lab, Adam Raney, once said, “If you are out on a hike and you break your ankle, call an ambulance. You don’t need to make a system dynamics model about it!”.

+ CONSIDERATIONS

This presentation of (some) characteristics of complex problems was influenced by John Sterman’s paper “Learning from Evidence in a Complex World” from 2006.

The examples and stories presented here are inspired from collaborations with students and staff at Jennings High School, Ritenour High School, with SKIP in St. Louis, MO, and with Health Equity Works and school district leaders in the St. Louis region.

+ SOURCES


+ ACKNOWLEDGEMENTS

Social System Design Lab Methods Briefs are short, digestible notes on applications of system dynamics and systems thinking in community settings. They are meant to capture and share out our current thinking on core ideas.

“Series 1: Systems Thinking Foundations” focuses on introducing core concepts of systems thinking and system dynamics as they relate to issues of education equity. This series draws from community-based modeling work with educators and students over the last ten years. Other briefs in this series include:

- Systems Thinking Iceberg | 1.01
- Mental Models | 1.03
- Framing Dynamic Problems | 1.04
- Understanding Systems from a Feedback Perspective | 1.05
- Accumulations | 1.06
- System Archetypes | 1.07

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