Introduction

- Chemistry laboratories often follow a cookbook style approach (Abrahams & Millar, 2008).
- Such approaches limit student engagement and constrain students’ learning experiences with and understanding of chemistry (Donnelly et al., 2014).
- This research investigates the effects of zoo inquiry projects (ZIPs) on student learning and instructor-student interactions compared to existing laboratory structures.

Research Questions

1. Does the ZIP laboratory structure improve student engagement with the learning experience?
2. What are the student perspectives on a ZIP laboratory structure?
3. How does the ZIP laboratory structure compare to more conventional laboratory formats with regard to student engagement and learning outcomes?

ZIP Laboratory Structure

Students collected water samples from the local zoo and worked with them throughout the semester. 3 labs topic (4 topics).

<table>
<thead>
<tr>
<th>Topics</th>
<th>Planning Lab</th>
<th>Experiment Lab</th>
<th>Presentation Lab</th>
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<tbody>
<tr>
<td>Salinity</td>
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<td>Thermodynamics</td>
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<td>Buffer Capacity</td>
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Laboratory Activity

- Research topic
- Research design
- Create experimental design procedure
- Perform experiment
- Collect experimental data
- Analyze data
- Present findings in poster/presentation
- Review/revise posters
- Receive feedback to improve experiment

Knowledge Integration (KI) Framework

(Linn & Eylon, 2011)

Constructivist instructional framework with four components:
1. Elicit ideas
2. Add ideas
3. Reflect on ideas
4. Distinguish ideas

Methods

Research Design and Participants

- Mixed method study – Quantitative (Conceptual & experimental design items) and qualitative (Power relations)
- 55 undergraduate non-science majors from diverse backgrounds (Predominantly female and Hispanic)
- The pre/post items were scored 0-5 with KI Framework rubrics, ranging from non-normative ideas to normative ideas containing disciplinary claimings.

Conceptual Items

1. Specific heat capacity
2. Polarity
3. Molarities
4. Stoichiometry
5. Solubility
6. Formula mass

Experimental Design Items

- Based on Experimental Design Ability Test (EDAT; Sirum & Humburg, 2011)
- Instrument assessment for sodium chloride density (Specific EDAT; post-test only)
- Hypothesis critique (Specific EDAT; post-test only)

Power Relations Data (Donnelly et al., 2014)

- Two post-test questions, four video observations (Two from each laboratory structure), four student interviews, and two instructor interviews

Table 1. Pre/Post Conceptual Gains by Treatment

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<thead>
<tr>
<th>ZIP</th>
<th>Conv</th>
<th>p*</th>
<th>d</th>
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<tbody>
<tr>
<td>Gain</td>
<td>1.26</td>
<td>1.67</td>
<td>0.01</td>
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<tr>
<td>SD</td>
<td>1.31</td>
<td>1.91</td>
<td>0.83</td>
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</tbody>
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Table 2. Pre/Post Experimental Design Gains

<table>
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Power Relations Findings

- More students in the ZIP laboratory (42.2%; n = 19/45) stated that they enjoyed the ownership they had over their own experimental designs when compared to students within the conventional laboratory (0%; n = 0/10).
- The difference is perceived to be that in the traditional format, the student values ownership and feels like their experiment is ‘their experiment.’ In the ZIP format, ownership is more distributed and joint.
- ZIP Laboratory Instructor interview

Conclusion and Future Work

- Conceptual and experimental design gains for the ZIP laboratory and conventional laboratory are similar, but the two specific post-test experimental design items appear to favor the ZIP condition.
- ZIP students report greater experimental ownership, with less instructor dependence.
- Having refined the assessment items through this pilot study, the ZIP structure is being implemented and investigated in 11 of 22 Introductory Chemistry Laboratories for non-science majors for an increased sample size of ~500 students.

Literature Cited


Acknowledgments

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