

Creating Assessment Questions for Systems Thinking Concepts

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We measure what we care about (Meadows, et al, 1972).

Abstract:

In this paper we undertake an effort to increase the collection of systems thinking assessment questions available to educators and researchers focused on the pre-college and undergraduate level of instruction. The first part of the paper lists a hierarchical set of systems thinking concepts that lend themselves to assessment through questions, followed by some examples of systems thinking assessment questions at each level. The second part of the paper presents some guidelines for developing concept inventories. It is the hope that systems thinking inventories at the primary school, middle school, and secondary school level will be developed in an effort to support the infusion of more systems thinking concepts in education for students ages 5 to 22. It is the intention to make the list of systems thinking assessment questions freely available through the Creative Learning Exchange. The research and analysis needed to develop systems thinking concept inventories is a second stage for this effort.

Introduction

The current pandemic is an immediate, and relatively short-term problem, but the United Nations (2019), taking a long-term view of global, systemic problems indicates that “students need education in mathematics and natural sciences, learning to write and communicate persuasively, cooperate in teams and acquire leadership and *systems thinking*” [italics added] to “understand the processes that maintain healthy functioning of the Earth system and sustain life (p. 49).”

This paper is divided into two sections. The first section describes one hierarchical set of levels of systems thinking concepts that lend themselves to being assessed by specific questions. Each level of systems thinking concepts is then followed by a short table that displays a subset of example assessment questions that could fall into that ST category. The second section discusses the development of concept inventories. Concept inventories are used in various science and mathematics disciplines to assess foundation concepts for a given subject (CEI, 2021). It is our goal to develop such concept inventories for ST at the primary school, middle school, and secondary school levels.

Part 1: Collecting Assessment Questions

This collection can be a valuable asset to educators who are trying to introduce ST in their instruction and to those of us who would like a broader variety of ST questions to use both in instructional and research settings. Hopefully this initial set of ST assessment questions will be improved and enhanced both in quality and quantity over time.

It is the intention of the authors to focus on students ages 5 to 22. To truly make ST a core method of analysis for future generations we must start in pre-college (Forrester, 2007). We have found that many questions intended for secondary school students have worked quite well for undergraduate students, so have extended the intended audience to include that age group as well.

While the ST assessment questions we collect will come from disparate disciplines, the core systems thinking concept being assessed in each question can often lend itself to being clothed in a scenario from another discipline; thus the collection of ST questions has the potential to be a seedbed.

A Suggested List of Core ST Concepts That Lend Themselves to Assessment

Some sample questions for each category in the ST concepts hierarchical list are provided to give the reader a sense of what could be used to begin the collection we aim to compile.

Level 1: **Recognizing** the dynamic nature of systems

Level 2: **Representing** the system with stocks and flows

Level 3: **Identifying** Feedback

Level 4: **Understanding** Dynamic Behavior

Level 5: **Using** Conceptual Models

Level 6: **Creating** Simulation Models

Level 7: **Testing** Policy

Part II: Creating Systems Thinking Concept Inventories

Concept inventories are sets of assessment questions (usually in multiple choice format) that center around core concepts in a particular discipline. The questions are field tested to determine if, in fact, they do capture whether the student understands the concepts for which the inventory was created. The inventories are assessed for validity (they measure what they claim to measure) and reliability. Having such an inventory allows educators and researchers an opportunity to measure a “gain in learning” if equivalent subsets of concept inventory questions are used at various points in an educational setting (Sands, et al, 2018).

Call to Action

We call on all of those educators and practitioners who have endeavored to assess systems thinking skills of their students/stakeholders to join us in our efforts to collect ST assessment questions. For each question submitted the name and email of the person submitting the question will be required. The questions can be in any format used to assess ST. If the questions are not in multiple choice format we can reformat the question by contacting its author during the reformatting process. We have created an online process for submitting an ST assessment question. See the URL below if you decide to submit an ST assessment question. To submit an ST assessment question please go to: <https://forms.gle/6hhP2csJky8fexTRA>

For the complete paper showing some sample ST assessment questions please go to: <https://ccmodelingsystems.com/portfolio/fisher-research/>