Why Students Struggle in General Chemistry: Understanding Open-Ended Assessment in the Chemistry 111 Classroom

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Theory: How do students learn?

Self-guided and inquiry-based learning is theory-supported and helps students develop higher-order cognitive skills.

Supporting Theorists:

- Jean Piaget[5] – Constructivism
- Maria Montessori[4] – Montessori Method
- Lev Vygotsky[6] – Child Development
- John Dewey[2] – Relevant Curriculum
- Benjamin Bloom[1] – Bloom's Taxonomy
- Alex Johnstone[3] – Johnstone's Triangle

Student Tasks

4 sections of students were asked to complete C*reative Exercises* throughout their general chemistry course.

Creative Exercises (CE's) are open-ended assessments that provide students with a prompt and ask them to write or illustrate correct, distinct, and relevant pieces of information about the prompt. Ability to complete a CE without prior knowledge of CE's was tested by varying whether students got a traditional exam question as a 'lead-in.'

Exercise 1

1. Convert 17.3g of KCl (potassium chloride) to moles.
2. Write down or draw at least 3 (no more than 5) correct, distinct, and relevant facts you can about:
   75.6g $CaCO_3$

Exercise 2

1.What is the structure of Ammonia (NH_3)? Draw the Lewis diagram.
2.Write down or draw at least 3 (no more than 7) correct, distinct, and relevant facts you can about:
A molecule of Ozone

Exercise 3

1. Balance and write the net ionic equation for the following molecular equation:
$Pb(NO_3)_2$ (aq) + KI (aq) -> PbI_2 (s) + KNO_3 (aq)
2. Write down or draw at least 3 (no more than 7) correct, distinct, and relevant facts you can about:
   6.7 g of $CaBr_2$ is dissolved in a 1 L solution of excess Li_2CO_3 in the reaction
   $CaBr_2$ (aq) + Li_2CO_3 (aq) → $CaCO_3$ + LiBr

Why should you care?

It's been researched that science is hard to learn. Johnstone[3] has produced work to prove it requires a level of abstract thought that requires educators to consider children's development to effectively teach. Making it easier to learn increases retention and confidence and decreases imposter syndrome among minorities in STEM.

Results

(from exercise 2)

42%

Of students chose to identify types of bonding on the second CE

60%

Of students were able to complete exercises without ANY mistakes

71%

Of students given the lead in did it exactly right

75%

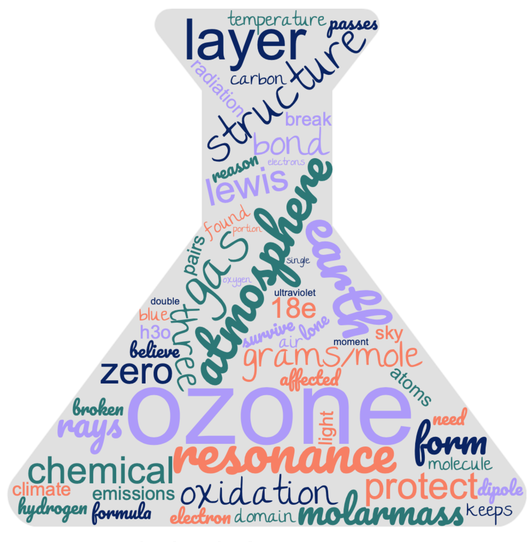
Of students provided information outside the scope of the course

Challenges

- Low response rate
- Difficulty with online survey
- Inability to follow students' thoughts
- If there was a mistake, it was carried through the exercise
- No demographic or grade data

Next Steps

- Interview students as they complete the exercises instead of worksheets
- Have students complete the exercise in class
- Collect information on what students thought of the exercises with Likert scale questions



Word Cloud of CE 2 responses

Acknowledgements

Many thanks to:

Advisor – Dr. Morris
Second Reader – Dr. Faust
Mentors at The College of Wooster, North Dakota State and Wooster High School.
My friends, family, lab mates, and carrel buddies.

Citations

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