



MatDL

Cross-Disciplinary Molecular Science Education in Introductory Science Courses: An NSDL MatDL Collection

Joint Conference on Digital Libraries

Pittsburgh, PA

June 2008

David Yaron, Jodi Davenport, Michael Karabinos, Gaea Leinhardt

CMU and University of Pittsburgh

Laura Bartolo, John Portman, Cathy Lowe

Kent State University

Donald Sadoway, W. Craig Carter and Colin Ashe

MIT



Outline

- Digital libraries as cognitive tools
- Digital libraries as component repositories
- Digital libraries as knowledge networks

Sumner, T. & Marlino, M. 2004. Digital libraries and education practice: A case for new models. Proceedings of the ACM/IEEE-CS Joint Conference on Digital Libraries, 170-178. Tucson, AZ USA. Association for Computing Machinery, Inc. (ACM).

NSDL Materials Digital Library Pathway

<http://matdl.org/matdlwiki>

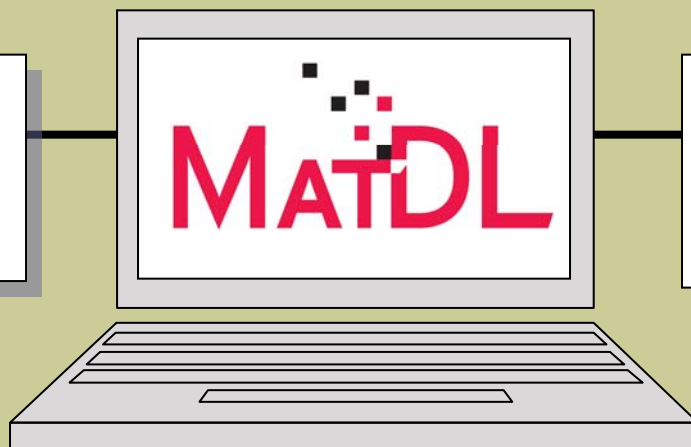
**NSF MS Initiatives
(NIRTs, MRSECs, IMIs)**

- Soft Matter Wiki

<http://matdl.org/virtuallabs>

Virtual Labs

- Intro to Solid State Chem
- Intro to Bio Physics
- Modern Chemistry



**Teaching Resource
Development**

- MS Teaching Archive

Stewardship

- MatDL Repository

Code Development

- Matforge
 - NIST FiPy
 - CMU
 - DOE CMSN

<http://teaching.matdl.org>

<http://matdl.org>

<http://matdlforge.org>

- Multidisciplinary, multi-institutional team
 - MIT – Materials Science & Engineering
 - Fall' 07 Introduction to Solid State Chemistry, 3.091
 - Don Sadoway, W. Craig Carter, Colin Ashe
 - CMU – ChemCollective & NSF Center on Science of Learning
 - Spr' 08 Modern Chemistry
 - David Yaron, Jodi Davenport, Michael Karabinos, Gaea Leinhardt
 - KSU – BioPhysics & MatDL
 - Fall'07 Introduction to BioPhysics
 - Laura Bartolo, John Portman, Cathy Lowe

Digital libraries as cognitive tools

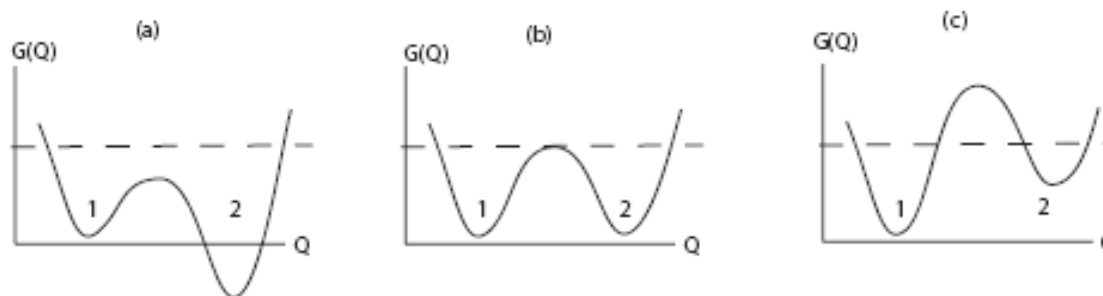
- Modality is that of virtual labs
 - Visualization and simulation tools
 - Common tools across disciplines, with discipline specific instruction (recurring patterns of molecular science)
- Context
 - Discipline specific courses: Chemistry, Biology, Materials Science (Physics..)
- Learning goals
 - Help novices construct expert mental models

Design Process

- Experts from multiple domains met to identify concepts/frameworks that are
 - Central to their domain
 - Have strong leverage
 - Are difficult to teach/learn
- Find intersections/overlaps
- Will cross-disciplinary design lead to more reusable learning objects?

Outcome of the Design Process

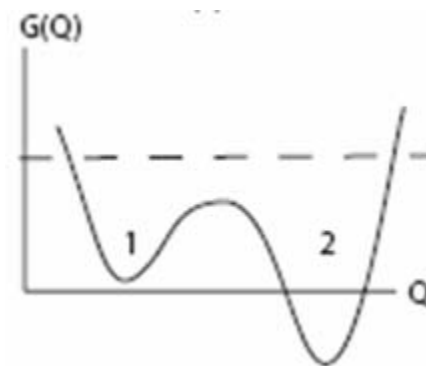
- Reaction paths and energy landscapes



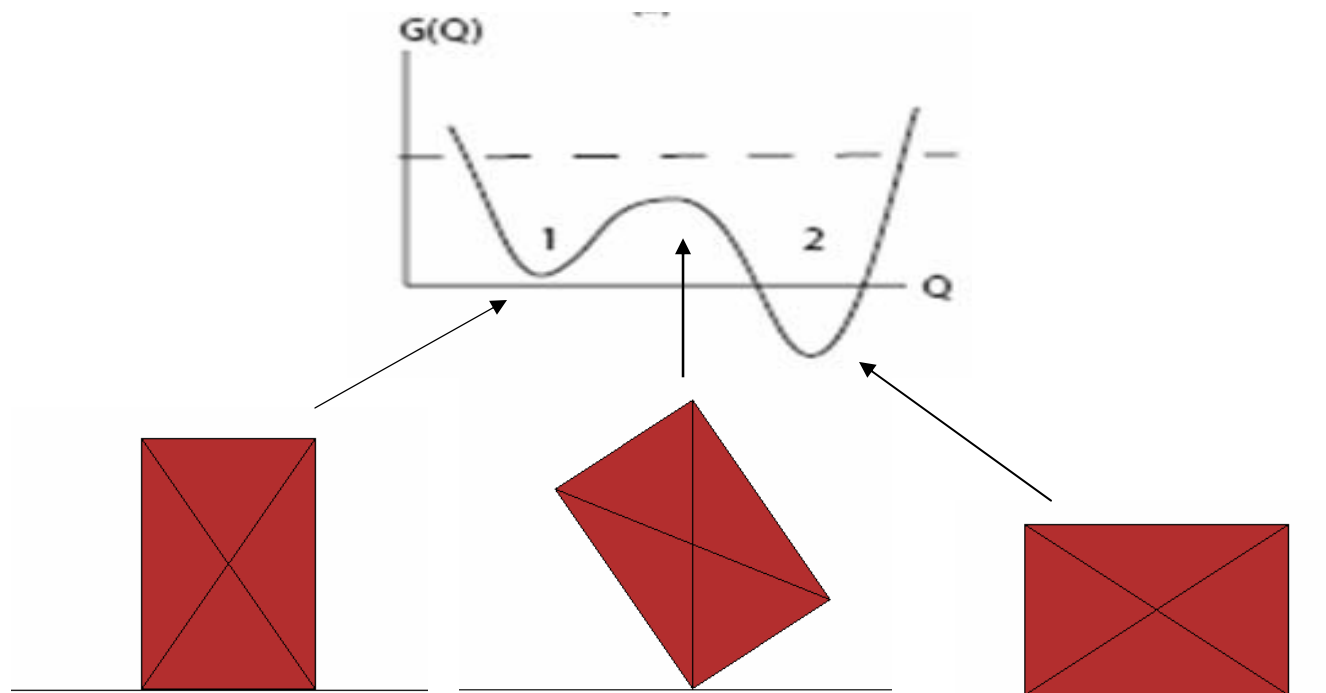
- Used to describe, for example,
 - Organic chemistry reactions
 - Diffusion on surfaces
 - Protein folding/unfolding

Development process

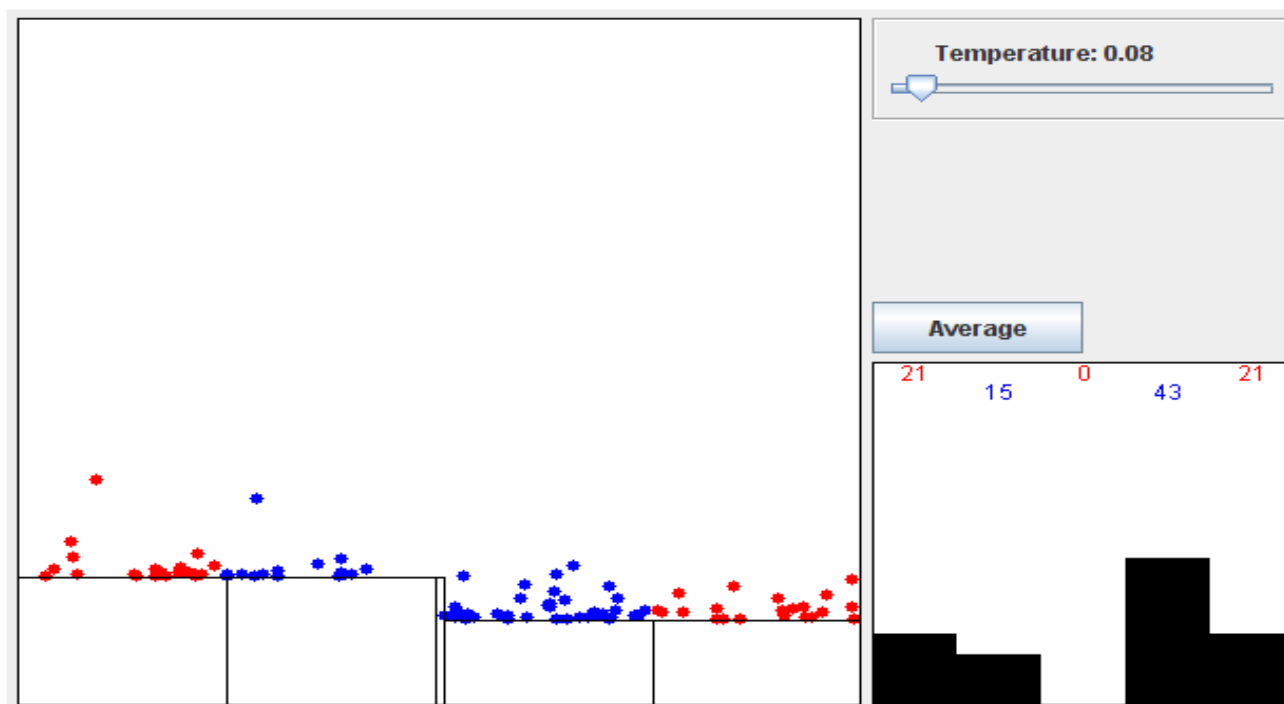
- Analyze content with experts, novices and psychologists
- Sequential focus on aspects of the diagram
 - What is Q ?
 - What is temperature?
 - Energy vs. free energy



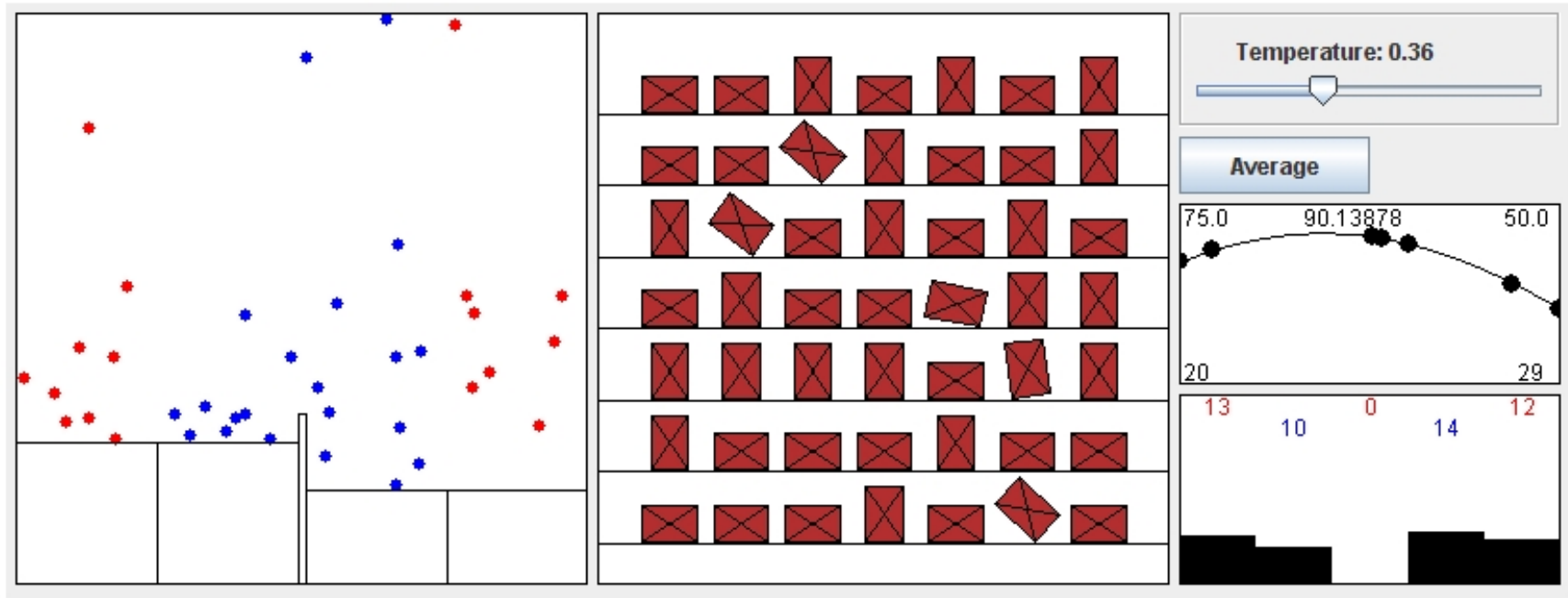
What is the reaction coordinate Q ?



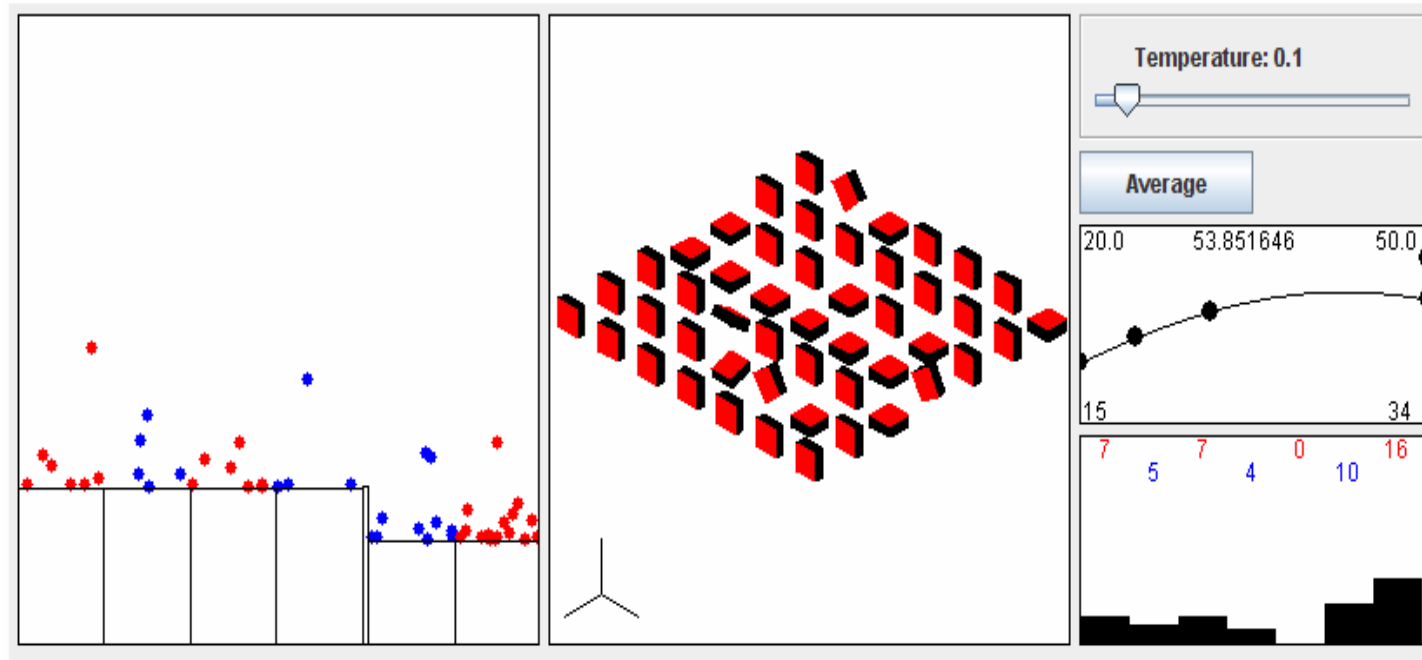
Motion connected to a heat bath



Coordination



Entropy: Energy vs. free energy



Formative assessment

- Psychologists examine for coherence
- Trial in computer cluster
 - 15 students, 3 faculty, 2 developers, 1 psychologist
 - Filmed the activity and a group discussion
 - Post survey
 - Meaning of representations
 - Self-perceptions of learning
 - Open-ended conceptual questions

<http://matdl.org/virtuallabs>

- Student perception of learning

Helped connect concepts in new ways	3.6
Helped see how the same principles apply to different topics	3.7
Was well organized	3.6
Was easy to understand	3.1
Was a good use of time	3.0
Was fun	2.7
Gave a deeper understanding of principles I already knew	3.2
Gave a deeper understanding of principles I did not know	3.5

- Pre and post test (23 items, N=69)

(M = .59, SD = .15) → (M = .67, SD = .12)

2-tailed paired sample t-test, $t(68)=4.638$, $p<.001$

Future topics

- Molecular forces
 - How do intra- and inter- molecular forces lead to structure formation
- Economies of exchange
 - Similarities across heat, proton and electron exchange
- How natural and designed systems promote one molecular process over another
 - From molecular science to molecular engineering

Digital libraries as component repositories

- Virtual Labs wiki <http://matdl.org/virtuallabs>
 - Support multidisciplinary development & use of VLS
- Virtual Labs code development <http://matforge.org/virtuallabs>
 - Support collaborative enhancement of existing & new VLS
- MatDL Repository matdl.org/repository/virtuallabs
 - Support reuse of source code & teaching resources
- Metadata & Dissemination
 - In MatDL Repository & NSDL NDR

Digital libraries as knowledge networks

- Development around core set of visualization tools and virtual manipulatives
 - Does design for use in multiple contexts and disciplinary courses lead to more reuseable learning objects?
 - Does bringing together perspectives from different disciplines lead to more a coherent set of instructional materials?

Thank you & Questions?

lbartolo@kent.edu yaron@cmu.edu

The NSDL Materials Digital Library Pathway is supported by the National Science Foundation DUE-0532831 and the Virtual Labs by DUE-0632726. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of NSF.