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Quantitative Literacy (QL) and Numeracy: A Discipline-Based Education Research Perspective

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Quantitative Literacy (QL) and *Numeracy*: A Discipline-Based Education Research Perspective from the Geosciences

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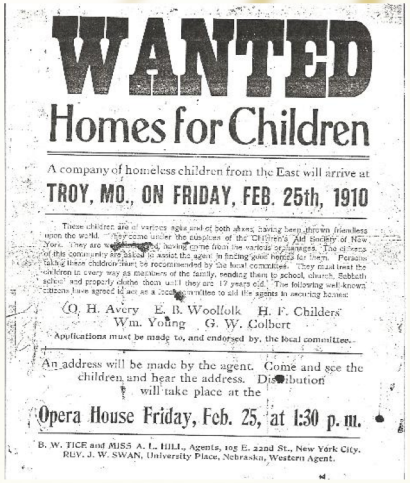
Madison's *Everybody's Orphan*

"Quantitative Literacy: Everybody's Orphan" Bernard L. Madison, 2001, *Focus*



WANTED

Homes for Children

A company of homeless children from the East will arrive at

TROY, MO., ON FRIDAY, FEB. 25th, 1910

These children are of various ages and of both sexes, having been thrown friendless upon the world. They come under the auspices of the Children's Aid Society of New York. They are well-behaved, having come from the various orphanages. The citizens of this community are asked to assist the agent in finding good homes for them. Persons taking these children must be recommended by the local committee. They must treat the children in every way as members of the family, sending them to school, church, Sabbath school and properly clothe them until they are 17 years old. The following well-known citizens have agreed to act as a committee to aid the agents in securing homes:

O. H. Avery E. B. Woolfolk H. F. Childers
Wm. Young G. W. Colbert

Applications must be made to, and endorsed by, the local committee.

An address will be made by the agent. Come and see the children and hear the address. Distribution will take place at the

Opera House Friday, Feb. 25, at 1:30 p. m.

B. W. TICE and MISS A. L. HILL, Agents, 105 E. 22nd St., New York City.
REV. J. W. SWAN, University Place, Nebraska, Western Agent.

Public domain

Context is key:

- Math departments = no context,
- discipline = nothing but context

This article provides an invitation for disciplines to take charge and raise the orphan.

Madison, Bernard L. 2001. "Quantitative literacy: Everybody's orphan." Focus 21 (6):10-11.

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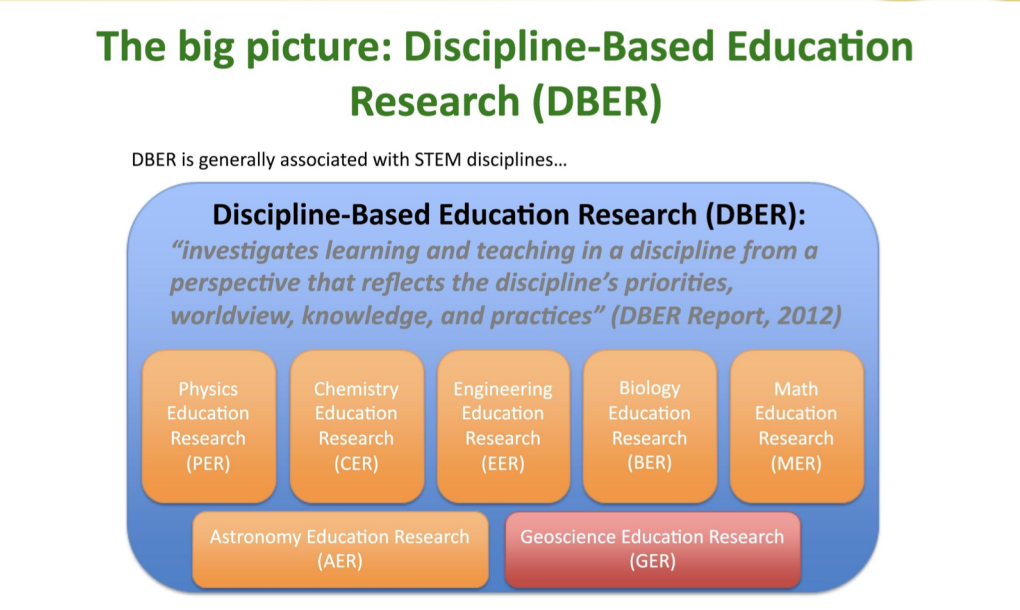
Discipline-Based Education Research (DBER)



Lukes, Laura. *Scope of geoscience education research (GER) and how it can be used: Community perspectives.* [Powerpoint slides]. Retrieved from: https://slideplayer.com/slide/6922215/

DBER is inherently interdisciplinary...Biology, geosciences, and astronomy education research are the most common disciplines. DBER is experts in a particular field figuring out what works best at instructing new experts in that same field. Those methods don't necessarily work in other fields.

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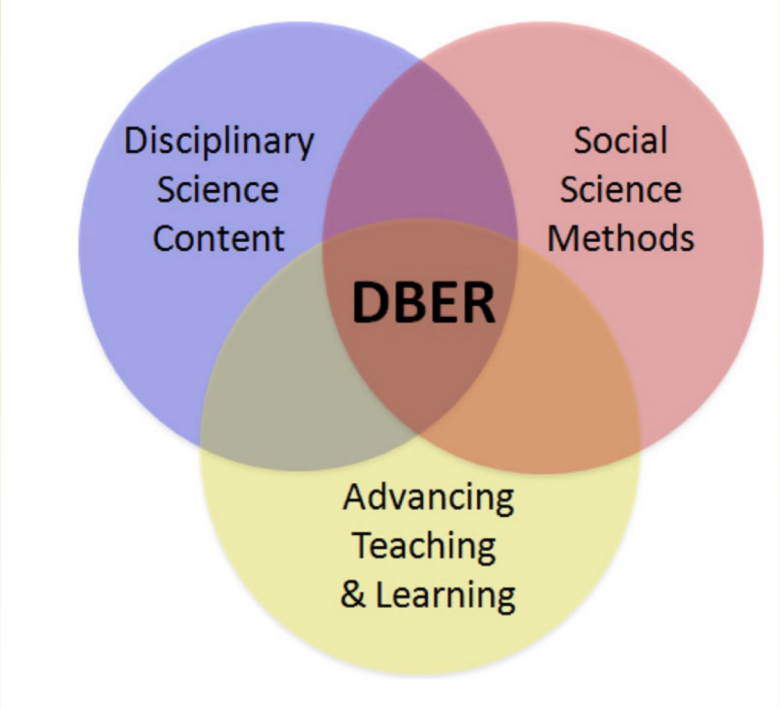
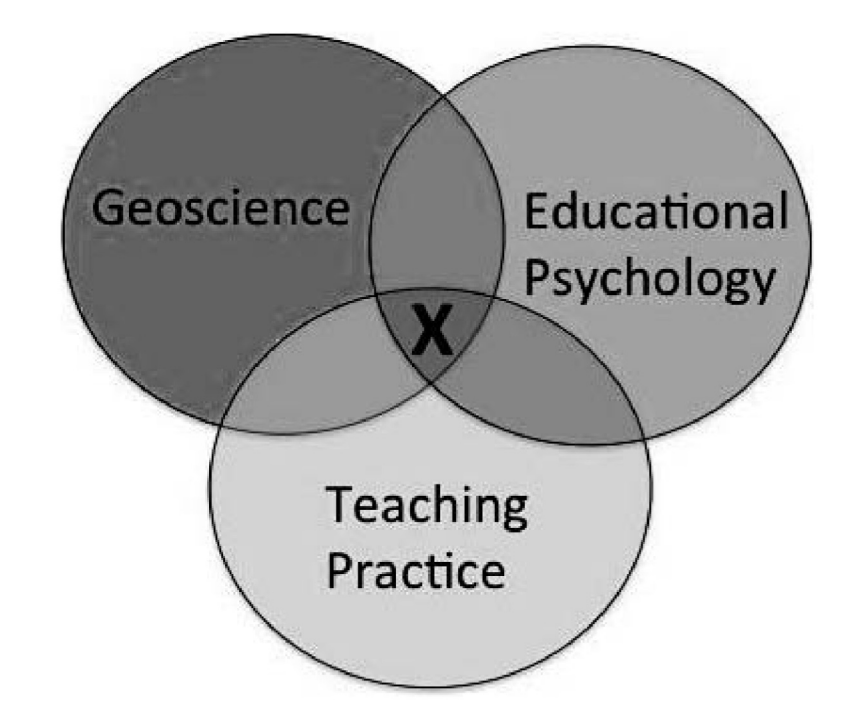
Singer, S., & Smith, K. A. (2013). Discipline-based education research: Understanding and improving learning in undergraduate science and engineering. *Journal of Engineering Education*, *102*(4), 468-471.

DBER and Geoscience Education Research (GER)





Dolan, E. L., Elliott, S. L., Henderson, C., Curran-Everett, D., John, K. S., & Ortiz, P. A. (2018). Evaluating discipline-based education research for promotion and tenure. *Innovative Higher Education*, *43*(1), 31-39.

Lukes, L. A., LaDue, N. D., Cheek, K. A., Ryker, K., & St. John, K. (2015). Creating a community of practice around geoscience education research: NAGT-GER. *Journal of Geoscience Education*, *63*(1), 1-6.

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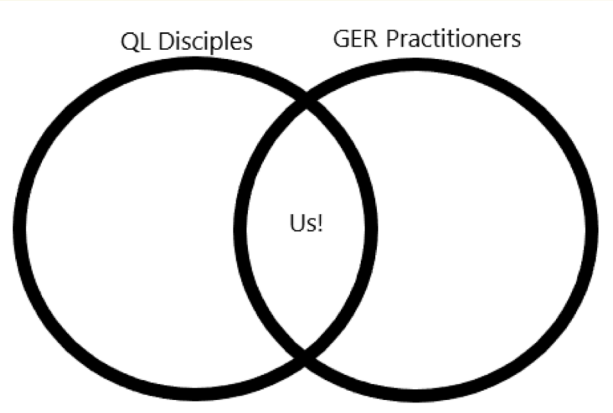
DBER - A Vehicle for QL Instruction

Geology includes quantitative practices (Manduca, et. al., 2008).

The lens of DBER/GER helps us find what works for geologists/geoscientists. We have the benefit of following 20 years of Len Vacher banging on that wall.



By Patrick Bell from Haddonfield, NJ, USA (new 6-5-06 064) [CC BY 2.0 (https://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons. Adapted

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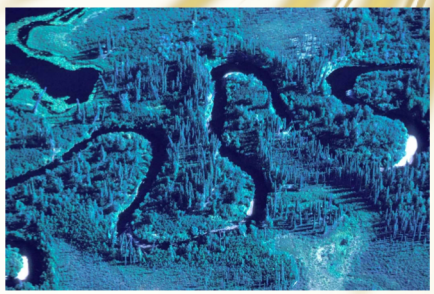
Manduca, Cathryn A, Eric Baer, Greg Hancock, R Hearther Macdonald, Sam Patterson, Mary Savina, and Jennifer Wenner. 2008. "Making undergraduate geoscience quantitative." Eos, Transactions American Geophysical Union 89 (16):149-150.

Perspectives - How We Got Here - Vic



Chalatna Creek - US Fish and Wildlife Service - Public Domain

BA - Geology - U. Florida 1999

Environmental Consulting to 2009

HS Science Teaching to 2014 (incl. Writing content for GA Virtual School)

Graduate School at USF with Len Vacher and Jeff Ryan:

How to put knowledge of geology together with love of educating

Discovery: DBER exists (GER), QL lacking in my prior education experience

MSc 2016, TA for Phy. Geology Lab (1yr), Comp. Geology (3.5 yrs)

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Perspectives - How We Got Here - Meghan

2006 - BS in Geology

2009 - MS in Geology (TA'ed all along the way)

2009/2010 - 3-month volunteer at HVO

Mt. Redoubt - USGS - Public Domain

2010 - Took a break to work at local water management district

2011 - Began Ph.D. program in geology and independently began teaching at local state colleges/science heavy liberal arts college (always wanted to be a teacher)

Now - Ph.D. candidate and continue to teach at local state colleges

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Perspectives - Current QL Instruction Thoughts

As HS science teacher, assigned students w/ lower math skill. I regret how little I fought to work it in anyway. QL is for everyone.

Teaching intro lab, >50% of students would skip a question requiring multiplication of two given values with a provided calculator.

Mike Pennington / Shaft of light, Westing CC-SA 2.0 via Wikimedia Commons

Then I found Computational Geology...(see Vacher, 2000, 1998-2005; Fratesi and Vacher, 2005; McGee et. al., 2007; Vacher and Lardner, 2010, 2012; Lehto and Vacher, 2012; Vacher et. al., 2012; Ricchezza and Vacher, 2016, 2017a, 2017b, 2018; Connor and Vacher, 2016; Ricchezza, 2016)

Vacher, H. L. (2000). A course in geological-mathematical problem solving. Journal of Geoscience Education, 48(4), 478-481. Vacher, H. L. (2005). Computational Geology series (1998-2005). National Association of Geoscience Teachers. Fratesi, B., & Vacher, H. (2005). Using spreadsheets in geoscience education: survey and annotated bibliography of articles in the Journal of Geoscience Education through 2003. Spreadsheets in Education (eJSiE), 1(3), 3. McGee, D. K., Stringer, C. E., Furmall, A., Harden, J., Connor, C., & Vacher, H. (2007). Contribution of spreadsheets across the curriculum modules to undergraduate geology courses at the University of South Florida - History and new directions. Paper presented at the 2007 GSA Denver Annual Meeting. Vacher, H. L., & Lardner, E. (2010). Spreadsheets across the curriculum, 1: The idea and the resource. Numeracy, 3(2), 6. Vacher, H. L., & Lardner, E. (2011). Spreadsheets Across the Curriculum, 3: Finding a list of mathematical skills for quantitative literacy empirically. Numeracy, 4(1). Lehto, H. L., & Vacher, H. (2012). Spreadsheets Across the Curriculum, 4: Evidence of Student Learning and Attitudes about Spreadsheets in a Physical Geology Course. Numeracy, 5(2), 5. Ricchezza, V. J., & Vacher, H. L. (2016). On a Desert Island with Unit Sticks, Continued Fractions and Lagrange. Numeracy, 9(2). Ricchezza, V. J., & Vacher, H. L. (2017). A Twenty-Year Look at "Computational Geology," an Evolving, In-Discipline Course in Quantitative Literacy at the University of South Florida. Numeracy, 10(1). Ricchezza, V. J., & Vacher, H. L. (2017). Quantitative Literacy in the Affective Domain: Computational Geology Students' Reactions to Devlin's The Math Instinct. Numeracy, 10(2), 11. Ricchezza, V. J., & Vacher, H. L. (2018). Quantitative Reasoning in the Geoscience Classroom: Modeling Functions and Logarithmic Scales. In The Trenches, 8. Connor, C., & Vacher, H. (2016). Learning volcanology: Modules to facilitate problem solving by undergraduate volcanology students. Statistics in Volcanology, 2(1), 3. Ricchezza, V. J. (2016). Alumni Narratives on Computational Geology (Spring 1997-Fall 2013). (Master of Science Thesis), University of South Florida, Tampa, FL

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Perspectives - Current QL Instruction Thoughts

Students take my courses for general ed req. = non-science majors who have avoided math up until this point.

Students cannot get past the idea of earth science/geology having math.

Students end up not even attempting activities involving math or QL, they accept taking a zero (even with one on one intervention).

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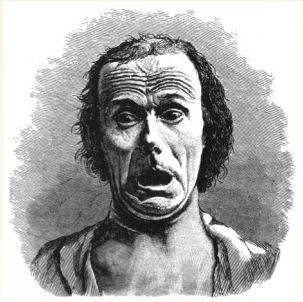
Perspectives - Current QL Instruction Thoughts

In CG, students generally come in afraid of math but needing the credit and possibly aware they need the skills.

One key: acknowledging their fear without shame.



Geology has math in it.

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Numeracy Breakdown

We did a quick analysis of the last three years of articles and notes from *Numeracy*. Based on our totally flawless and not-at-all-subjective categorizations:

Social Science/Humanities: 14

Mathematics/Statistics/Math Education: 14

Natural Science/Health Science: 9

Header from *Numeracy*, with "Wave of Numbers" (c)2007 Beth Fratesi

How are other STEM-DBER folks (and for that matter, non-STEM) making QL adaptations?

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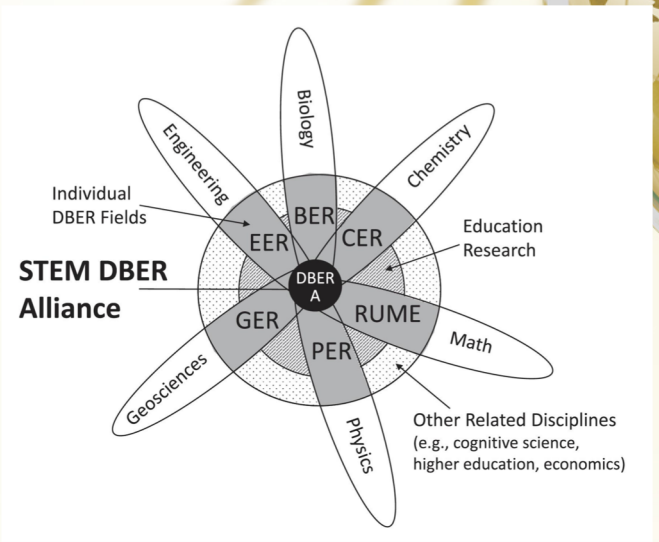
So What, And Who Cares?

QL belongs in-context (thanks Bernie) and GER has quantitative context easily applicable for QL.

Non-geoscience DBER QL practices might apply to geosciences.

STEM (or non-STEM)-DBER-QL Alliance?



Henderson, C., Connolly, M., Dolan, E. L., Finkelstein, N., Franklin, S., Malcom, S., ... & John, K. S. (2017). Towards the STEM DBER alliance: Why we need a discipline-based STEM education research community.

Publications in Numeracy trend towards subjects other than natural science and health.

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Q and A

The nature of DBER is that what works in the geosciences is domain-specific and may not work in other areas.

What works/worked for you?

Tell us a bit about what area you teach/research in, and how you've applied QL/DBER. Was it successful?

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