# A Multidimensional Comprehension Index of Systems Thinking

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## Extended Abstract

Systems Thinking (ST) continues to remain a beneficial approach to address complex problems. How to measure one's comprehension and understanding of ST has become more of a prominent issue. Despite all the attention and effort to measure ST skills, a quantitative approach that captures how ST's multidimensionality affects ST assessment is still missing. This paper proposed a systematic and rigorous approach to create a Multidimensional Comprehension Index of ST (MCIST). First, we used the Lake Urmia Vignette (LUV) measurement tool proposed by Davis et al. (2020) that assess 143 undergraduate students' understanding of complex systems. The LUV collects and measures three types of ST skills: (i) Number of variables, (ii) Numbers of casual links and (iii) Number of closed loops.

Second, we form a conceptual framework based on these ST skills and transform this framework into the quantifiable tool, MCIST, using Data Envelopment Analysis (DEA). DEA is a non-parametric method commonly used in the fields of operations research and economics for efficiency and performance measurement. It is usually known for its ability to benchmark multi-dimensional inputs and outputs for multi-criteria performance assessment (Cooper et al., 2011). We include two other ST skill set in the MCISE, Middle nodes and Connectivity which captures the depth of the casual network and separates respondent's interconnectivity skills from detailed complexity skills, respectively. Third, we use the MCIST to benchmark the performance of comprehension ST thinking on each participant and compare with LUV model. We then perform meta-analyses to validate how the MCIST score relates to the participants' responses. The result shows that: (i) DEA serves as a robust approach to capture ST's multidimensional characteristics. (ii) the MCIST model can capture multiple ST skills, including loops, connectivity, and middle nodes, without influence by the length of the responses.

Future work includes, first, instead of testing using undergraduate students, extend the scope to different cohorts, such as professionals and graduate students. We can then perform hypothesis testing between different heterogeneous groups. Second, the dynamic changes of individuals' understanding of complexity need to be studied. The participants in this study are first-year engineering undergraduate students who have not decided their engineering major. Future work can include having the same set of students conduct the LUV task again during their senior year when they already have taken a number of engineering courses in their major. We can then examine the dynamic changes of the scores to see how their understanding of complexity changes within the years. Last, in this study, we use the most basic DEA model, the BCC output-oriented model as a baseline for the multi-dimensional index ST assessment approach. Future assessments can be conducted using other DEA models that have different fundamental assumptions.

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