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

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

Laura Frost
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Statesboro, GA

Background

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>x</td>
<td></td>
</tr>
<tr>
<td>Guided</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Translated to the classroom,

<table>
<thead>
<tr>
<th>Level</th>
<th>Topic</th>
<th>Data</th>
<th>Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmation</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Lecture</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Structured</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Lect.-Interact.</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Guided</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discovery</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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

Learning Levels: Gagné and Briggs (1974)

Lowest to Highest
- Information
  - Recall
- Concepts
  - Classifies
- Rules (simple)
  - Demonstrates
- Higher Rules (complex)
  - Generate

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.

A typical implementation involves the Learning Cycle (Karplus, Piaget)

Exploration Concept Invention Application


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What level of learning is expected?
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  - Assumes prior knowledge in the discipline on which to build.
The level you reach in class differs

- **Intro. course**
  - Exploration
  - Concept
  - Invention
  - Application
  - Lowest
- **Upper level course**
  - Exploration
  - Concept
  - Invention
  - Application
  - Highest

Implementation Similarities

- **Groups**: 4-5 students
- **Roles**: Manager, Recorder, Presenter, Spy/Technician
- **Metacognition**: Feedback sheet
- **Attitude**: Initial discomfort

Implementation Differences

<table>
<thead>
<tr>
<th></th>
<th>Introductory Course</th>
<th>Upper Level Course</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning</strong></td>
<td>Discover concepts during class, reinforce after class</td>
<td>Discover concepts prior to class, apply concepts during class</td>
</tr>
<tr>
<td><strong>Prof’s Job</strong></td>
<td>Facilitate learning</td>
<td>Clarify assignment and facilitate learning</td>
</tr>
<tr>
<td><strong>Source of Information</strong></td>
<td>Activities</td>
<td>Textbook, assignments, professor (some)</td>
</tr>
<tr>
<td><strong>Accountability</strong></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
  - Team-based Learning (TBL) teambasedlearning.apsc.ubc.ca

AREA OF AGREEMENT

<table>
<thead>
<tr>
<th></th>
<th>Cooperative Learning</th>
<th>Team-Based Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group work in or out of class?</strong></td>
<td>In-class</td>
<td>In-class</td>
</tr>
</tbody>
</table>

AREAS OF DIFFERENCE

<table>
<thead>
<tr>
<th></th>
<th>Cooperative Learning</th>
<th>Team-Based Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group duration?</strong></td>
<td>Change groups</td>
<td>Keep groups entire term</td>
</tr>
<tr>
<td><strong>Size of groups?</strong></td>
<td>4 or lower</td>
<td>5-7</td>
</tr>
<tr>
<td><strong>Assign roles?</strong></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Concern with process skills?</strong></td>
<td>Critical</td>
<td>Nice, not critical</td>
</tr>
<tr>
<td><strong>Grade group work?</strong></td>
<td>Maybe</td>
<td>Critical</td>
</tr>
<tr>
<td><strong>Ensure prompt feedback on group and individual performance?</strong></td>
<td>Nice, not critical</td>
<td>Critical</td>
</tr>
<tr>
<td><strong>Use peer assessment?</strong></td>
<td>Maybe</td>
<td>Critical</td>
</tr>
</tbody>
</table>

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

Michaelsen et al. Team-Based Learning, 2002
Final Grade Distribution
CHEM 1140
Lecture-Interactive (N=285 students)
- D: 7%
- F: 8%
- A: 20%
- C: 25%
- B: 40%

Inquiry (N=271 students)
- D: 3%
- F: 6%
- A: 32%
- C: 23%
- B: 36%

Final Grade Distribution
CHEM 5541
Lecture-Interactive (N=45 students)
- D: 11%
- F: 7%
- A: 19%
- C: 41%
- B: 27%

Inquiry (N=34 students)
- D: 9%
- F: 3%
- A: 18%
- C: 41%
- B: 29%

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)
$60\% \pm 16$

POGIL Average (N=266)
$65\% \pm 13$

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
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

<table>
<thead>
<tr>
<th></th>
<th>F06</th>
<th>Sp07</th>
<th>Su07</th>
<th>F07</th>
<th>Sp08</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>67</td>
<td>31</td>
<td>30</td>
<td>30</td>
<td>32</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Positive</th>
<th>F06</th>
<th>Sp07</th>
<th>Su07</th>
<th>F07</th>
<th>Sp08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socialization</td>
<td>26%</td>
<td>16%</td>
<td>13%</td>
<td>27%</td>
<td>22%</td>
</tr>
<tr>
<td>Learning Process</td>
<td>21%</td>
<td>32%</td>
<td>23%</td>
<td>27%</td>
<td>9%</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>53%</td>
<td>52%</td>
<td>53%</td>
<td>47%</td>
<td>50%</td>
</tr>
</tbody>
</table>

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

Formative Evaluation of Intro. Sections

<table>
<thead>
<tr>
<th>Negative</th>
<th>F06</th>
<th>Sp07</th>
<th>Su07</th>
<th>F07</th>
<th>Sp08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Process</td>
<td>12%</td>
<td>32%</td>
<td>23%</td>
<td>17%</td>
<td>31%</td>
</tr>
<tr>
<td>Learning Process</td>
<td>22%</td>
<td>26%</td>
<td>37%</td>
<td>33%</td>
<td>37%</td>
</tr>
<tr>
<td>Worksheets</td>
<td>23%</td>
<td>29%</td>
<td>7%</td>
<td>17%</td>
<td>16%</td>
</tr>
<tr>
<td>Explanations</td>
<td>26%</td>
<td>---</td>
<td>7%</td>
<td>30%</td>
<td>---</td>
</tr>
</tbody>
</table>

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

Formative Evaluation of Intro. Sections

<table>
<thead>
<tr>
<th>Change</th>
<th>F06</th>
<th>Sp07</th>
<th>Su07</th>
<th>F07</th>
<th>Sp08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explanations</td>
<td>55%</td>
<td>46%</td>
<td>27%</td>
<td>60%</td>
<td>47%</td>
</tr>
<tr>
<td>Groups</td>
<td>22%</td>
<td>23%</td>
<td>10%</td>
<td>20%</td>
<td>41%</td>
</tr>
</tbody>
</table>

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

Formative Evaluation of Intro. Sections

<table>
<thead>
<tr>
<th></th>
<th>F06</th>
<th>Sp07</th>
<th>Su07</th>
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<td>67</td>
<td>31</td>
<td>30</td>
<td>30</td>
<td>32</td>
</tr>
</tbody>
</table>

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

[Image of a survey format]

1. How much did the following aspects of the class help your learning?

- The instructional approach in this class
- How the class topics, activities, reading, and assignments fit together
- The pace of the class

1.4 Please comment on how the INSTRUCTIONAL APPROACH in this class helped you learn:

POGIL higher

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%)

Conclusion 4

• Majority of students think the approach helped them learn.

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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• Center for Excellence in Teaching
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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.