Affordances and Constraints:
Student Discourse during Virtual and Hands-on Biology Experiments

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INTRODUCTION

In response to the COVID-19 pandemic, science teachers worldwide have been faced with the challenge of providing alternative meaningful student learning opportunities beyond traditional methods, which raises question of the learning effectiveness and equitability of virtual labs when compared to traditional hands-on lab experiences. Gibson's theoretical framework describes that each learning experience provides specific affordances but also creates specific constraints to learning at the same time. There is little research on the effectiveness of student learning using virtual labs and online simulations when practiced independently and in conjunction with traditional hands-on experimentation. This presentation is about my own action research on the quality and quantity of student discourse when engaged in online vs. hands-on lab experiences in the Biology high school science classroom.

Discourse data will be collected while participating during an osmosis lab, both virtually and hands-on. A pre-lab test and post-lab test will be administered. And finally a student post-survey will be collected. The data collected will be analyzed for relationships between the quantity and quality of student discourse within both types of experimentation methods, the understanding/achievement of students, and their perceptions of the students' own learning experiences (see Table 1 below).

PARTICIPANTS

Table 1: Participant Demographics:
High School General Biology Students (N:64)

Gender	Male: 32 Female: 32
Grade Level	9: 4 10: 18 11: 40 12: 2
Ethnicity	Hispanic: 10 Mixed: 3 White: 25 Black: 23 Asian: 3
Modifications:	ESL: 4 504: 2 EC: 4 AIG: 2

METHODOLOGY

Research Questions:

1. How is student discourse important in the biology classroom?
2. What types of affordances and constraints are common to virtual labs?
3. What types of affordances and constraints are common to hands-on labs?
4. How does student discourse change, if at all, when engaged in a virtual lab compared to a hands-on lab considering all affordances and constraints?
5. How are students' understanding in the biology classroom affected by the quality and quantity of student discourse?

DATA COLLECTION

Quantitative Measures:

- Pre/Post Content Assessment (osmosis and molecular cellular transport)
- Students' osmosis lab report (with rubric)

Qualitative Measures:

- Quality of student discourse measured using evidence coding categories (modes and types based upon Bloom's taxonomy).
- Post Video Diary Surveys (student perceptions comparing virtual lab learning to hands-on learning experience)

METHODS

- Students will be randomly placed into one of two conditions: virtual or hands-on.
- Group A students will conduct the virtual lab on day 3 Group B students will conduct the hands-on lab on day 3.
- Both types of labs should take approximately sixty minutes to perform on each day (see figure one below for virtual lab).
- The lab report will be the same, including pre-lab information, generation of a hypothesis, steps of the experiment, data collection and observations, data analysis, conclusions, and analysis questions.

https://video.esc4.net/video/assets/Science/Biology/Gateway%20Resources/cell%20homeostasis%20virtual%20lab%20

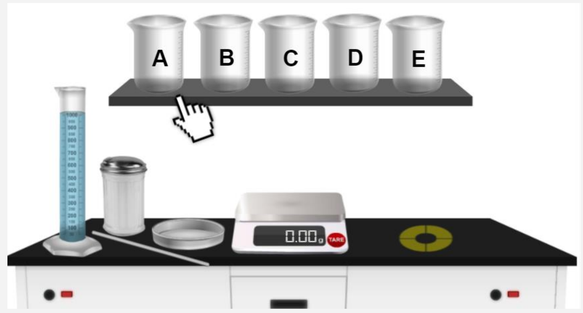

Figure 1: Virtual Osmosis Lab

Lesson Timeline

Fall Semester 2021
Unit 4: Molecular Cell Transport (6 day unit)

Day Prior: Guided Outline (students read a portion of a textbook and answer questions about content)
Day 1: Pre-lab assessment, Lecture notes (structure and function of the cell membrane), Dialysis Tubing Osmosis Demo, cell membrane modeling (virtual simulation)
Day 2: Lecture notes (passive transport), Gummy Bear Osmosis Demo, molecule movement research (virtual)
Day 3: Tonicity Video Review, participation in virtual osmosis lab (Group A) and hands-on lab (Group B) with discourse data collection.
Day 4: Continue discourse data collection as students obtain hands-on labs results, and all students (A and B) meet with their partners to discuss findings and make conclusions, post-lab assessment. Each group will perform the opposite lab than the day prior.
Day 5: Students obtain hands-on labs results, and all students (A and B) meet with their partners to discuss findings and make conclusions, students will continue lecture notes (active transport and adaptations for unicellular survival).
Day 6: Post-Video Diary survey, and Unit 4 regular assessment

RESULTS & ANALYSIS

First, the pre and post-lab assessment means and standard deviations will be calculated for each condition (virtual versus hands-on) and documented using Table 2. Then the pre-lab and post-lab assessment data will be analyzed using one-way ANOVA to analyze how student achievement differs for students in each condition. Data analysis will continue using a parallel analysis design for group A & B for discourse as related to student understanding (audio recording of discourse and scoring, lab report analysis - rubric, student video diary) and then each group will be compared.

Table 2: Assessment Data

	Pre-Lab Assessment		Post-Lab Assessment	
	Mean	Standard Deviation	Mean	Standard Deviation
Virtual Lab				
Hands-on Lab				
Total				

CONCLUSIONS

- Expected findings: that each of the conditions (virtual and hands-on) will create its own affordances and constraints and therefore students discourse will be unique to each condition.
- Additionally, each condition will offer different opportunities for students to develop skills unique to each condition (Puntambekar, et al., 2019).
- Students may perceive that they had a more enjoyable learning experience by participating in the hands-on lab experiment but may also appreciate that the virtual lab made affordances to re-do portions of the lab or to go back and conduct the procedures again, whereas that option is typically limited by time constraints or the availability of resources, when performed hands-on.

IMPLICATIONS

- Technology can be used to meet certain allowances when hands-on opportunities to learn are limited or unavailable.
- Determining a balance between offering virtual labs and hands-on labs may contribute to their affordances compensating for the constraints that each condition creates (Puntambekar, et al., 2019).
- Results may determine best practices and teaching methods in the high school Biology classroom.