INVESTIGATION OF STUDENT ATTITUDES AND UNDERSTANDING IN GENERAL CHEMISTRY
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Overview of Project

This project aims to analyze the state of the current Chemistry 103 lab manual in order to understand the demands placed on entry-level chemistry students. This analysis includes a look into the level of inquiry present in each lab, as well as the skills needed to perform the experiment. Finally, the assessment(s) for each lab will be analyzed to ensure that they correspond with the lab’s learning objective(s).

This project acts as a supplement to another UWEC study which examines the effect of inquiry-based laboratory experiments on students’ content knowledge and attitude toward chemistry.

Goals

• Gather information about the impact of a guided inquiry laboratory experiment on students’ learning
• Analyze the Chem 103 laboratory manual and the level of inquiry in each experimental procedure
• Suggest next steps for modifying the lab sequence

Results: Lab Manual Analysis

Each lab was analyzed for the presence of an experimental question and the presence of a specific procedure to follow. This information was used to categorize each lab into one of four types of inquiry: confirmatory, structured, guided, or open. The results are shown below:

<table>
<thead>
<tr>
<th>Lab number</th>
<th>Lab title</th>
<th>Level of Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab 1</td>
<td>Introductory Exercises</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 2</td>
<td>Ionic Compounds #1 Fundamentals and Solubility</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 3</td>
<td>Ionic Compounds #2 Precipitation</td>
<td>Structured Inquiry</td>
</tr>
<tr>
<td>Lab 4</td>
<td>Stoichiometry #1 Determining the Mole Ratios in a Chemical Reaction</td>
<td>Structured inquiry</td>
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<tr>
<td>Lab 5</td>
<td>Stoichiometry #1 (Alternate) The Reaction of Zinc and Iodine</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 6</td>
<td>Stoichiometry #2 Reactions of Carbonates (Mass Lost Experiment)</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 7</td>
<td>Ionic Compounds #3 pH and Acid/Base Neutralization Reactions</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 8</td>
<td>Ionic Compounds #3 pH and Acid/Base Neutralization Reactions</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 10</td>
<td>Gas Laws</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 11</td>
<td>Stoichiometry #3 Gas Stoichiometry</td>
<td>Structured inquiry</td>
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<tr>
<td>Lab 12</td>
<td>Molecular Modeling: Visualizing Molecular Shape and Polarity</td>
<td>Structured inquiry</td>
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<tr>
<td>Lab 13</td>
<td>Intermolecular Forces in Liquids: Relationship to Vapor Pressure and Rate of Evaporation</td>
<td>Structured inquiry</td>
</tr>
<tr>
<td>Lab 14</td>
<td>Lab Practical: Identification of Liquids and Solids</td>
<td>Guided inquiry</td>
</tr>
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Background

A 2012 article from Wheeler and Bell elaborates on the necessity of inquiry in the chemistry classroom. Inquiry is defined as “an active learning process in which students answer research questions through data analysis.”

Research indicates that inquiry-based laboratory experiments provide a more meaningful learning experience for students because they become engaged and take ownership in the material. It has also been suggested that students exhibit a greater understanding of the goals and content of an inquiry-based experiment versus a traditional experiment.

Furthermore, inquiry can be separated into levels of student involvement, which scaffold the learning process to support students’ success. The four levels of inquiry are distinctive because of how much information the instructor provides in each case. In order for students to excel at the most complex and demanding level of inquiry (open inquiry), they must first experience confirmatory, structured, and guided inquiry sequentially. In the current (2014-2015) Chem 103 laboratory coursework, students are given a final lab practical based on guided inquiry. This research project aims to analyze the sequence of labs leading to this culminating assessment and suggest best practices for student success.

Levels of Inquiry

<table>
<thead>
<tr>
<th>Conditions</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Confirmatory</td>
<td>Students are given a specific question and laboratory procedure to confirm a previously taught concept or skill</td>
</tr>
<tr>
<td>Structured</td>
<td>Structured—Students are given a specific research question and procedure in order to find an outcome, with no prior knowledge of the expected outcome</td>
</tr>
<tr>
<td>Guided</td>
<td>Students are given a specific question and must develop a procedure to answer it</td>
</tr>
<tr>
<td>Open</td>
<td>Students develop their own specific question and procedure in order to answer it</td>
</tr>
</tbody>
</table>

Conclusion

• Nearly every lab in the General Chemistry 103 laboratory manual contains the same level of inquiry
• The current manual does not provide students with scaffolded opportunities to practice guided or open inquiry in the lab setting.
• Suggestions for adaptations to the current lab sequence will be prescribed by the end of the 2014-2015 school year.

Next Steps

The Chemistry 103 lab manual is currently being analyzed for various other characteristics in addition to levels of inquiry. These characteristics include:
• Lab materials used
• Lab skills required/developed
• Learning objectives
• Assessment strategies employed

The results of this analysis will be used to suggest modifications and/or additions to the manual based on current educational theory.

Acknowledgments

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References
6. UW-Eau Claire CHEM 103 lab manual, Fall 2012.