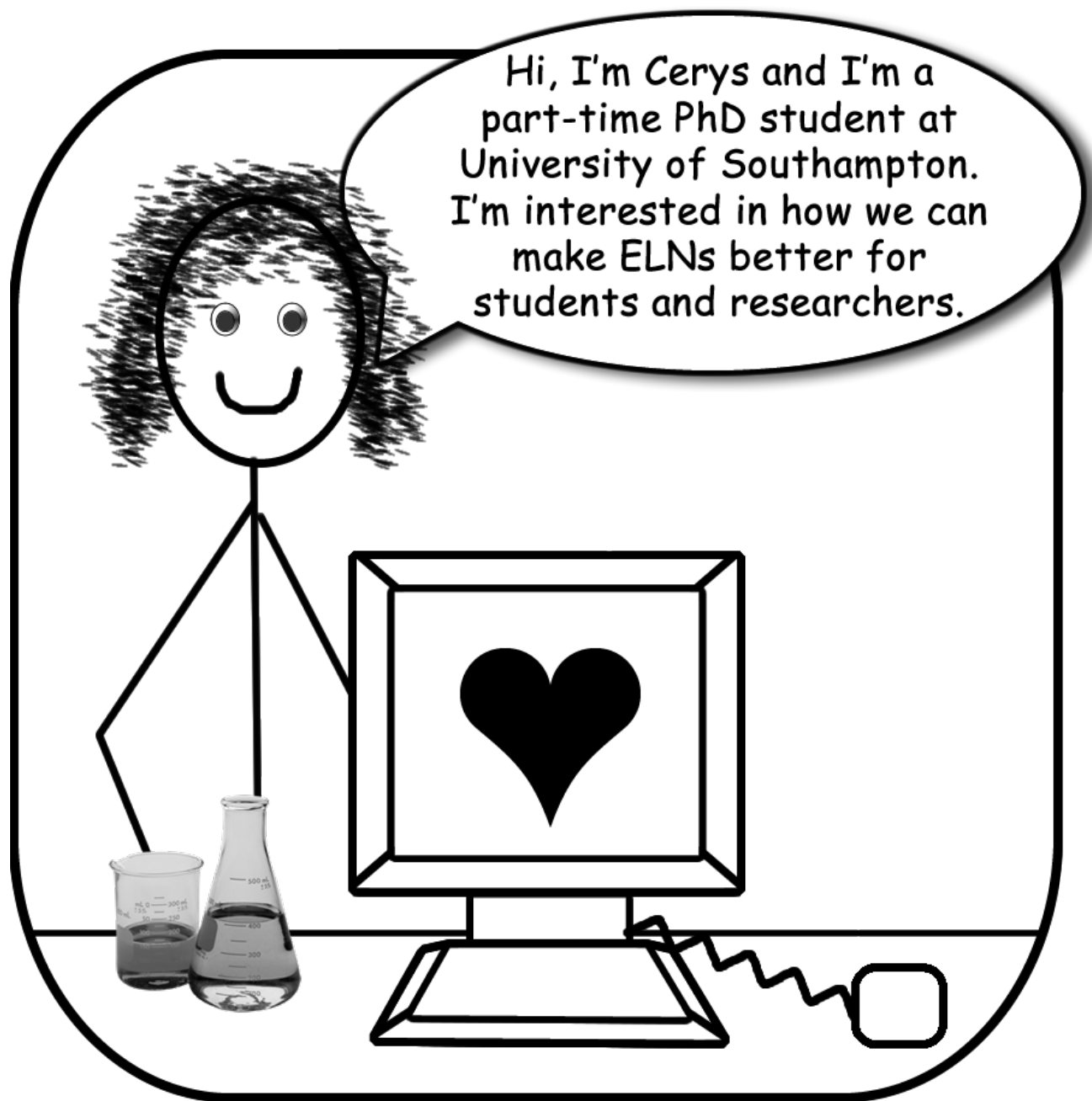


# **Knowledge and memory: a study of what students remember about chemistry experiments**

Cerys Willoughby and Jeremy Frey

18 March 2014



# LabTrove

“preserving the record”



- > [About Us](#)
- > [Get LabTrove](#)
- > [Documentation](#)
- > [Support](#)
- > [Publications](#)
- > [Users](#)
- > [Contact Us](#)

our experiment

### Pictet-Spengler route to Praziquantel

Synthesis of intermediates and derivatives of PZQ

Older Posts >>> Search

Continuation: Acid-catalyzed Pictet-Spengler reaction with methanesulfonic acid (MW56-9 to MW56-12)  
17th March 2011 @ 07:14

Acid-catalyzed Pictet-Spengler using methanesulfonic acid in various concentrations

Continuation of Acid-catalyzed Pictet-Spengler reaction with methanesulfonic acid (MW56-5 to MW56-8)

Archives

- March 2011 (8)
- February 2011 (8)
- August 2010 (5)
- July 2010 (5)
- June 2010 (14)
- May 2010 (3)

Sections

- Experiments (36)

Tools

Show/Hide Keys

LabTrove enables the formation of a Smart Research

LabTrove  
labtrove

labtrove Public Blog Post: Synthesis of amine-linked analogue of TCMDC-123812 via reductive aminatio...  
<http://t.co/Bla5hWbb> #malaria #drugdesign  
yesterday · reply · retweet · favorite

labtrove Public Blog Post: Synthesis of ether-linked analogue of TCMDC-123812 (PMY 37-1) <http://t.co/XhqyRb8i> #malaria #drugdesign  
yesterday · reply · retweet · favorite

labtrove Public Blog Post: Synthesis of 2-Ethoxycarbonylthiolan-3-one  
<http://t.co/m9mUBQKS> #malaria

# Capturing the experiment record

15/05/08 55

Actual mass of 1.8 naphthylidene  
- Dissolution of the solid in DCM  
brown solution.  
- On addition of the amine  
which dissolved again on  
After stirring overnight!

0.0 - 15/05/08 22:00

This formed so  
to tell if the new  
due to polarity of the

The workup proceeded  
Reaction was  
separated.  
The organic  
(2x 50ml) H<sub>2</sub>O  
and lower  
than organic  
layer.  
This new  
vialled down  
Reagent  
0.83  
Clean b.

Chemical reaction scheme showing the reaction of 1,8-Naphthyridine with 2,7-dichloro-1,4-benzodioxane to form a product.

| Name                          | Mass/Volume | Moles    | Remarks  |
|-------------------------------|-------------|----------|--|
| 1,8-Naphthyridine             | 1.10g       | 4.31mmol | Not known, Toxic as toxic  |
| 2,7-dichloro-1,4-benzodioxane | 0.97ml      | 9.48mmol | Harmful if contact with skin and if swallowed<br>Causes burns    |
| Triethylamine                 | 1.31ml      | 9.48mmol | Highly flammable<br>Harmful by all routes<br>Causes severe burns |
| Dichloromethane               | 50ml        | solvent  | Limited evidence of a carcinogenic effect                        |

Procedure  
1,8-Naphthyridine-2,7-dichloro-1,4-benzodioxane (1.10g, 4.31mmol) was dissolved in DCM (50ml) in a round bottom flask.  
To this 2-(trimethylsilyl)pyridine (0.97ml, 9.48mmol) was added to the reaction mixture by needle syringe. Following this triethylamine (1.31ml, 9.48mmol) was added dropwise.  
The reaction was then left to stir overnight and was TLC'd before being worked up.

Proposed Work up

We want to understand what students remember about experiments and whether the use of questionnaires improves or impairs the **quality** of information they capture.



# It's not about the procedure..

- What did I do?
- Why did I make that decision?
- What did I see?
- Why do I think that happened?
- How does it relate to my knowledge in chemistry?
- What might I forget to record that is important?
- Will what I capture help me when I come to look up the experiment in the future?



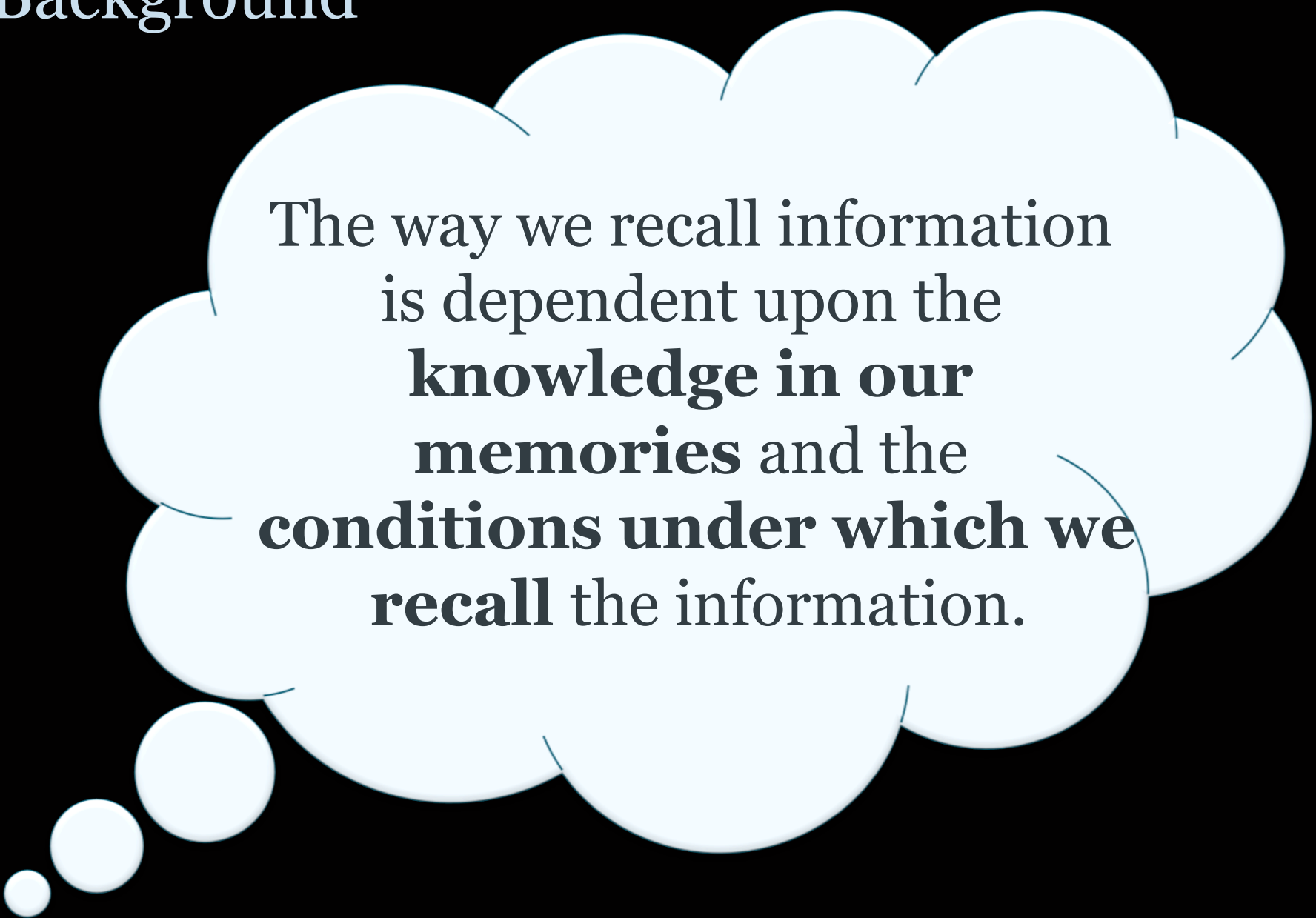
ELNs can provide a structured environment for recording information



But is that  
good or bad?



# Background



The way we recall information  
is dependent upon the  
**knowledge in our  
memories** and the  
**conditions under which we  
recall** the information.

# Memory and knowledge structures

## Schemas



## Scripts



# Remembering

Cues



Perspectives



photo credit: Jack Zalium

Anderson and Pichert (1978)



# Using templates

- Structured
- Provides cues
- Potential problems





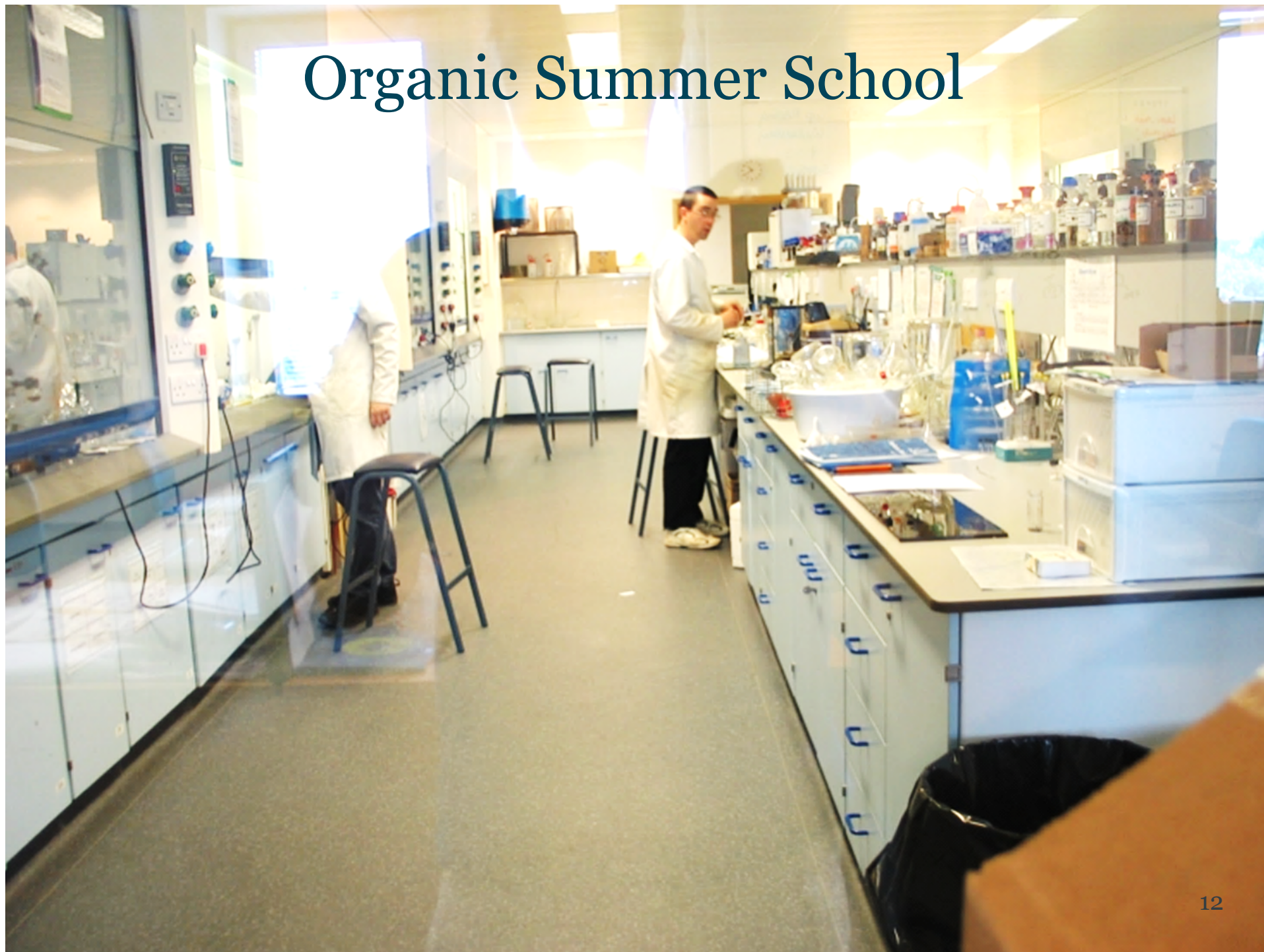
A close-up photograph of a student in a white lab coat and safety goggles. The student is pouring a clear liquid from a beaker into a flask. The flask already contains a yellow, granular precipitate. The background is blurred, focusing on the student's face and the laboratory glassware.

## Study aimed to find out:

- What knowledge students might have about a chemistry experiment
- What differences using a template makes to the information students record

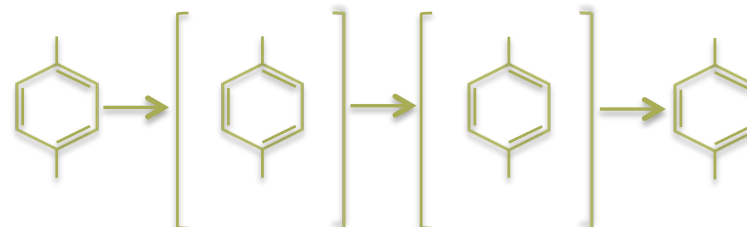


# Organic Summer School



# Pre-experiment questionnaire

- Free recall
- Complete a reaction scheme
- Name the chemicals and identify safety information
- Identify equipment required for the experiment
- Identify measurements and observations that might be used in the experiment
- Describe step-by-step experiment instructions

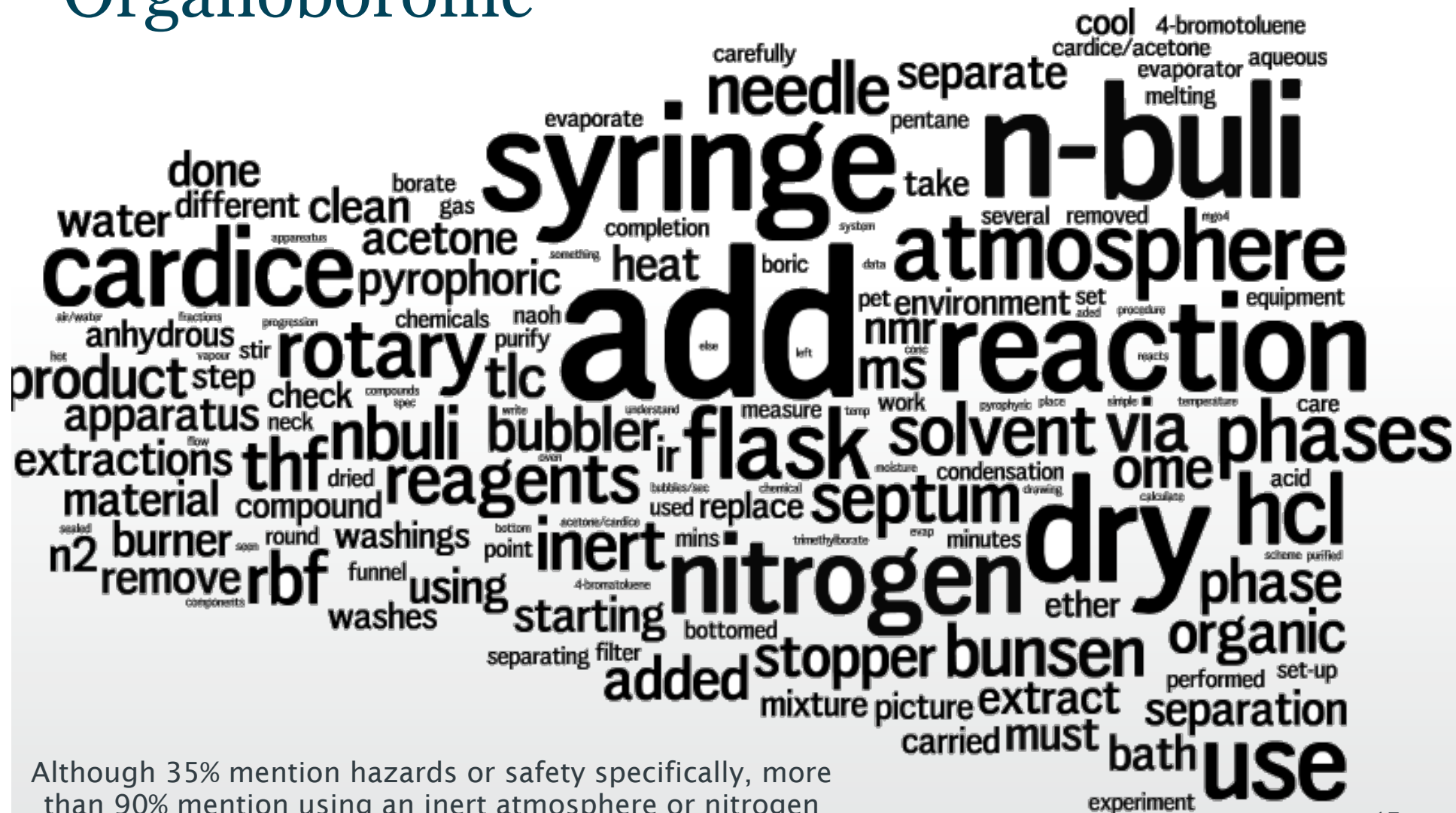


## Thinking about experiments

- >90% statements relate specifically to steps in the experiment
- >85% of students recalled steps in the correct order
- Equipment, chemicals and “actions”
- Some general “experiment” steps are recalled, but most are the specific to the experiment

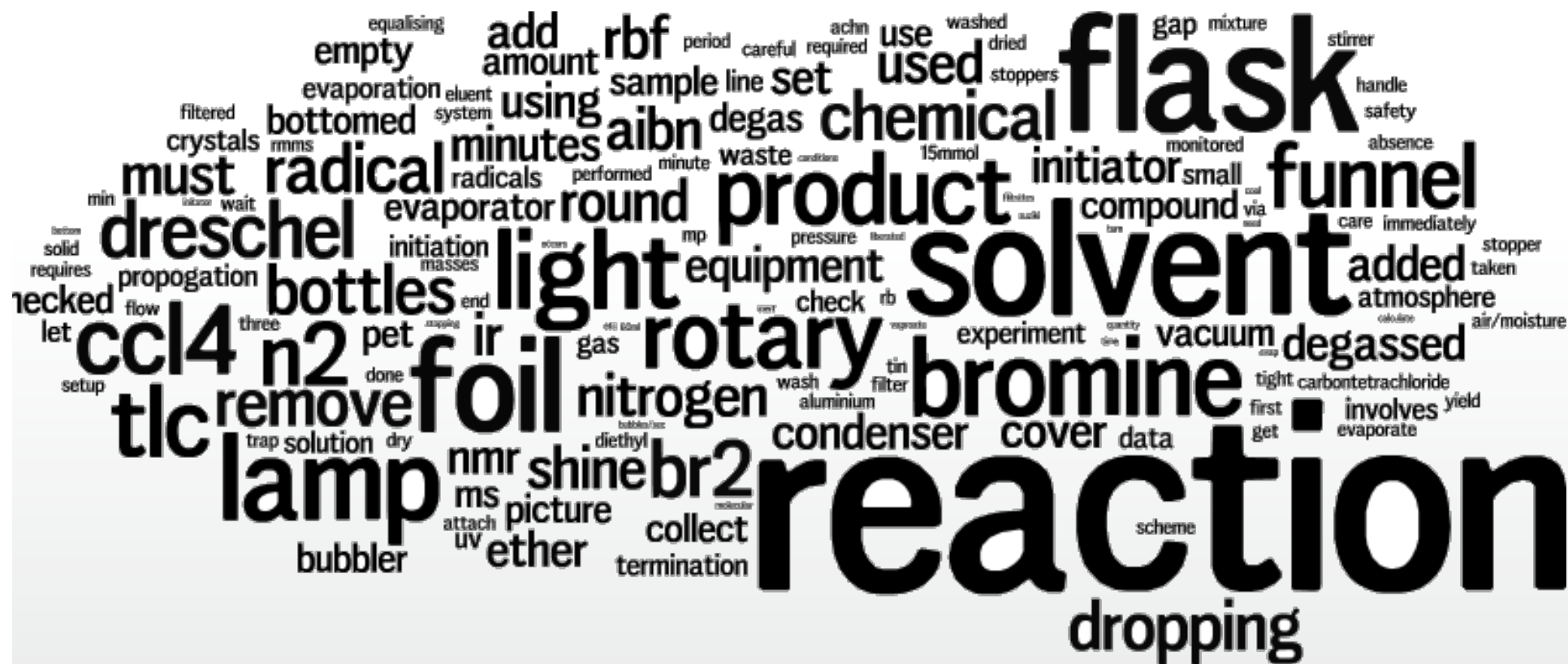


# Organoboronic



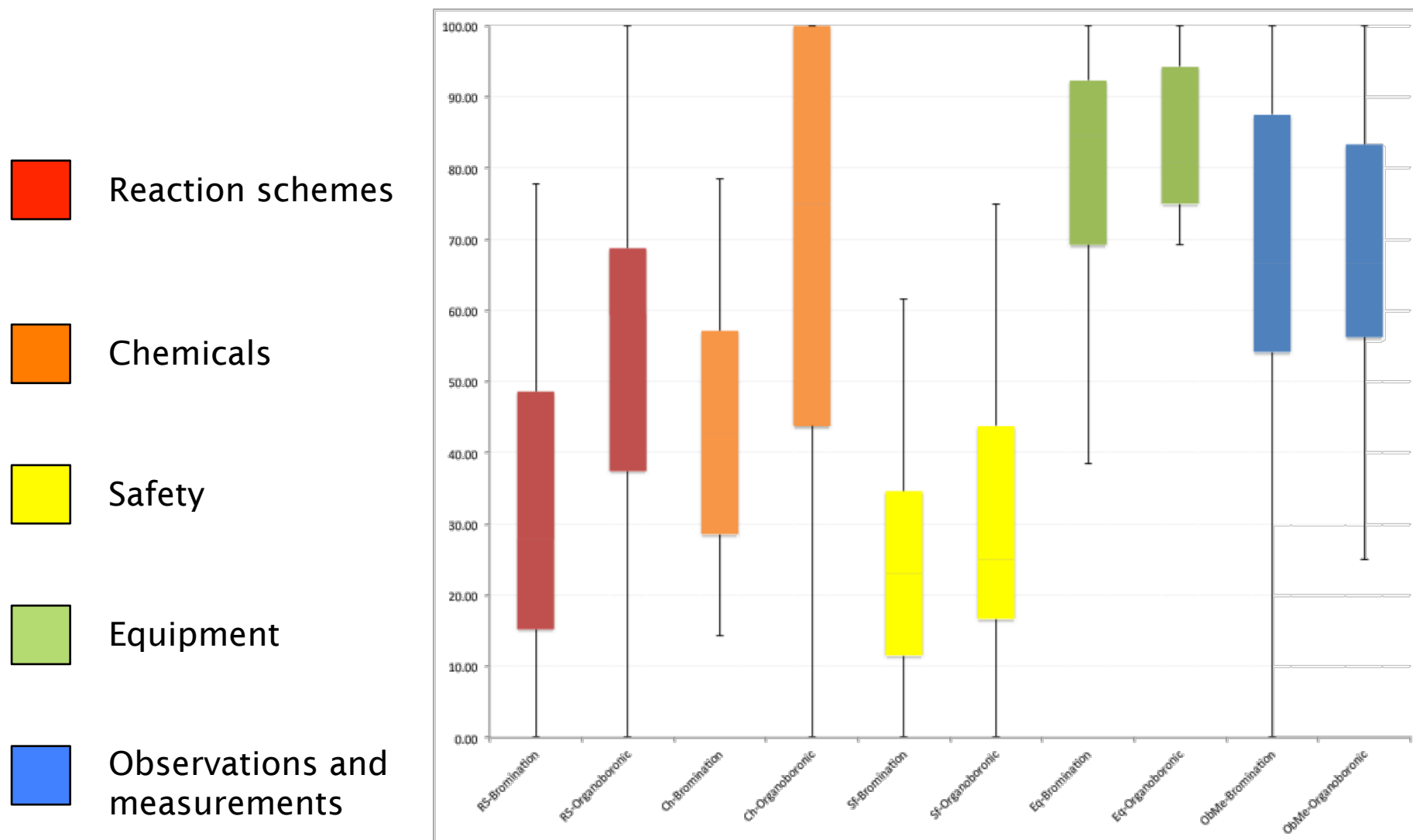
Although 35% mention hazards or safety specifically, more than 90% mention using an inert atmosphere or nitrogen bubbler, and 65% mention using heating to dry the flask.

# Bromination



35% mention safety specifically, but the use of the flask wrapped in foil and the use of light/lamp is more significant in this experiment. 50% use the term “radical”

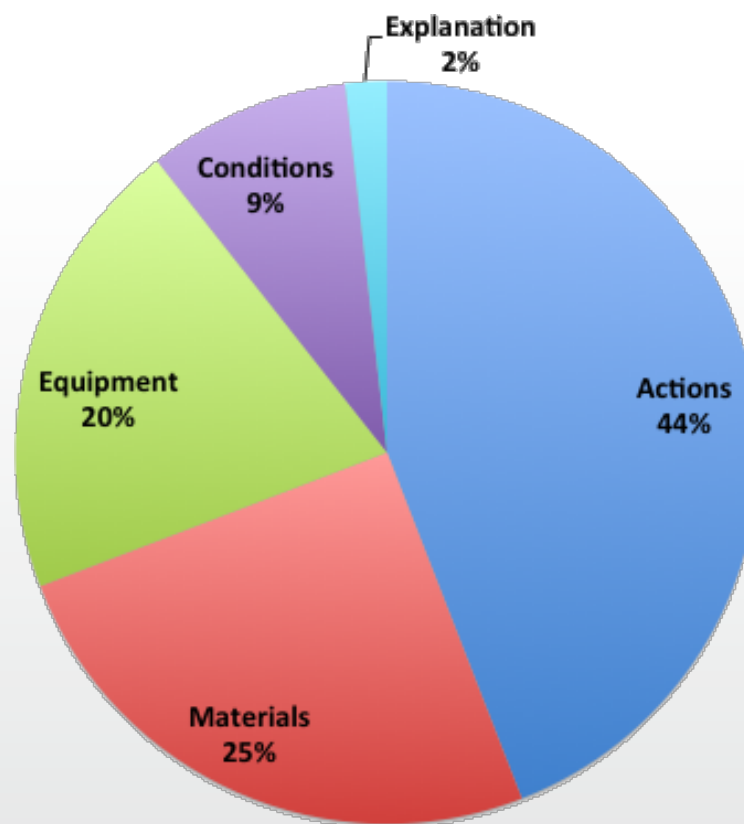
# Other pre-experiment questions



# And step-by-step experiment instructions

## High-level experiment script

- “Do safety”
- Set up equipment
- “Weigh out” reagents (calculate RMMs)
- “Do reaction”
- “Get” product
- Analyze product



# Post-experiment questionnaires

## Template condition

1. Name of experiment
2. Aim of the experiment
3. Balanced equation with relative molecular masses
4. Step-by-step experiment procedure
5. Results
6. Discussion
7. Conclusions

## No Template condition



# Study findings

## Templates (cued)

- Give us information we ask for: reaction schemes, RMMs, results, details of the analysis
- Fewer observations and explanations
- Learning and theory

## No Templates (free)

- Give more of the personal experience: observations and explanations
- Fewer reaction schemes, no RMMs, fewer results and analysis, much less learning and theory

# Unexpected findings

A change in the style of reporting

“What I  
Did”



90% used this  
style with no  
template

Do this



More than half of  
those students  
switched to this  
style when they  
used the template

# Summary

- Students tend to remember “procedure” information, especially unique aspects
- Using cues encourages students to record additional information
- But, need to make sure personal experiences are not lost
- Cues can be provided for information they might forget
- Cues can be provided to encourage discussion
- More to be done on cues and changing perspectives

# Acknowledgements

Smart Research Framework, e-Research South. Simon Liversedge, Laura Cowen, Colin Bird. Thomas Logothetis and students, University of Southampton Chemistry Synthetic Organic Chemistry Summer School.

# Metadata Study

<http://sites.google.com/site/cmetastudy/>





