Group Problem Solving In General Chemistry Recitation to Promote Learning

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<table>
<thead>
<tr>
<th>Front</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantitative Problem Solving</strong></td>
</tr>
<tr>
<td>(physics, chemistry, etc)</td>
</tr>
<tr>
<td><strong>Situational Problem Solving/Logical Reasoning</strong></td>
</tr>
<tr>
<td>(psychology, etc)</td>
</tr>
<tr>
<td><strong>Interconnecting Factual Knowledge</strong></td>
</tr>
<tr>
<td>(anatomy, etc)</td>
</tr>
<tr>
<td><strong>Discussion of Ideas</strong></td>
</tr>
<tr>
<td>(literature, etc)</td>
</tr>
</tbody>
</table>
Group Problem Solving in General Chemistry Recitation to Promote Learning

Madhu Mahalingam, Fred Schaefer, Elisabeth Morlino

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University of the Sciences in Philadelphia
Background

• Problem solving is an integral part of Chemistry
• Poor problem solving skills is an impediment to learning General Chemistry
• Traditional Lecture & Recitation model – Passive
  – Does not improve critical thinking/problem solving skills
Before

- Typical Lecture/recitation
  - ~90 students/section
- 1 recitation/lecture section
  - 8 contact hrs/faculty
- Optional Recitation
  - Attendance at recitation < 20%
  - Passive Q & A format

After

- Lecture
  - ~180 students/section
- 4 recitations/lecture section
  - 7 contact hrs/faculty
- Mandatory recitation
  - ~40 students/section
  - Group problem solving
**Potential Impact of Recitation**

- Develop problem solving skills in chemistry
- Improve conceptual understanding
- Improve communication skills
- Promote a team approach to learning
Recitation Structure

- Heterogeneous groups based on Math SAT or Chemistry grades
- Student Preparation for recitation
- Teaching assistants for recitation/grading
  - Undergraduate TAs more effective than graduate students
  - Interact well with students and are familiar with the format
- Student Participation – peer evaluation
## Overview of Problem Solving Levels

<table>
<thead>
<tr>
<th>Levels of Knowledge</th>
<th>Forms of Knowledge</th>
<th>Concept</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 0.5</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Informational (Language)</td>
<td>Terminology</td>
<td>Knows meaning of words</td>
<td>Follows a method</td>
</tr>
<tr>
<td><strong>Level 1.0</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Informational</td>
<td>Memorizes and repeats information</td>
<td>States facts and definition</td>
<td>Initiates use of a method-how</td>
</tr>
<tr>
<td><strong>Level 2.0</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comprehension &amp; Understanding</td>
<td>Analyzes information</td>
<td>Is able to make connections between concepts</td>
<td>Rationalizes the use of a method- why</td>
</tr>
</tbody>
</table>

# Productive Group Problem Solving Session

<table>
<thead>
<tr>
<th>Component</th>
<th>Tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Background knowledge (Level 0.5 &amp; Level 1)</td>
<td>• Terminology, equations</td>
</tr>
<tr>
<td>• Basic level of comprehension (Level 1)</td>
<td>– Webassign*</td>
</tr>
<tr>
<td>• Communication/exchange of ideas</td>
<td>• Webassign</td>
</tr>
<tr>
<td></td>
<td>• Peer evaluations</td>
</tr>
</tbody>
</table>

*https://www.webassign.net/
Assignment of Groups

- 3-5 students per group
- Groups assigned by instructor
- Less than 12 groups per recitation
- Peer evaluations used as part of assessment

Development of Effective Problem Sets

- Multi-step problems
- Answers not obtainable from direct application of formula
- Problems that encourage discussion of ideas (estimation, qualitative answers)
- Comprehensive problems that require use of concepts/skills learned previously
Average Exam Scores
Before & After Implementation

Average Exam Scores
Semester Trend

Fall Before  Fall After  Spring Before  Spring After

64  66  68  70  72  74  76
Effect on Exam Grade Distribution

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2000</td>
<td></td>
</tr>
<tr>
<td>Fall 2001</td>
<td></td>
</tr>
<tr>
<td>Fall 2002</td>
<td></td>
</tr>
<tr>
<td>Fall 2003</td>
<td></td>
</tr>
</tbody>
</table>
Results Summary

- Average exam scores improved
- Grade distribution shifted towards higher grades
- D and F grades decreased by about 10%
Student Response

• “I think recitation is very beneficial to get a better understanding of the material. It gives us a chance to ask questions and to work on problems. It is also good to work with others to get a little help or a better understanding.”

• “Overall, I like how the recitation has been organized. Sometimes I have no clue how to do the problems that have been assigned, but I learned how to do it from my group.”

• “I was not too fond of group activity because I found it difficult to rely on other people, but this worked out very well.”
Conclusions

• Group problem solving in General Chemistry recitation improved exam grades
• Effective implementation of group work is critical to success of the model
  – Student preparation
  – Problem sets that encourage discussion
  – Groups assigned by instructor
  – Accountability of individuals in the group
Acknowledgement

- Dr. Phyllis Blumberg, Director of Teaching & Learning Center.
- Department of Chemistry & Biochemistry
Statistical Analysis of Results

- Improvement in mean (2 sample t-test) and median (Mann-Whitney) after implementation

<table>
<thead>
<tr>
<th></th>
<th>Average Score</th>
<th>p-value for t-test</th>
<th>p-value for Mann-Whitney test</th>
</tr>
</thead>
<tbody>
<tr>
<td>F01</td>
<td>67.5</td>
<td>0.004617</td>
<td>0.003306</td>
</tr>
<tr>
<td>F02</td>
<td>71.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TEAM MEMBERS EVALUATION FORM: For each question, circle the number that fits your response to the question best using the following number assignment for your responses. Please be honest in your evaluations.

1-Never/Not at all  2-rarely/Not very  3-sometimes/somewhat  4-usually/very  5-always/extremely

Name of student being evaluated ____________________

Is the student prepared for recitation, i.e., seems to understand the concepts involved in problem solving?

How effective is the student in initiating/maintaining the group effort in developing the solution for the problem sets?

Has the student notified a team member if he/she is unable to make it to recitation?

Note: N/A = 5

Is the student receptive to ideas and opinions presented by other team members?

How engaged is the student in the team effort?

Add up the numbers circled for each question and enter total here ____________________
Calculation of Recitation Score

<table>
<thead>
<tr>
<th>Name</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
<th>Score 4</th>
<th>Individual Average</th>
<th>Team Average</th>
<th>Adjustment Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student A</td>
<td>100</td>
<td>87.5</td>
<td>62.5</td>
<td>87.5</td>
<td>84.38</td>
<td>83.59</td>
<td>1.01</td>
</tr>
<tr>
<td>Student B</td>
<td>100</td>
<td>100</td>
<td>87.5</td>
<td>100</td>
<td>96.88</td>
<td>83.59</td>
<td>1.05</td>
</tr>
<tr>
<td>Student C</td>
<td>87.5</td>
<td>87.5</td>
<td>100</td>
<td>87.5</td>
<td>90.63</td>
<td>83.59</td>
<td>1.05</td>
</tr>
<tr>
<td>Student D</td>
<td>87.5</td>
<td>75</td>
<td>12.5</td>
<td>75</td>
<td>62.5</td>
<td>83.59</td>
<td>.75</td>
</tr>
</tbody>
</table>