MATH AS METAPHOR: CONNECT PHYSICS-CHEMISTRY-BIOLOGY WITH DEVELOPMENTAL MATH INSTRUCTION

met·a·phor (metəˌfôr,-fər/) noun
A thing regarded as representative or symbolic of something else, especially something abstract

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Math Dilemma at Open-Access Colleges

“.. recent federal data indicate that 68% of community college students and 40% of students at open-access four-year colleges take at least one remedial course. Research suggests that many more students are referred to developmental courses but never enroll in them…”

“..For instance, among the 63,650 students in the study who were assigned to three levels of developmental math, only 11% ever successfully completed college-level introductory algebra. ...And even among the students who had the tenacity to complete all three levels of remedial math ~25% of those who completed all three developmental courses) failed to enroll in the gatekeeper math course…”

“...many students assigned to developmental courses drop out before completing their sequence and enrolling in college-level courses.”

*Taken from*
“*What We Know About Developmental Education Outcomes,*” 2014, Community College Research Center.
The math course is envisioned as a 6-hour/week developmental math course that will prepare students for success in pre-calculus (re-envisioned), statistics, freshman chemistry & algebra based physics courses.

Math Proficiency:
• **conceptual understanding**—comprehension of mathematical concepts, operations, and relations
• **procedural fluency**—skill in carrying out procedures, flexibly, accurately, efficiently, and appropriately
• **strategic competence**—ability to formulate, represent, and solve mathematical problems
• **adaptive reasoning**—capacity for logical thought, reflection, explanation, and justification
• **productive disposition**—habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one’s own efficacy.

(Uri Triessman)

Translate Math Equations & Processes!!

- **Translation Activities:** writing out the definitions, examples, illustrating word problems in pictures and words.

- What do the symbols mean to students? Make sure we are on the same page. **Example 5 = 5 wrong??**

- **Estimation** and sense making

- **Fractions, per cents, & proportional thinking**

- **Use** algebra, geometry, & statistics physical and virtual manipulatives for concept exploration and sense-making.

- **Concurrent use of ALEKS adaptive software** to build math skills. **Goal? Move students to a pre-calculus level.**
Connect Science Phenomena to Math

Use of ST/SD, concept mapping, cycle drawing – develop intuition about graphs generated by math functions or data.

ST/SD systems thinking/systems dynamics modeling:
There are many physics, chemistry, biology, environmental, social science, & math interactive models available in ‘run time’ versions.
Predator-Prey Modeling
Observe Science Phenomena, Collect & Analyze Data
Working Toward Mastery

![Graph showing the relationship between time spent, projects worked on, translating math equations and symbols, connecting science, math, and data analysis, and achieving mastery and confidence.](image)

- Time Spent
- Projects Worked On
- Translate Math Equations & Symbols
- Connect Science, Math & Data Analysis
- Achieve Mastery & Confidence
References


Report to the President: Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics (2012), President’s Council of Advisors on Science and Technology http://www.whitehouse.gov/administration/eop/ostp/pcast/docsreports

“Resources and Reform: Thinking Through the Costs of a Developmental Math Redesign.” This webinar looks at what college resources are required to implement a statewide redesign of developmental mathematics, drawing on interviews with faculty, administrators, and staff in Virginia community colleges.


ALEKS, [http://www.aleks.com/](http://www.aleks.com/) (McGraw-Hill) Assessment and LEarning in Knowledge Spaces is a web-based, artificially intelligent assessment and learning system, available online 24/7. ALEKS uses adaptive questioning to quickly and accurately determine exactly what a student knows and doesn't know in a course. ALEKS then instructs the student on the topics she is most ready to learn. As a student works through a course, ALEKS periodically reassesses the student to ensure that topics learned are also retained. ALEKS courses are very complete in their topic coverage and ALEKS avoids multiple-choice questions. [http://www.aleks.com/highered/math/research_behind_aleks](http://www.aleks.com/highered/math/research_behind_aleks)


ALPS Program (Accelerated Learning Program) at the Community College of Baltimore County. [http://alp-deved.org/](http://alp-deved.org/)

Shodor Foundation, nonprofit organization serving students and educators by providing materials, models, and instruction relating to computational science (scientific, interactive computing)  http://shodor.org/

Maryland Virtual High School of Mathematics and Science (maintained by the Shodor Foundation) is repository of mostly system thinking/dynamics models for biology, chemistry, physics, earth/space science, environmental science and math.  http://mvhs.shodor.org/

InterActivate (engaging, interactive math and science exploration activities) Shodor Foundation Inc.,  http://www.shodor.org/interactivate/

Creative Learning Exchange, has an extensive library of systems thinking/dynamic models, lessons (STEM, social science & humanities), and tutorials  http://www.clexchange.org/

System Thinking in Schools (K-12), The Waters Foundation  http://watersfoundation.org/our-resources/


*Vensim* by Ventana, system thinking/dynamics software, free to download from [http://vensim.com/free-download/](http://vensim.com/free-download/) for use by students and educators.


Teach Mathematics: Algebra Virtual Manipulatives
[http://www.teachmathematics.net/page/2958/algebra-virtual-manipulatives](http://www.teachmathematics.net/page/2958/algebra-virtual-manipulatives)

Teach Mathematics: Geometry Virtual Manipulatives,
[http://www.teachmathematics.net/page/2960/geometry-virtual-manipulatives](http://www.teachmathematics.net/page/2960/geometry-virtual-manipulatives)

Teach Mathematics: Statistics Virtual Manipulative,

Science Case Net, repository of problem based learning cases and a network for educators [http://sciencecasenet.org/](http://sciencecasenet.org/)

PBL Clearing House, repository of problem based learning cases at University of Delaware. [http://www.udel.edu/inst/](http://www.udel.edu/inst/)