General chemistry students' language fluency in the context of precipitation reactions

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Background

- Academic language: The specialized language structures and functions that are necessary in order for one to read, understand, talk, discuss, conceptualize, symbolize, and write about topics in the various science subjects
- Science subjects have a language register - norms and patterns of language use that are central to the practice of each discipline:
  - formulating hypotheses, predicting, describing, generalizing, classifying, interpreting data, making inferences, and communicating findings
- Academic language is important in the learning of science because teaching and learning is mediated through language
  - Students need to understand language to engage in activities in the classroom
- The academic language of science is a challenge for students because of its use of information-bearing vocabulary and grammatical structure that condenses complex ideas into few words
- Students are expected to learn the language of science (a new language) while they are learning science content

Research Question

What is the nature of general chemistry students' understanding and use of academic language in the context of precipitation reactions?

Methodology

- Data was collected from a general chemistry (I) class in the spring semester
- Students worked in groups of two to three (n=47 groups) after viewing the precipitation reaction video in class
- Activity was completed after the "Reactions in Aqueous Medium" chapter
- Audio transcripts of group discussions were analyzed and coded for different aspects of language fluency

Activity prompts:

1. Watch the 12-second video in the link below. In the space below, describe what you observed.

2. Based on the ions in the two solutions, what are the formulas of the compounds in each solution?

3. Based on the formulas you determined above, predict the products and write a complete molecular equation of the reaction.

4. Write a complete ionic equation for the reaction.

5. Write the net ionic equation.

6. Suppose we ***initially*** measure the conductivity of ***one*** of the solutions, and then slowly add the second solution to it, how would you expect the conductivity of the mixture to change? Assume you have equal amounts of each solution.

7. (a)In the space below, sketch a graph of **current conducted** by solution 1 against **amount of solution 2 added**.

(b) Explain your sketch.

Results

Using Context Appropriate Vocabulary

Students use the correct vocabulary term when answering the question or explaining their reasoning

CORRECT EXAMPLE	INCORRECT EXAMPLE
1: Okay, so for number one we can say that when you mix them, where they meet, everything turns yellow. 3: um, 2: Reacted to form a yellow… 3: React and it creates a yellow precipitate.	3: Lead iodine, and there's pictures of it as like a solid yellow thing,

For Question 1, the expected answer is **yellow precipitate**

A total of 8 groups said yellow precipitate

Translating from Symbolic to Verbal Form

Students are unable to translate element symbols to their correct verbal form

$Pb(NO_3)_2 + 2KI \rightarrow PbI_2 + 2KNO_3$

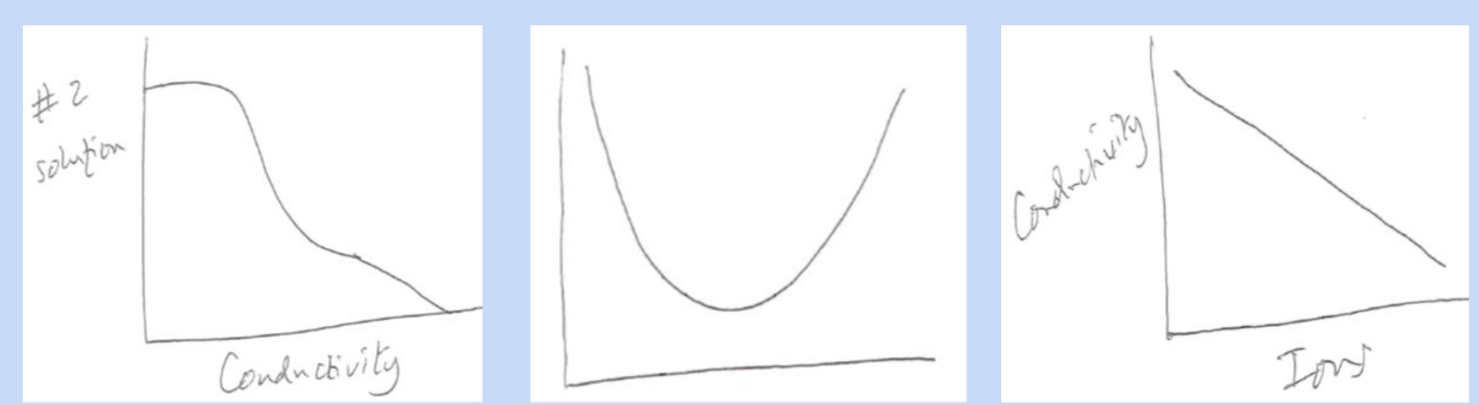
CORRECT EXAMPLE	INCORRECT EXAMPLE
Student 1: Yeah. so Pb2 plus and NO3 minus and K plus I negative, so lead nitrate or something Student 2: Yeah Student 1: and potassium iodide	**S1:** for number 2, lead plus ammonia and potassium plus iodine. **S2:** For number 3, lead plus ammonia plus potassium plus iodine gives us lead iodine **S2:** lead iodine and **(In background):** potassium ammonia (said just slightly ahead of but almost simultaneously with student 2 below) **S2:** potassium ammonia.

Interpreting Language of Instructions

Students are unable to comprehend instructions

1: … Does that mean like this thing where it shows one is more conductive than the other maybe? I don't…
2: Yeah, that's… that would make the most sense. I'm just kinda confused by the wording of it.

Student 2: Current conducted
Student 1: against an amount of solution two added.
Student 2: What?
Student 1: huh?
Student 2: Current conducted against amount, what?



Use of Colloquial Language

Students use non scientific language in their explanations

Total: Stuff (14 groups), Thing (30 groups)

3: …but then if you look at the stuff in between it doesn't change color but it looks like it has a, like a film over it almost.	Student 2: Yeah. Unless one of these wasn't supposed to go together? Student 1: mmm Student 2: Like were we supposed to keep them Student 1: No, this goes, this goes together. This is, this is right. This is a thing. These are things.

Use of Context Inappropriate Language

Students use vocabulary terms that are out of context

Total: Neutral (11 groups), Acid/base (3 groups)

Student 2: So slowly add the second solution. I guess, yeah, they naturally, like cancel out or neutralize each other.	1: Obviously it was two acid base… or an acid and a base., Right and it became neutral, that's why it... that showed a new color. It kind of like stopped like a wall.

Discussion

- Few groups used appropriate vocabulary in describing observations, most used generic words
- Some student groups could not translate between different forms of language (symbolic to verbal)
- Interpreting language in instructions was a challenge to some groups
- Patterns of language use show convoluting of concepts
- Students used colloquial language during discussions
- Students memorized definitions they could not apply

Implications

- Academic language is central to science (chemistry) – needs to be explicitly taught
- Students need opportunities to 'talk' and use language
- There is a need for effective assessments of language fluency, especially through talk
- Collaborative group activities can help students develop fluency
- There may be a gap between students' knowledge of vocabulary and true understanding
- Students need opportunities to connect different forms of language

References

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