

Wicked Problems and the Systems Thinking Skills We Need to Solve Them

Feature

by Lucy Santos Green , January 2019

This past year, my husband and I bought a house. When we purchased the home, we knew it needed some work. Six months later and that original list of problems to tackle has now multiplied. We often joke that we are starring in our own version of Tom Hanks's *The Money Pit*.

Those of you who have built or remodeled a home are, no doubt, shaking your heads in sympathy (those of you in my part of the country probably mumbled "bless her heart" by the end of the second sentence). You know what we know: projects that first present themselves as simple, straightforward tasks, can oftentimes become complex, ever-changing beasts. Problems can be wicked. The quick and dirty definition of a wicked problem is a problem without a specific solution. Horst Rittel and Melvin Webber described a wicked problem as containing the following characteristics:

- It is difficult to define or explain. Sometimes, the only way to understand a wicked problem is to try to solve it.
- It has no end. The solution then becomes this is the best we could do with the time and resources we have.
- Solutions are weighted by whether these are *better* or *worse*, not *right* or *wrong*.
- Another thing about solutions: it is impossible to list every possible one.
- Trial and error cannot exist. Each time the problem solver tries out a solution, it changes the nature of the wicked problem.
- It is a unique problem. While it might be similar to other problems you have faced, the factors are different enough that a prepackaged solution will not work.
- The reasons why a wicked problem exists may be identified or described differently depending on the lens of the person examining it. This variability will also impact how the potential solutions are identified and weighted (1973).

A key characteristic of wicked problems is that they do not exist independently. They actually grow out of other problems. Because of this characteristic, Steve Eastbrook prefers to describe them as "*dilemmas* to which we can respond, rather than problems that we can solve" since "any attempt to solve them will give rise to further, unanticipated problems" (2014, p. 24).

What qualifies as a wicked problem? Here are just a few examples: homelessness, debunking misinformation spread on the Internet, obesity, the tax code, climate change, poverty. At first glance these seem like distant, adult dilemmas. However, we know better. These issues are affecting our students and communities daily. When we call on school librarians to prepare 21st-century learners, we are calling on them to help learners gain the skills necessary to tackle these dilemmas, these wicked problems.

This is where systems thinking comes in. The National Research Council defines systems thinking as "the ability to understand how an entire system works; how an action, change, or malfunction in one part of the system affects the rest of the system" (2010, p. 3). Systems thinking skills are crucial in addressing wicked problems (large systems with many confounding parts) such as healthcare because they provide a "set of concepts for understanding and reasoning about a system's behavior...including the observation that systems tend to have properties that cannot be traced to individual components or groups of components, but rather arise from the interaction of those components with the entire system" (Eastbrook 2014, p. 28). In other words, systems thinking helps us to identify not only the system but also the system's parts, as well as how the ways these parts interact with each other create more complexity in the system.

When a student understands a complex system, he or she is able to create a sophisticated mental model of it. In contrast, research tells us that people new to systems thinking may be able to identify parts of a system, but they struggle to understand how these parts relate and react to each other. They are often unable to identify the levels in a system and cannot explain how these levels are connected. At the other end, expert systems thinkers "represent complex systems in terms of interconnected structures, behaviors, and functions" (Tripto, Ben-Zvi-Assaraf, and Amit 2018, p. 669).

Orit Ben-Zvi-Assaraf and Nir Orion (2010) developed a hierarchy to demonstrate how systems thinking skills develop over time. Students with **basic skills** can identify and analyze objects and processes in a system. However, they still "tend to focus on simple linear relationships in systems, and on easily visible components" (Tripto, Ben-Zvi-Assaraf, and Amit 2018, p. 669). At the **next skill level**, students are able to evaluate and synthesize relationships between the objects and processes in a system. They can also create a mental model of the system, sketching out these objects, processes, and relationships. Students with **fully developed skills** are capable of treating "a set of phenomena as a system" (Roychoudhury et al. 2017, p. 73). They understand a system's dimensions, visualize how that system fits into a larger system, and are able to pull out a system's own individual subsystems. Students at this level are also capable of rich mental modelling that helps them make predictions about how the system might behave when modified.

Systems thinking can be taught with instructions, suitable cognitive tools, and a gradual progression from modeling simple to more complex systems (Hung 2008; Akcaoglu

and Green 2018). In a study that examined how high school students develop systems thinking skills over time, researchers used the topic of climate change as the curriculum focus. The ability to develop a rich and detailed mental model of climate change "involves understanding complicated evidence from various sources such as ocean, ice, atmosphere, land, human activities, and the interactions among them" (Roychoudhury et al. 2017, p. 79). Consequently, Anita Roychoudhury and team found that students developed a deeper understanding of climate change when they explored it as a complex system, rather than focusing on memorizing facts about climate change and its causes.

While research on the development of systems thinking skills in K–12 is relatively new and somewhat hampered by the overwhelming time constraints educators and students face, there are a few items I would like to draw to your attention. First, because the higher a student's system thinking ability is, the richer his or her mental models are, external representations of systems (for example, concept maps) are a great way to assess student understanding (Akcaoglu and Green 2018; Jacobson et al. 2017; Hung, 2008). Second, there is promising evidence that students can develop systems thinking through design tasks. Akcaoglu and I (2018) detail how systems thinking skills were indirectly addressed and nurtured in a project with sixth grade middle school students who used Kodu to design original video games. This finding is especially relevant to school libraries that host makerspace programs to encourage student creativity and innovation. Third, complex systems are becoming more heavily emphasized in science education. Science education researchers argue that students who understand complex systems are able to make connections between different science subjects—a hallmark of scientific literacy (Jacobson et al. 2017).

If you are wondering what this has to do with school librarianship, then let me assure you that the answer is: plenty! The development of systems thinking skills has been marked by the National Research Council as a 21st-century critical skill (2010). Even so, systems thinking cannot be developed overnight. Helping students develop such mental complexity takes time and should be an effort undertaken over the years, beginning as early as possible. As a school library researcher and educator, I am passionate about our involvement in fostering systems thinking skills because I believe we are part of the foundational learning (reading, inquiry, and ethical behavior) students need in order to grow systems thinking skills (Johnston and Green 2018). Without the abilities to read and engage with information in critical and ethical ways, our students are not capable of developing the background knowledge and rich mental models that accompany growth in systems thinking. Research in our field provides plenty of evidence for what I am claiming.

School library researchers consistently find students are better at verbalizing the process for finding information than they are at evaluating and curating the information they collect (Krueger and Donham 2013). In fact, without a structured inquiry process, modeled and supported by the school librarian, students settle for the first information source they find (Kuhlthau, Heinström and Todd 2008; Kovalik, Yutzey, and Piazza 2013). Left to their own devices, students skip "a point of focus formulation... without building background knowledge and formulating essential questions" (Kuhlthau, Heinström and Todd 2008, para. 9). Additionally, students rarely select and analyze information from multiple resources on their own, a step crucial to the process of identifying components of complex systems (Kovalik, Yutzey, and Piazza 2013; Jacobson et al. 2017).

In contrast, students who participate in a structured and guided inquiry process understand that "information seeking is a demanding process which requires reflection and analytical decisions" (Kuhlthau, Heinström and Todd 2008, para. 9). They consistently develop more meaningful investigations that go beyond fact-finding (Krueger and Donham 2013). We also know that when school librarians co-design, co-teach, and co-assess student research projects, students improve in performance on higher-order thinking tasks (Ercegovac 2012). This is because despite information literacy standards outlining information seeking, access, evaluation, use, and communication, classroom teachers tend to focus exclusively on location skills (Newell 2004).

These studies are just a few examples of the ways school librarians contribute to development of the foundational learning required for growth in systems thinking. Again, these are not skills students will develop after one project, or even one school year. Growth in systems thinking is a marathon, not a sprint. It requires a commitment to vertically plan with other school librarians and classroom teachers. It means the school library program lays a strong and robust foundation in information literacy and inquiry beginning in the early grades, consistently threading these concepts throughout the curriculum in progressive years.

Fully realizing our role in student development of systems thinking means we carefully consider each and every technology tool, collaborative project, or makerspace activity for the opportunity to wrestle with the complex systems and wicked problems these vehicles may or may not provide. Finally, it means a professional commitment to familiarizing oneself with the terminology of systems thinking and the research in this area so that you are able to advocate for the critical role in foundational learning your program plays, in ways accessible to other stakeholders. It is a big calling, but one we answered long ago when we claimed the library as the heart of the school.

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