

Writing to learn science: using the Science Writing Heuristic

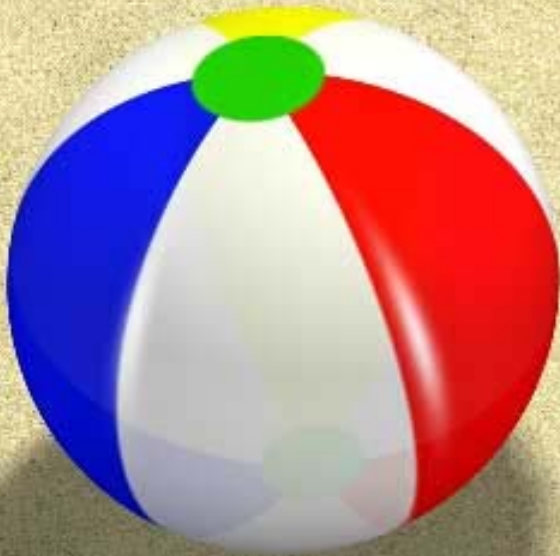
Dr. James Rudd

California State University - Los Angeles

2009 Western Regional Noyce Conference

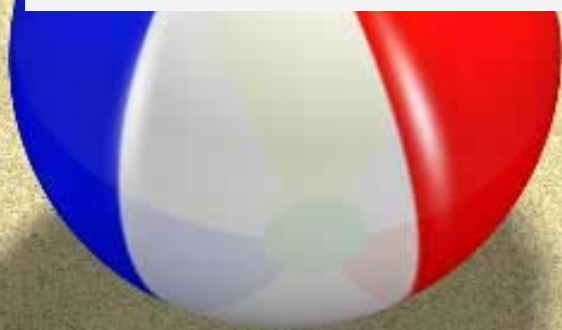
January 25, 2009

Ontario, CA



Sample writing from a standard laboratory report

"Overall the lab went well, and I learned a lot about determining empirical formulas. We first added HCl to Zn, then we evaporated and got an off-white solid. We found the empirical formula to be 1 Zn to 2 Cl for a formula of ZnCl_2 and we calculated a percent yield of 95%. Human error could have occurred. We might not have been careful enough in weighing and transferring. We might not have gotten all the solid out of the dish."



Sample writing from SWH-style report

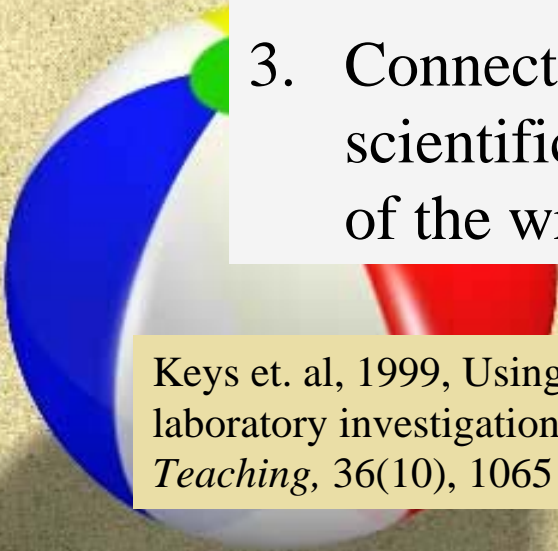
"Hydrogen gas was given off in the reaction, and Zn and Cl combined. The evidence for this was the emergence of a colorless gas from the mixture when HCl was combined with Zn. Since a new, unidentified substance formed and the gas given off was hydrogen, the substance must contain some combination of Cl and Zn."

"The empirical formula for the substance is ZnCl_2 ... [the student shows the necessary calculations to determine moles of Zn and Cl] ... The ratio is 0.0085 mol of Zn to 0.0175 mol of Cl. Since 0.0085 is approximately half of 0.0175, the empirical formula is ZnCl_2 . Balanced equation is $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2(\text{s}) + \text{H}_2(\text{g})$ [followed by calculation of % yield]."

The Science Writing Heuristic

1. Learning approach based on inquiry.
2. Templates for instruction and student writing.
3. Connections between observations and scientific explanations through elements of the written report.

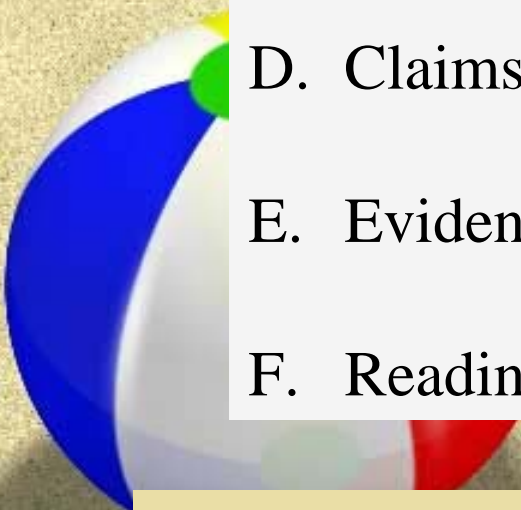
Keys et. al, 1999, Using the science writing heuristic as a tool for learning from laboratory investigations in secondary science, *Journal of Research in Science Teaching*, 36(10), 1065 - 1084.



Student writing template

- A. Beginning Questions or Ideas
- B. Tests and Procedures
- C. Observations
- D. Claims
- E. Evidence
- F. Reading and discussion

Rudd, et. al, 2001, Recrafting the General Chemistry Laboratory Report, *Journal of College Science Teaching*, 31, 230-234.



Comparison of laboratory reports

<u>SWH</u>	<u>Standard format</u>
Beginning Questions or Ideas	Title, Purpose
Tests and Procedures	Outline of procedure
Observations	Data and Observations
Claims	Discussion
Evidence	Balanced Equations, Calculations, and Graphs*
Reflection	n/a

Comparison of laboratory reports

SWH vs. standard format:

At an expert level of content understanding, the difference in the writing formats may appear subtle.

For students still forming basic understandings, there are significant differences in

1. Efforts to engage with lab work.
2. Efforts to incorporate observations and data into understandings about chemistry.

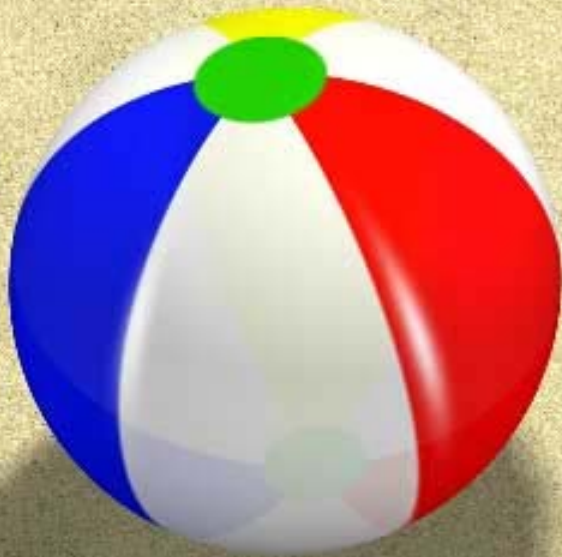
Published results

- Higher level of engagement with lab activities.
- Stronger connection of observations to chemistry concepts in written work. (sample writing)
- Improved performance on lab practical exam.
Standard mean (s.d.) = 63.0% (22.5)
SWH mean (s.d.) = 72.8% (17.7)

Rudd, et. al, 2001, Recrafting the General Chemistry Laboratory Report, *Journal of College Science Teaching*, 31, 230-234.



Mystery activity



Physical and chemical change

Reversible and irreversible change

We will investigate the concepts of physical change, chemical change, reversible change, and irreversible change.

What Beginning Ideas or Questions do you have?



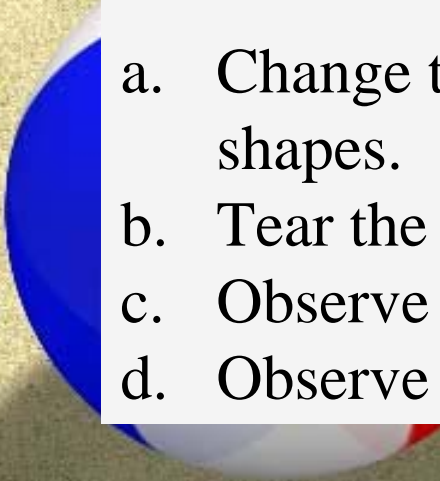
Physical and chemical change

Reversible and irreversible change

(tests and procedures are given)

Record your observations, and consider if the process was a physical change, chemical change, reversible change, and/or irreversible change?

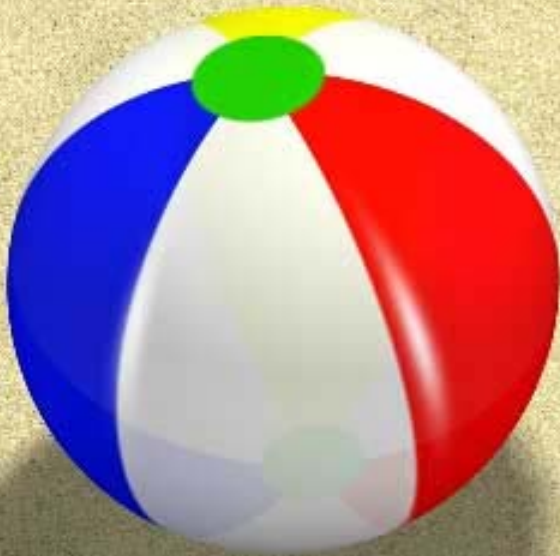
- a. Change the shape of the clay into three different shapes.
- b. Tear the paper into several smaller pieces.
- c. Observe the egg demonstration.
- d. Observe the gak demonstration.



Physical and chemical change

Reversible and irreversible change

Answer your Beginning Questions and/or expand on your Beginning Ideas by constructing your Claims and providing supporting Evidence.



Mystery activity

Examples of student claims and evidence were:

- (1) Mr. Xavier was dead. His dead body was found.
- (2) Mr. Xavier was murdered. The knife with blood on it was the murder weapon, and the red stain under his body was from the fatal wound.
- (3) Mr. Xavier died from a heart attack. The knife with blood was from his steak dinner, and the red stain was from a glass of spilled wine.
- (4) The ground outside was wet. There was a storm.

2009 Western Regional Noyce Conference

January 23-25, 2009 Ontario, CA

Writing to learn science: using the Science Writing Heuristic

Dr. James Rudd (Cal State LA), January 25, 11:00 AM – 12:00 PM

The session will introduce the Science Writing Heuristic (SWH), a writing to learn approach that guides students to think like scientists when engaging with laboratory (hands-on) activities and observing demonstrations. Students using the SWH format write Beginning Questions, Tests and Procedures, Observations, and Claims and Evidence. Unlike experts in science (instructors and practicing scientists), science learners (novice scientists) think and write much differently when using the SWH format as compared to completing traditional laboratory reports.

Student writing template

- | | |
|---------------------------|--|
| A. Ideas | What are my questions? |
| B. Tests and procedures | What did I do? |
| C. Observations | What did I see? |
| D. Claims | What can I claim? |
| E. Evidence | How do I know? Why am I able to make these claims? |
| F. Reading and discussion | How do my ideas compare with other ideas? |

2009 Western Regional Noyce Conference

January 23-25, 2009 Ontario, CA

Writing to learn science: using the Science Writing Heuristic

Dr. James Rudd (Cal State LA), January 25, 11:00 AM – 12:00 PM

Mystery activity

You and your partner are private detectives who have been hired to investigate the death of the wealthy but eccentric Mr. Xavier, a man who was well known for his riches and for his reclusive nature. He avoided being around others because he was always filled with anxiety and startled easily. He also suffered from paranoia, and he would fire servants that he had employed for a long time because he feared they were secretly plotting against him. He would also eat the same meal for dinner every night, two steaks cooked rare and two baked potatoes with sour cream.

Upon arriving at the tragic scene, you are told that Mr. Xavier was found dead in his home early this morning by the servants. The previous evening after the chef had prepared the usual dinner for Mr. Xavier, the servants had been dismissed early in order to avoid returning home during last night's terrible storm. When they returned in the morning, Mr. Xavier's body was found face down in the dining room.

Looking into the room, you start your investigation. The large window in the dining room has been shattered and appears to have been smashed open from the outside. The body exhibits laceration wounds and lies face down by the table, and there is a large red stain on the carpet that emanates from under the body. An open bottle of red wine and a partially eaten steak still remain on the table. A chair that has been tipped over is next to the body, and under the table is a knife with blood on it.

Based on these preliminary observations, please work with your partner to draw initial conclusions about what happened. Please provide as much evidence as you can to support each conclusion you make.