Research Briefs: Quantitative Reasoning in Environmental Science: A Learning Progression

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Quantitative Reasoning in Environmental Science: A Learning Progression

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Abstract
The ability of middle and high school students to reason quantitatively within the context of environmental science was investigated. A quantitative reasoning (QR) learning progression was created with three progress variables: quantification act, quantitative interpretation, and quantitative modeling. An iterative research design was used as it is the standard method for the development of learning progressions. The learning progression was informed by interviews of 39 middle and high school students from 5 schools in the Western USA using QR assessments. To inform the lower anchor, intermediate levels, and upper anchor of achievement for the QR learning progression, an extensive review of the literature on QR was conducted. A learning progression framework was then hypothesized. To confirm the framework, three QR assessments within the context of environmental literacy were constructed. The interviews were conducted using these QR assessments. The results indicated that students do not actively engage in quantitative discourse without prompting and display a low level of QR ability. There were no consistent increases on the QR learning progression either across grade levels or across scales of micro/atomic, macro, and landscape.

Practical Application
The primary focus of this research is on the development of a QR learning progression. However, there are implications for teaching. Students need to engage in real-world problem-based learning to become environmentally literate. QR can serve as a major support or barrier to this development. To enhance QR, teachers must require students to provide quantitative as well as qualitative support for their arguments. Students should be provided multiple quantitative representations (tables, graphs, equations, science models) within a science context and use QR to provide data-based informed decisions about critical issues that impact their place. Students should engage in building their own QM representing these issues, then test and refine those models. The QR learning progression provides a view of how QR develops in the context of environmental science. The learning progression can be used to determine QR strengths and areas in need of development. Developing QR will require a change in both content and pedagogical practice; content needs to be within a real-world context and QR is inherently interdisciplinary requiring a change in teacher practice.

Citation
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