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Guided Inquiry in an Upper Level Vs. Lower Level Undergraduate Course

Laura DeLong Frost
Georgia Southern University, ldelong@georgiasouthern.edu

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Guided Inquiry in an Upper Level vs. Lower Level Undergraduate Course

Laura Frost
Department of Chemistry
Georgia Southern University
Statesboro, GA

Conventional
• Teaching is telling
• Knowledge is facts
• Learning is recall

New Paradigm
• Teaching is enabling
• Knowledge is understanding
• Learning is an active reconstruction of subject matter

Outline
• Guided Inquiry Defined
• Learning through Constructivism
  – (how high is the level of learning?)
• Inquiry Instruction
  – Varieties: POGIL vs. Team-Based Learning
• Assessing Student Learning
  – Is it Working?

Definitions: What is Inquiry Based Instruction?
“The creation of a classroom where students are engaged in essentially open-ended, student-centered, hands-on activities.” Colburn 2000.

Levels of inquiry can be distinguished by the amount of information given to the student

In the lab, Bell, Smentana and Binns define these levels as:

<table>
<thead>
<tr>
<th>Level</th>
<th>Question</th>
<th>Method</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmation</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Structured</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guided</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Open</td>
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</tbody>
</table>

Translated to the classroom,
Guided Inquiry is based on the Constructivist Model of Information Processing

Five Key Ideas about Learning (Bransford, et. al.)

People learn by:
- Constructing their own understanding based on their prior knowledge, experiences, skills, attitudes, and beliefs.
- Following a learning cycle of exploration, concept formation, and application.
- Connecting and visualizing concepts and multiple representations.
- Discussing and interacting with others.
- Reflecting on progress and assessing performance.

Implementation Tools for Inquiry

- Learning teams
- Guided-inquiry activities to develop understanding
- Questions to promote critical thinking
- Problem solving
- Reporting
- Metacognition
- Individual accountability

What level of learning is expected?

- Introductory Course
  - Does not assume prior knowledge of concepts from which to build

- Upper Level Course
  - Assumes prior knowledge in the discipline on which to build.
The level you reach in class differs

**Intro. course**
- Exploration
- Concept
- Invention
- Application

**Upper level course**
- Exploration
- Concept
- Invention
- Application

Lowest → Highest

Implementation Similarities

<table>
<thead>
<tr>
<th>Groups</th>
<th>4-5 students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roles</td>
<td>Manager, Recorder, Presenter, Spy/Technician</td>
</tr>
<tr>
<td>Metacognition</td>
<td>Feedback sheet</td>
</tr>
<tr>
<td>Attitude</td>
<td>Initial discomfort</td>
</tr>
</tbody>
</table>

Implementation Differences

<table>
<thead>
<tr>
<th></th>
<th>Introductory Course</th>
<th>Upper Level Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td>Discover concepts during class, reinforce after class</td>
<td>Discover concepts prior to class, apply concepts during class</td>
</tr>
<tr>
<td>Prof's Job</td>
<td>Facilitate learning</td>
<td>Clarify assignment and facilitate learning</td>
</tr>
<tr>
<td>Source of Information</td>
<td>Activities</td>
<td>Textbook, assignments, professor (some)</td>
</tr>
<tr>
<td>Accountability</td>
<td>Daily quizzes</td>
<td>Assignments due prior to class</td>
</tr>
</tbody>
</table>

Guided Inquiry Methods Necessarily Vary with Level of Course

- **Cooperative vs. Team-based**
  - Process Oriented Guided Inquiry Learning (POGIL) [www.pogil.org](http://www.pogil.org)
  - Team-based Learning (TBL) [teambasedlearning.apsc.ubc.ca](http://teambasedlearning.apsc.ubc.ca)

Is It Working?

Courses: CHEM 1140/5541

**Student Learning**

- Course Grades
- Final Exam Grades
- Common Final Exam Questions
- Cognitive Analysis
- Topic Analysis

**Student Perceptions**

- Formative Evaluations
- SALG survey
**Final Grade Distribution**

**CHEM 1140**
- Lecture-Interactive (N=285 students)
- Inquiry (N=271 students)

**Final Grade Distribution**

**CHEM 5541**
- Lecture-Interactive (N=45 students)
- Inquiry (N=34 students)

**DFW Rates – CHEM 1140**
- Lecture-Interactive (5 sem, N=304)
  - DFWs: 20%, 8% were W
- Inquiry 1st time (POGIL)
  - DFWs: 24%, 9% were W
- Inquiry 2nd-6th time combined
  - DFWs: 14%, 8% were W

**DFW Rates – CHEM 5541**
- Lecture-Interactive (2 sem, N=45)
  - DFWs: 31%, 13% were W
- Inquiry 1st time (1 sem, N=34)
  - DFWs: 18%, 6% were W

**Summary Final Grades**
- At both levels
  - More students passing the class
  - DFW rates overall lowered

**Final Exam Score – CHEM 1140**
- (6 semesters of inquiry data, all questions)
- Lecture-Interactive Average (N=274)
  - 60% ± 16
- POGIL Average (N=266)
  - 65% ± 13
  - Significant 99% confidence level
Final Exam Score – CHEM 5541
(One semester of inquiry data, common questions)
Lecture-Interactive Average (N=43)  
66.7% ± 2.4
POGIL Average (N=34)  
70.5% ± 2.7
Looks higher, but not statistically different

Summary Final Exam Scores
• Introductory course final exam score higher
• Upper level course, higher trend.

Common Final Exam Questions
Learning Level

Intro. Course: Common Final Exam Questions Grouped by Learning Level

The Later Final Exams Were More Difficult

The Later Final Exams Were More Difficult
**Upper Level: Common Final Exam Questions Grouped by Learning Level**

![Graph showing Inquiry vs. L-I by Learning Levels](image)

**Common Final Exam Questions Topic**

Measured as % of students getting complete correct answer

Change = average of all Inquiry sections (6 semesters) vs. Lecture Interactive (F'05)

**Introductory Course: Average Difference in Correct Responses**

![Graph showing change in % correct Inquiry minus L-I for topics](image)

*All semesters contained this topic*

**Upper Level Course: Average Difference in Correct Responses**

![Graph showing change in % correct Inquiry minus L-I for topics](image)

**Conclusion 1 – Final Exam Analysis**

- **LEARNING LEVEL**
  Inquiry did as well often better than L-I in the Intro course demonstrate problem solving.

- **TOPIC**
  Inquiry overall learned more at both levels

**Assessing Student Perceptions Formative**

Can we correct students' difficulties with guided inquiry learning?
Formative Evaluation of Intro. Sections

Formative Evaluation Parameters

N= 67 31 30 30 32

Q1: What has been the most positive part of your group work experience in this class?

Q2: What has been the most negative part of your group work experience in this class?

Q3: If you could change anything about the way this course is designed, what would you change?

Formative Evaluation of Intro. Sections

Positive F06 Sp07 Su07 F07 Sp08
Socialization1 26% 16% 13% 27% 22%
Learning Process2 21% 32% 23% 27% 9%
Problem Solving3 53% 52% 53% 47% 50%

1 Making friends, meeting nice/new people
2 Staying focused/alert, learning to work w/group, team skills
3 Help in interpreting and figuring out problems in groups

Negative F06 Sp07 Su07 F07 Sp08
Group Process1 12% 32% 23% 17% 31%
Learning Process2 22% 26% 37% 33% 37%
Worksheets3 23% 29% 7% 17% 16%
Explanations4 26% --- 7% 30% ---

1 Rudeness, feeling inadequate
2 Group lack of knowledge, socialization instead of on-task, loss of learning and lack of feedback
3 Lost in worksheets, hard, no confirmation of answers, hard to get used to these
4 Not enough explanation, guidance, clarity on if we are doing it right

Change F06 Sp07 Su07 F07 Sp08
Explanations1 55% 46% 27% 60% 47%
Groups 2 22% 23% 10% 20% 41%

1 Add more instructor explanations, more teacher/student interaction
2 No more groups, lecture and then group work

Conclusion 3

Formative
Can we correct student difficulties with guided inquiry learning?
- Not sure

Assessing Student Perceptions

Summative
What do students see as good about Guided Inquiry Learning?
**Student Perception of Learning**

- **Student Assessment of Learning Gains**

  www.salgsite.org

1. HOW MUCH did the following aspects of the class HELP YOUR LEARNING?
   - Instructional approach taken in this class
   - How the class topics, activities, reading and assignments fit together
   - The pace of the class
   - Please comment on how the INSTRUCTIONAL APPROACH to this class helped your learning.
   - The mental stretch required of us
   - The grading system used
   - The feedback we received
   - The quality of contact with the teacher
   - Working with peers outside of class

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**Intro. Class: Student Perception of Learning (N=172)**

- How much did each of the following aspects of the class help your learning?
  - the way in which the material was approached
  - how the class activities, lab, reading, and assignments fit together
  - the pace at which we worked
  - group work in class
  - The mental stretch required of us
  - the grading system used
  - the feedback we received
  - the quality of contact with the teacher
  - working with peers outside of class

**Upper Level Class: Student Perception of Learning (N=25)**

How much did each of the following aspects of the class help your learning?
- Resources (online, textbook) (79%)
- Class Activities (60%)
- Instructional Approach (55%)

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**Conclusion 4**

- Majority of students think the approach helped them learn.

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**Conclusion Summary**

**LEARNING**
- Levels
  Inquiry did as well often better as L-I and in intro course demonstrate problem solving.
- Topics
  Inquiry overall learned more at both levels

**STUDENT PERCEPTIONS**

Students want more explanation
Inquiry approach perceived as helpful to learning

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References


Slavin, R.E., “Research for the Future: Research on Cooperative Learning and Achievement: What we know, what we need to know”, Contemporary Educational Psychology, 21, 1996.