New Orleans JAZZED about Engineering Education

Paper ID #16989

From Assessment to Intervention: Conceptual Understanding of Rate and Accumulation Processes

Ms. Carli Denyse Flynn, Syracuse University

Carli Flynn is a PhD candidate in the Civil and Environmental Engineering Department at Syracuse University. She has a MS degree from Carnegie Mellon University and a BS degree from Cornell University. Her engineering research interests include studying green infrastructure adoption for stormwater management in U.S. municipalities. Her education research interests extend to understanding how learners make sense of complex problems that require coordinating knowledge from multiple disciplines, the integration of stakeholder considerations into the engineering design process, and mixed methods research designs.

Dr. Cliff I. Davidson, Syracuse University

Wilmot Professor of Engineering Director, Environmental Engineering Program Syracuse Center of Excellence in Environmental and Energy Systems and Department of Civil and Environmental Engineering

Dr. Sharon Dotger, Syracuse University

Sharon Dotger is a Dual Associate Professor of Science Education at Syracuse University and Chair of the Department of Science Teaching. Her research interests focus on teacher and student learning in science and the relationships between instruction and learning outcomes for students.

From Assessment to Intervention: Conceptual Understanding of Rate and Accumulation Processes

This Work in Progress paper investigates how engineering students think and learn about rate and accumulation processes. Previous research found robust misconceptions about rate and accumulation processes among sophomore engineering students, leading to the development of the Rate and Accumulation Concept Inventory (RACI)[1,2]. The primary motive for our developing the RACI was to provide a valid tool that teachers and curriculum developers could use to assess student mastery of rate and accumulation processes. The primary goals of the RACI are to assess (1) overall mastery of rate and accumulation concepts, (2) mastery of these concepts within particular contexts (e.g., heat flow, water flow), and (3) the prevalence of certain misconceptions related to rate and accumulation processes. Initial pilot testing of the RACI indicated persistent misconceptions across multiple contexts. Content validity evidence was developed using multiple faculty reviews of the test items. Internal consistency reliability was assessed on an earlier version of the RACI using the Kuder-Richardson Formula 20. This yielded a value of 0.77 for the instrument and ranges of 0.64 to 0.76 for the three contextual categories[2].

Several efforts are underway to improve the validity, reliability, and fairness of the RACI. A thorough taxonomy of the RACI has been developed to synthesize the understandings and abilities that are included in the RACI question items. Initial findings from this process led to the addition of question items. Methods suggested by the Evidentiary Validity Framework[3] are used to assess the validity of each of the primary goals of the RACI. Additional pilot tests using a range of student populations will provide further reliability analysis of the RACI. These tests are being conducted in both sophomore and junior level classes in a variety of disciplines, including civil and environmental engineering, mechanical engineering, and chemical engineering.

This research also includes the development of instructional methods with the aim of correcting student misconceptions identified by the RACI. Inquiry-based learning activities were designed using variation theory[4] to challenge students' conceptual understanding of rate and accumulation processes across multiple contexts. Activities include the use of toy bricks to construct rate and accumulation graphs. These activities will be tested in a required sophomore civil and environmental engineering course. The success of these activities will be measured using formative assessments and pre-post course RACI scores. An observation protocol will also be used to assess students' responses to the class activities[5].

References

1. Flynn, C.D., Davidson, C.I., Dotger, S., 2014. Engineering Student Misconceptions about Rate and Accumulation Processes, in: ASEE 2014 Zone I Conference. Bridgeport, CT, USA.
2. Flynn, C.D., Davidson, C.I., Dotger, S., Sullivan, M., 2015. Development and Pilot Test of the Rate and Accumulation Concept Inventory, in: 2015 ASEE Annual Conference and Exposition. Seattle, WA.
3. Jorion, M.N., Gane, B.D., DiBello, L.V., Pellegrino, J.W., 2015. Developing and Validating a Concept Inventory, in: 2015 ASEE Annual Conference and Exposition. Seattle, WA.
4. Mun Ling, L., Marton, F., 2011. Towards a science of the art of teaching: Using variation theory as a guiding principle of pedagogical design. Int. J. Lesson Learn. Stud. 1, 7–22.
5. Shekhar, P., Demonbrun, M., Borrego, M., Finelli, C., Prince, M., Henderson, C., Waters, C., 2015. Development of an observation protocol to study undergraduate engineering student resistance to active learning. Int. J. Eng. Educ. 31, 597–609.