



Advancing Equity & Strengthening Teaching through Mathematical Modeling

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Mathematics modeling has the potential to “re-humanize” mathematics (Gutierrez, 2018) by providing students opportunities to make connections, and experience mathematics in a way that can help them navigate the realities in their daily life. Mathematical Modeling has several attributes of an approach that “(re)humanizes” mathematics. By tapping into students’ funds of knowledge, mathematics becomes personally relevant, and using real-world problems illustrates the usefulness of mathematics to students’ everyday situations and becomes a tool through which both students and teachers can affect social change.

Pivotal Spaces that promote equitable participation and modeling competencies

In the modeling process, we identified pivotal spaces for equity and for rigorous mathematics: a) In these spaces, teachers have to make decisions that could advance, or hinder equitable participation and diverse contributions. In other words, teachers have to make and enact instructional decisions that have consequences with respect to equity; b) They have the potential to foster the development of MM competencies which are central to modeling as content/practice standards (Kaiser, 2007; Maa β , 2006; CCSSM, 2010). This is key given such cognitively demanding competencies are often under-emphasized in elementary settings serving historically marginalized children. Our work focuses on these pivotal spaces and teaching practices to support equitable participation and development of modeling competencies in elementary students.

Math Modeling and Cultural/Community Social Justice Contexts Selected Resources

Major Report:

GAIMME: *Guidelines for Assessment and Instruction in Mathematical Modeling Education, Second Edition*, Sol Garfunkel and Michelle Montgomery, editors, COMAP and SIAM, Philadelphia, 2019.

<https://www.siam.org/Publications/Reports/Detail/Guidelines-for-Assessment-and-Instruction-in-Mathematical-Modeling-Education>

Books:

Aguirre, J. Mayfield-Ingram, K., & Martin, D. (2013). *The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-based Practices*. Reston, VA: National Council of Teachers of Mathematics.

Felton-Koestler, M., Simic-Muller, K., & Menéndez, J. M. (2017). *Reflecting the World: A Guide to Incorporating Equity in Mathematics Teacher Education*. Charlotte, NC: Information Age Publishing.

Gutstein, E., & Peterson, B. (2013). *Rethinking mathematics: Teaching social justice by the numbers* (2nd ed.). Milwaukee, WI: Rethinking Schools.

Hirsch, C., & Roth McDuffie, A. (2016). *Annual Perspectives in Mathematics Education: Mathematical Modeling and Modeling Mathematics*. Reston, NJ: National Council of Teachers of Mathematics.

Wager, A. A., & Stinson, D. W. (Eds.). (2012). *Teaching mathematics for social justice: Conversations with educators*. Reston, VA: National Council of Teachers of Mathematics.

Elementary

- Carlson, M., Wickstrom, M., Burroughs, E., & Fulton, E. (2018). A case for modeling in the elementary school classroom. Hirsch & A. Roth McDuffie (Eds.) *Annual Perspectives in Mathematics Education: Mathematical modeling and modeling with mathematics*. Reston, NJ: National Council of Teachers of Mathematics. 121.
- English, L. D., Fox, J. L., & Watters, J. J. (2005). Problem posing and solving with mathematical modeling. *Teaching Children Mathematics*, 12(3), 156-163.
- English, L. (2013). Surviving an avalanche of data. *Teaching Children Mathematics*, 19(6), 364-372.
- English, L. (2014). Statistics at play. *Teaching Children Mathematics*, 21(1), 36-44.
- Plumb et al (2017) Flint Michigan Water Crisis: connecting to local issues in mathematics classroom. *Teaching Children Mathematics*, 23(9) 518-520.
- Simic-Muller, K., Turner, E.E., Varley, M. (2009). Math Club Problem Posing. *Teaching Children Mathematics*, 16(4) 206-212.
- Suh, J., Matson, K., Seshaiyer, P., Jamieson, S., & Tate, H. (2021). Mathematical Modeling as a Catalyst for Equitable Mathematics Instruction: Preparing Teachers and Young Learners with 21st Century Skills. *Mathematics*, 9(2), 162-. MDPI AG.
- Suh, J. M. & Seshaiyer, P. (2019). Co-designing and implementing PBL through Mathematical Modeling in STEM contexts (529-550). In Moallem, M., Hung, W., & Dabbagh, N. (Eds). *Handbook of Problem Based Learning*. Hoboken, NJ: Wiley-Blackwell Publishing.
- Suh, J. M., Burke, L., Britton, K., Matson, K., Ferguson, L., Jamieson, S., & Seshaiyer, P. (2018). Every Penny Counts: Promoting Community Engagement to Engage Students in Mathematical Modeling. In R. Gutierrez & Goffney, I. (Eds.), *Annual Perspectives in Mathematics Education: Rehumanizing Mathematics for Students who are Black, Indigenous, and/or Latin@*. (pp.63-78). Reston, VA: National Council of Teachers of Mathematics.
- Suh, J., Matson, K., & Seshaiyer, P. (2017). Engaging Elementary Students in the Creative Process of Mathematizing Their World through Mathematical Modeling. *Education Sciences*, 7(2), 62.
- Suh, J. & Seshaiyer, P. (2016). The Role of Information Technology in Engaging Elementary Students in Mathematical Modeling. In G. Chamblee & L. Langub (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2016* (pp. 2576-2583). Chesapeake, VA: Association for the Advancement of Computing in Education (AACE).
- Wickstrom, M. H., & Aytes, T. (2018). Elementary Modeling: Connecting Counting with Sharing. *Teaching Children Mathematics*, 24(5), 300-307.

Middle School/High School

- Aguirre, J.M. & Zavala, M. (2013). When equal isn't fair. Using ratios to scale up mathematical arguments. In E. Gutstein & B. Peterson. *Rethinking mathematics: Teaching social justice by the numbers*. pp. 115-121. Milwaukee, WI: Rethinking Schools, Ltd.
- Anhalt, C. O., & Cortez, R. (2015). Mathematical Modeling: A Structured Process. *Mathematics Teacher*, 108(6), 446-452.
- Anhalt, C., Cortez, R., & Smith, A. (2017) *Mathematical Modeling: Creating Opportunities for Participation in Mathematics*. Book chapter in *Access and Equity: Promoting High Quality Mathematics in Grades 6-8*, Anthony Fernandes, Sandra Crespo, and Marta Civil (Eds.), National Council of Teachers of Mathematics (NCTM), pp. 105-119.
- Baron, L. M. (2015). An authentic task that models quadratics. *Mathematics Teaching in the Middle School*, 20(6), 334-340.
- Bostic, J. D. (2015). A blizzard of a value. *Mathematics Teaching in the Middle School*, 20(6), 350-357.
- Bush, S. B., Gibbons, K., Karp, K., & Dillon, F. (2015). Epidemic, exponential functions, and modeling. *Mathematics Teaching in the Middle School*, 21(2), 90-97.
- Felton, M. D., Anhalt, C. O., & Cortez, R. (2015). Going with the flow: Challenging students to make assumptions. *Mathematics Teaching in the Middle School*, 20(6), 342-349.
- Hendrickson, K. A. (2015). Fracking: Drilling into math and social justice. *Mathematics Teaching in the Middle School* 20(6), 366-371.
- Imm, K. L., & Lorber, M. D. (2013). The footprint problem: A pathway to modeling. *Mathematics Teaching in the Middle School*, 19(1), 46-54.
- Moore, T. J., Doerr, H. M., Glancy, A. W., & Ntow, F. D. (2015). Preserving pelicans with models that make sense. *Mathematics Teaching in the Middle School*, 20(6), 358-364.
- Rubel, L. H., Chu, H., & Shookhoff, L. (2011). Learning to Map and Mapping to Learn Our Students' Worlds. *Mathematics Teacher*, 104(8), 586-591.
- Simic-Muller, K. (2015). Social justice and proportional reasoning. *Mathematics Teaching in the Middle School*, 21(3), 163-168.

- Tran, D., & Dougherty, B. J. (2014). Authenticity of mathematical modeling. *The Mathematics Teacher*, 107(9), 672-678.
- Turner, E. E., & Font Strawhun, B. T. (2007). Posing Problems that Matter: Investigating School Overcrowding. *Teaching Children Mathematics*, 13(9), 457-463.

k-12 Professional Development/Teacher Education related to modeling and social justice mathematics teaching

- Aguirre, J., Anhalt, C., Cortez, R., Turner, E., & Simi-Muller, K., (2019). Engaging teachers in the powerful combination of mathematical modeling and social justice. *Mathematics Teacher Educator*. 7(2) 7-26.
- Anhalt, C. (2014). Scaffolding in mathematical modeling for ELLs. In Civil, M & Turner E. (Eds.) *Common Core State Standards in Mathematics for English Language Learners*, pp.111-120, Alexandria, VA: Tesol International Association, 2014.
- Anhalt, C. O., & Cortez, R. (2016). Developing understanding of mathematical modeling in secondary teacher preparation. *Journal of Mathematics Teacher Education*, 19(6), 523-545.
- Anhalt, C., Cortez, R. & Been Bennett, A. (2018). The Emergence of Mathematical Modeling Competencies: An Investigation of Prospective Secondary Mathematics Teachers, *Mathematical Thinking and Learning International Journal*, 20(3) 1-20.
- Anhalt, C. O., Staats, S., Cortez, R., & Civil, M. (2018). Mathematical Modeling and Culturally Relevant Pedagogy. In Y.J Dori, Z.R. Mevarech, and D.R. Baker (Eds). *Cognition, Metacognition, and Culture in STEM Education* (pp. 307-330). Cham, Switzerland: Springer Publications.
- Cirillo, M., Bartell, T.G., & Wager, A. (2016). Teaching mathematics for social justice through mathematical modeling. In C. Hirsch & A. Roth McDuffie (Eds.) *Annual Perspectives in Mathematics Education: Mathematical modeling and modeling with mathematics*. Reston, NJ: National Council of Teachers of Mathematics.
- Oslund, J. A. (2012). Teaching for equity and social justice in a mathematics methods course for future elementary teachers. In L.J Jacobson, J. Mistele & B. Sriraman (Eds.) *Mathematics teacher education in the public interest: Equity and social justice*. (pp. 213-230). Charlotte, NC: Information Age.
- Remillard, J.T., Ebby, C.B., Lim, V., Reinke, L., Hoe, N., Magee, E. (2014). Increasing Access to Mathematics through Locally Relevant Curriculum. In K. Karp (Ed.), *Annual Perspectives on Mathematics education* (pp.89-96). Reston, VA: NCTM.
- Rubel, L. H., Hall-Wieckert, M., & Lim, V. Y. (2016). Teaching mathematics for spatial justice: Beyond a victory narrative. *Harvard Educational Review*, 86(4), 556-579.
- Rubel, L. H., Lim, V. Y., Hall-Wieckert, M., & Sullivan, M. (2016). Teaching mathematics for spatial justice: An investigation of the lottery. *Cognition and Instruction*, 34(1), 1-26.
- Rubel, L., Lim, V., Hall-Wieckert, M., & Katz, S. (2016). Cash across the City: Participatory Mapping & Teaching for Spatial Justice. *Journal of Urban Learning, Teaching, and Research*, 12, 4-14.

MATH MODELING RESOURCE WEBSITES:

***Mathematical Modeling with Cultural and Community Contexts (M2C3)**

Active NSF research project focused on teaching and learning with math modeling grades 3-5.
<https://sites.google.com/qc.cuny.edu/m2c3/>

***Immersion Project: Integrating Mathematical Modeling in Elementary Grades**

Elementary math modeling project funded by NSF
<http://completemath.onmason.com/math-modeling/>

Math Works Math Modeling Challenge (MC3)

<https://m3challenge.siam.org/resources>

Stepping Stones Modeling Project

<http://www.indiana.edu/~hmathmod/projects.html>

40 modeling projects have been written and tested by high school teachers under the direction of university mathematics and education professors.

CPALMS (Several Modeling Eliciting Activities in various content areas including math, science and STEM

<http://www.cpalms.org/Public/>

Case Studies for Kids

Purdue Engineering modeling eliciting activities based on the work of Dick Lesh.

<https://engineering.purdue.edu/ENE/Research/SGMM/CASESTUDIESKIDSWEB/resources.htm>

Forthcoming Springer Book in Spring 2021

Exploring Mathematical Modeling with Young Learners Suh, Jennifer M., Wickstrom, Megan H., and English, Lyn (Eds.),

- Anhalt, C., Cortez, R, & Aguirre, J.M. (In Press). Mathematical modeling thinking: A construct for developing competency across grades.
- Carlson, M. A. (In Press). Teaching practices to support early mathematical modeling.
- Fulton, E. W. (In Press). Teachers' Use of Students' Mathematical Ideas.
- Suh, J.M, Matson, K., Birkhead, S., Green, S., Rossbach, M., Seshaiyer, P. & Jamieson, T.S. (In Press). The Importance of Problem Formulation and Elementary Teachers as Designers of the Early Modeling Experiences for Elementary Students.
- Turner, E., Roth McDuffie, A., Aguirre, J., Foote, M. Q., Chapelle, C., Bennett, A., Granillo, M. & Ponnuru, N. (In Press). Upcycling Plastic Bags to Make Jump Ropes: Elementary students leverage experiences and funds of knowledge as they engage in a relevant, community-oriented mathematical modeling task.

Recent Presentations

- Turner, E., Carlson, M.A., Suh, J. M.. & Aguirre, J. (2021 February) [Advancing Equity and Strengthening Teaching through Mathematical Modeling](#). Association of Mathematics Teacher Education. Virtual Conference.
- Suh, J.M., Turner, E., Roth McDuffie, A., Aguirre, J. & Birkhead, S.(2020 February) Defining Core Practices for Mathematical Modeling for Elementary Mathematics Teachers. Association of Mathematics Teacher Education. Phoenix, AZ.