Translational science education research in the classroom: From theory to (successful) practice.

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STEM Teaching and Learning

• Scientific Teaching
• Just-in-time Teaching/Clickers
• Inquiry-based/POGIL T&L
• Problem/Case-based Learning
• Collaborative/Peer Learning
• “Flipped” or Hybrid classrooms
• Authentic research experience
• Evidence-based practices
• Discipline-based approach
• Course Transformation/Redesign
• Blooming Questions/Critical Thinking
Scholarship of Teaching and Learning

Classroom

Results
- Learning Gains
- Learning Progressions (2)

Implementation
- Effective Teaching Practices
- Scholarly Teaching

Community

Planning
- Curriculum Mapping
- Learning Progressions (1)

Development
- Assessment Development
- Professional Development
- Curriculum Development

Results
- Learning Gains
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What are common problems you want to address?
**Implementation Fidelity**

- Always the exception and never the rule

<table>
<thead>
<tr>
<th>Implements method</th>
<th>Believes in method</th>
<th>Does not believe in method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>![Checkmark]</td>
<td>![X]</td>
</tr>
<tr>
<td>No</td>
<td>![X]</td>
<td>![X]</td>
</tr>
</tbody>
</table>

**Diagram:**

- Green checkmark indicates "Believes in method".
- Red X indicates "Does not believe in method".

**Legend:**

- ![Checkmark]: Always implements method.
- ![X]: Does not implement method.
Goal: Increase Transfer Success

- Discipline-specific cohort of transfer students
- Peer-based Supplemental Instruction

Upper-Division Transfer Students: Designing a Supplemental Instruction Program for Nursing Students Within a Science Based Curriculum

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School of Nursing, University of Maryland, Baltimore, Shady Grove Campus, Rockville, Maryland, USA
Isabell Cserno May
Center for Modern Languages, Leuphana University, Lüneburg, Germany

The transition to upper-level course work of transferring students, predominantly students from 2-year/community colleges, has been explored in recent education research literature. Yet, it has not been sufficiently explored whether and what academic support programs could be successful in supporting transfer students with the transfer process. This article demonstrates the success of an academic support program for a discipline-specific cohort of transfer students entering their junior year in a nursing program at a public university within the University System of Maryland. The study explored prior academic preparation, results of Nursing Entrance Test scores, and interventions provided by an academic support initiative. For a course in pathopharmacology, this collaborative environment—facilitated by successful peers based on Supplemental Instruction, workshops on accelerated learning techniques, and individual tutoring—indicates that participation in such a comprehensive program resulted in an overall higher grade point average at the end of the first semester. There was also a reduced rate of failure or drop out from 15% to 7% in subsequent semesters. Overall, such an initiative could serve as a model for other institutions.
• What personnel will manage the program/keep it sustainable?
• Cost? Space?
• Who will serve as the SI instructors? What qualifications and training will they need?
• Will students volunteer or will this be mandatory? How will you recruit/advertise?
• Do we identify all transfers or key indicators of certain transfers?
• Are there existing programs that are more suited to run this program?
• Will all instructors/staff/admin be on board with the project? What training will they need?
• How will you assess efficacy of program? What does success look like?
• Will I live long enough to see the results?
• Will it create additional barriers to graduation/build student resentment?
Example: Undergraduate Peer Instruction

• University of Kansas, Intro Bio for non-majors
  – Average semester enrollment: 750-920 students
  – Typical personnel: Two faculty (one Tenure-track, one adjunct) and one Graduate TA
  – Low attendance (60-70% on average)
  – Consistent near 50% DFW rate

• Resources available to students prior to intervention:
  – Study skills development SI via student services
  – Course-specific SI via STEM grant program
  – Free one-on-one and group tutoring services via Office of Undergraduate Studies
  – Tutoring services for student-athletes
  – Private tutoring services
What Worked?

- Undergraduate lecture facilitators
- TA Training
- Faculty Training and Development
- Increase in lecture activity (lecture attendance improved 20%)
- Embedded expertise with continuous feedback
What didn’t work?

• Sustainability – TA training and cost to hire undergrads hard to maintain without permanent personnel
• Faculty development – differences among the faculty teaching course AND lack of incentive to change
• Lack of cooperation with other mentoring programs on campus
• Lack of technology to handle large enrollment course
Version 2.0

- True Team-Teaching approach
- Lecture TAs (Grad and Undergrad)
- Improved Wi-Fi capability in lecture room
- Enhanced clicker technology
- Embedded expert as co-instructor
Examinations That Support Collaborative Learning: The Students’ Perspective

By Georg W. Rieger and Cynthia E. Heiner

- Group Exams
- Two-Stage Exams
- Collaborative Exams
Suggested Format

• Two-hour period dedicated to examination
• First stage: Individual Exam, Second Stage: Group Exam. Questions may be more explanatory in group exams
• Exam score is a percentage of individual and group exam scores
The Evolution of the Group Exam

• Version 1.0: In-class activity with unassigned group. Worth a few in-class participation points.
• Version 2.0: In-class activity with assigned groups. Worth a few in-class participation points.
• Version 3.0: In-class activity with assigned groups (with peer eval system). Graded on correctness and additional points added to exam score.
Group Exam Rules & Regulations

• As a group, come up with an answer **AND explain** your answer choice for each question. Questions without an accompanied explanation will get zero points.

• You **MAY NOT** use any other source of information besides your group members to answer questions. **NO NOTES, NO BOOKS, NO MOBILE DEVICES.**

• Your group exam score, up to 10 points, will be added to your individual exam grade (e.g. a 78% on the group exam will add 7.8 points to your individual exam grade).
- Increased exam average
- Increased performance on higher-order thinking questions
- Increased performance on post-lecture practice questions
- More student-prompted discussion in lecture about practice questions
At the college level, the effectiveness of active-learning interventions is typically measured at the broadest scales: the achievement or retention of all students in a course. Coarse-grained measures like these cannot inform instructors about an intervention’s relative effectiveness for the different student populations in their classrooms or about the proximate factors responsible for the observed changes in student achievement. In this study, we disaggregate student data by racial/ethnic groups and first-generation status to identify whether a particular intervention—increased course structure—works better for particular populations of students. We also explore possible factors that may mediate the observed changes in student achievement. We found that a “moderate-structure” intervention increased course performance for all student populations, but worked disproportionately well for black students—halving the black-white achievement gap—and first-generation students—closing the achievement gap with continuing-generation students. We also found that students consistently reported completing the assigned readings more frequently, spending more time studying for class, and feeling an increased sense of community in the moderate-structure course. These changes imply that increased course structure improves student achievement at least partially through increasing student use of distributed learning and creating a more interdependent classroom community.
Effects of a Research-Infused Botanical Curriculum on Undergraduates’ Content Knowledge, STEM Competencies, and Attitudes toward Plant Sciences

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In response to the American Association for the Advancement of Science’s Vision and Change in Undergraduate Biology Education initiative, we infused authentic, plant-based research into majors’ courses at a public liberal arts university. Faculty members designed a financially sustainable pedagogical approach, utilizing vertically integrated curricular modules based on undergraduate researchers’ field and laboratory projects. Our goals were to 1) teach botanical concepts, from cells to ecosystems; 2) strengthen competencies in statistical analysis and scientific writing; 3) pique plant science interest; and 4) allow all undergraduates to contribute to genuine research. Our series of inquiry-centered exercises mitigated potential faculty barriers to adopting research-rich curricula, facilitating teaching/research balance by gathering publishable scholarly data during laboratory class periods. Student competencies were assessed with pre- and postcourse quizzes and rubric-graded papers, and attitudes were evaluated with pre- and postcourse surveys. Our revised curriculum increased students’ knowledge and awareness of plant science topics, improved scientific writing, enhanced statistical knowledge, and boosted interest in conducting research. More than 300 classroom students have participated in our program, and data generated from these modules’ assessment allowed faculty and students to present 28 contributed talks or posters and publish three papers in 4 yr. Future steps include analyzing the effects of repeated module exposure on student learning and creating a regional consortium to increase our project’s pedagogical impact.
Scholarship of Teaching and Learning

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Scholarly Teaching

• What role do I play in an active-learning, student-centered course?
Creating Self-Regulated Learners


Which is Bigger?

- Nucleic Acid OR Protein
- During Meiosis: Sister Chromatid OR Homologue

A second population of snails (species B) with thick shells (normally found in predator-rich environments) are placed in a predator-free environment and the offspring do not vary in shell-thickness compared to their parents. Why does species A vary and Species B does not when placed in a different environment?

A. Species A and Species B are too distantly related and have different genes for shell-thickness.
B. Species B does not have genes that are influenced by the environment so offspring do not vary.
C. Species B only occurs in crayfish-rich environments so there is no need for offspring to vary in shell-shape.
D. Species A has a new gene that allows for variation in shell shape
Barriers to Constructivist Approaches

- Instructor bias
- Time
- Incentive
- Lack of appropriate assessment
- Knowing how to read your audience
Action Plan
Conceptual Difficulties
Suggested Model

1) Introduce a concept by incorporating into an existing foundational framework (NS)

2) Address/Confront BOTH pervasive and related conceptual difficulties

3) ASSESS!

E.g.: Pax6 in fly eye development as the basis of teaching gene expression and regulation
# Hypothetical Learning Progression for Evo-Devo CC6

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<tbody>
<tr>
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<td>Developmental processes can vary among individuals in a population (SCd1)</td>
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<td>Developmental variation is heritable (SCd6)</td>
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<td>Modified developmental processes often result in modified phenotype (FCa6)</td>
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<td>Mutation</td>
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<td>Population-Level Processes</td>
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<td>Developmental processes are the proximate causes of phenotype (FCa1)</td>
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<td>Basic inheritance</td>
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<td>Selection</td>
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