A FRAMEWORK FOR EVALUATING STUDENTS' SYSTEMS THINKING IN MATHEMATICS

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In the 21st century, people are living in an increasingly complicated world and thus should be prepared to think and act holistically and integratively rather than considering each component individually. In other words, individuals have to be equipped with systems thinking (ST). This is a 21st century skill that should be cultivated among students and has been included in the 2022 PISA math framework (OECD, 2020), indicating that mathematics is a subject that should help train students to be systems thinkers. However, ST connotation, structure, and evaluation when it is applied to mathematics have not been elaborated previously. Although PISA 2022 includes ST in its math framework, item developers have indicated that items in PISA 2022 are not specifically developed for evaluating this skill.

Studies exploring ST in mathematics are rare. Salado et al. (2018) studied four middle school students' ST skill in solving mathematical problems by investigating whether they can use relevant elements in the real-world context. However, the students only provided traditionally expected mathematical answers. In addition to research in mathematics, a systematic literature review of studies discussing ST connotations, structures, and evaluations in other fields, such as engineering, management, biology, and chemistry (e.g., Lavi et al., 2020), could provide insights regarding the picture of ST in mathematics. Based on such literature review of research from 2003 to 2020, this paper identifies the ST skill as a skill of identifying elements in a system and their interconnections and integrating them into a holistic structure, and a three-element operational framework is proposed for the evaluation of ST, outlined as follows. Test items in the math world and real world were also developed accordingly.

- Identify/construct relevant components: the key of evaluation is whether students consider multiple perspectives in their consideration.
- Recognise/construct relationships: the key of evaluation is whether students can consider diverse nonlinear relationships rather a simple linear one.
- Analyse/construct a system: the key of evaluation is whether students can systematically organise relevant components and relationships into a structure or analyse a structure in this manner.

References

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