Chemical Engineering Summer School 2021

Proposals for host site being accepted until 9/1/2018

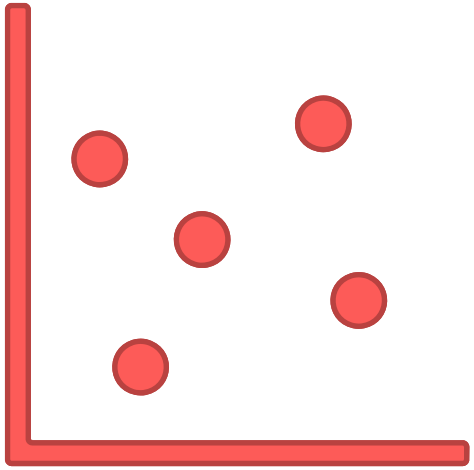
https://goo.gl/forms/kfSq1DPSXjYa5pBs1

chesummerschool.org for details on past summer schools

How we teach: Unit Operations Lab

The AIChE EdDiv Survey Committee:
Jennifer Cole, Northwestern University
Kevin Dahm, Rowan University
Laura Ford, University of Tulsa
Kevin Hadley, South Dakota School of Mines
Lucas Landherr, Northeastern University
David Silverstein, University of Kentucky
Margot Vigeant, Bucknell University

TL;DR



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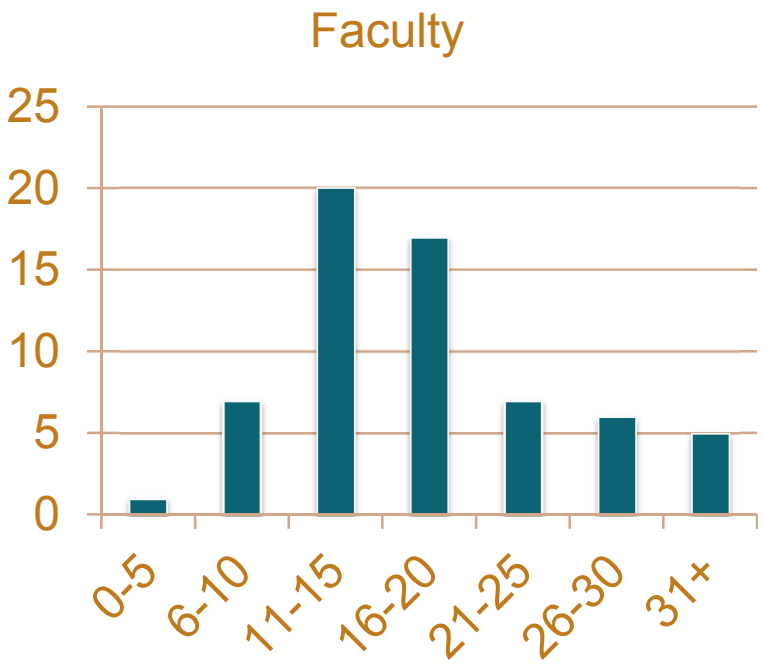
Survey Goals

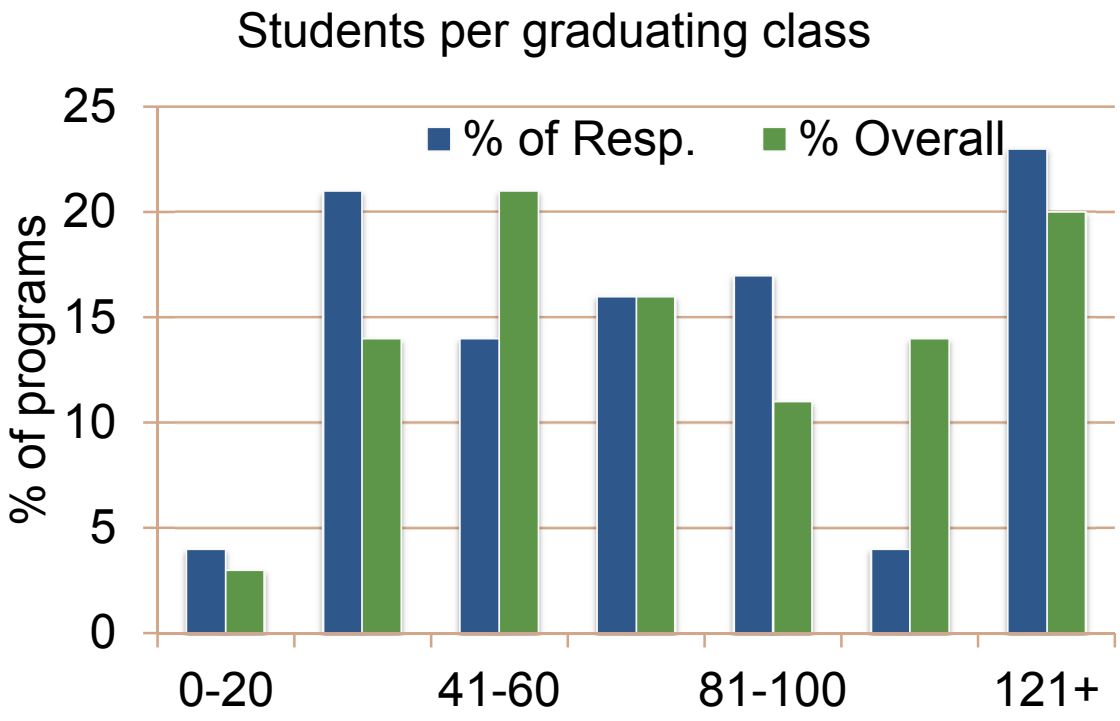
- "What is the state of the art in undergraduate teaching of X"
- Last known survey on Unit Operations Lab is Woods and Patterson, 1978

Changes from AIChE:
7 more schools
Additional questions

Who responded?

- 70 responses

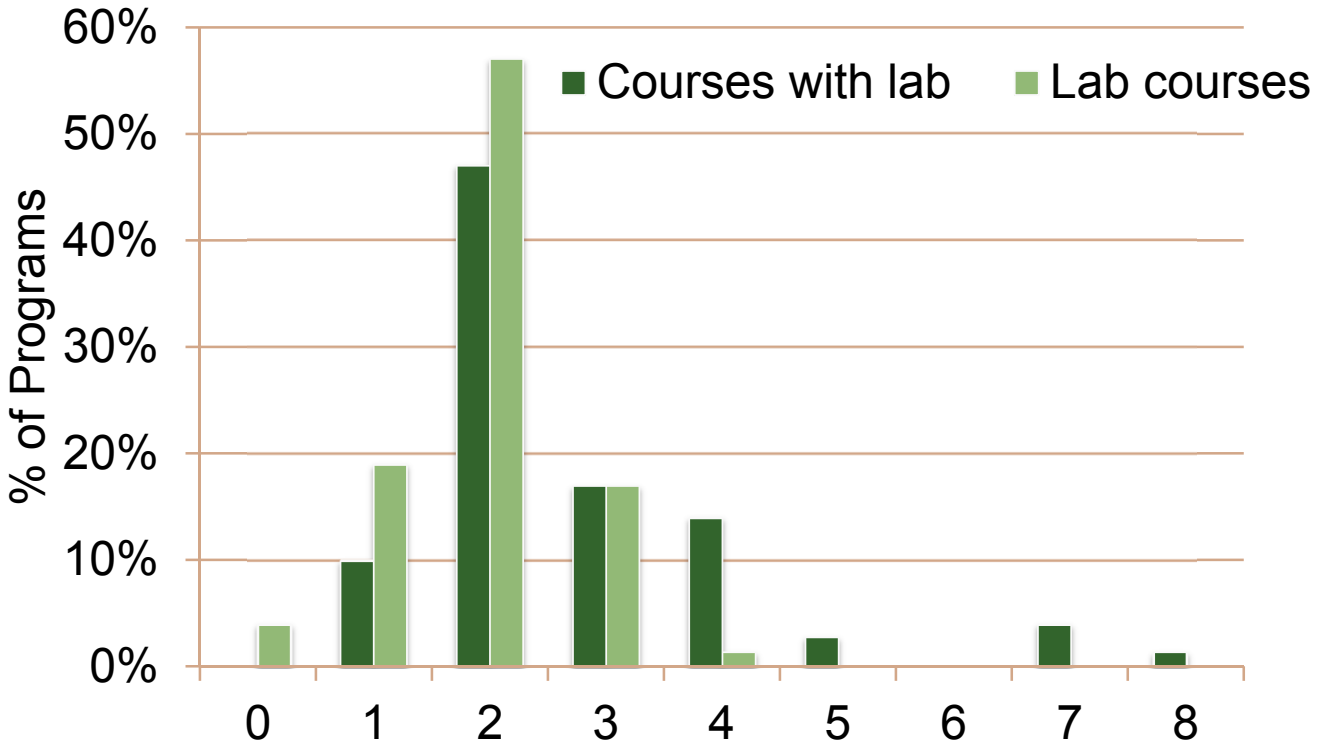




Laboratory is a setting where students are primary actors in experimentation, design, operation and/or control of equipment. Data collection is a key aspect of a laboratory experience.

Independent-lab-course is a course whose primary mode of instruction is laboratory. This should be reflected in the relative distribution of lab to lecture hours. This course may not be associated with concurrent registration in a specific lecture course. “Unit Operations” or “Junior/Senior Lab” are common examples of this type of course.

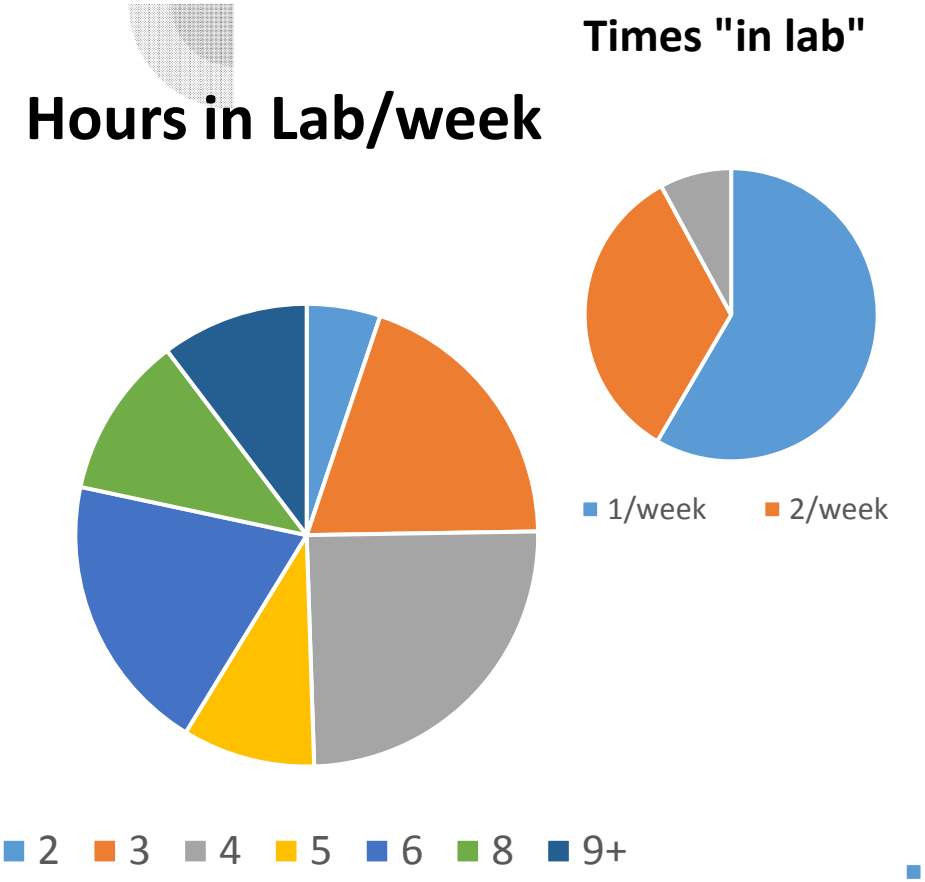
How many courses with labs? How many lab courses?

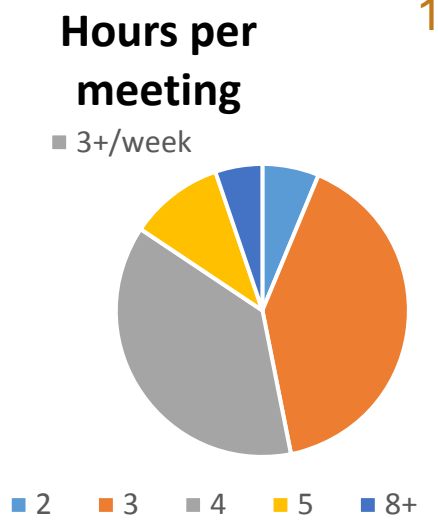


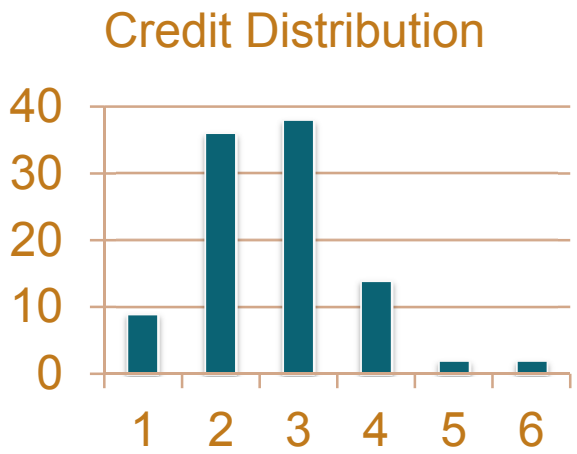
How are the courses related?

- Theory / Data analysis vs. Open-ended problem solving
- Topical focus (Heat and Mass, Fluids, etc)
- One has a research focus, one has an industry focus
- Bookending the curriculum

Credit-Meet Time-Lab Time Correlation

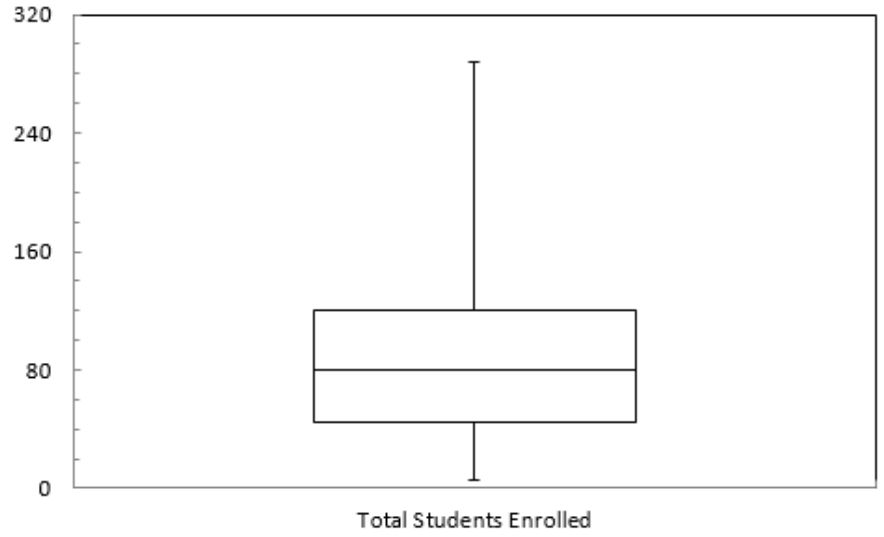


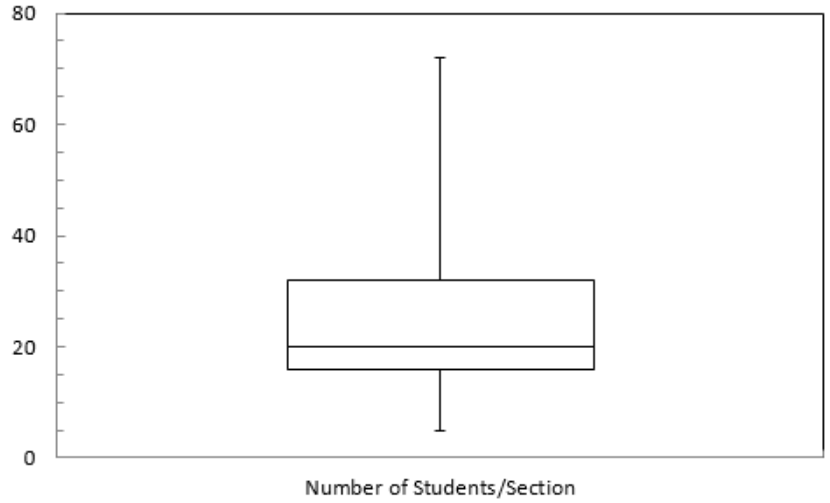




Class Size

- Two outliers of one section with 90 in one and 200+ in another
- Institutions are trying to keep class size small
- Offer multiple sections
- Median Students enrolled: 80
- Median Offered Section: 3
- Median Students/Section: 20
- Median Teams/Section: 7





Goals and Experiments

Desired Outcomes of Course (Feisel & Rosa 2005)

Outcome	Represented	Directly Assessed
Practice data analysis	100.00%	93.4%
Practice effective teamwork	98.4%	80.3%
Demonstrate laboratory ethics	98.4%	93.4%
Exercise creativity within an engineering context	88.5%	62.3%
Become familiar with appropriate instrumentation	83.6%	36.1%
Design an experiment	78.7%	62.3%
Identify the strengths and weaknesses of theoretical models as descriptors of real-world outcomes	77.1%	57.4%

More Desired Outcomes of Course

Outcome	Represented	Directly Assessed
Practice professional communication of experimental planning, processes, and results	67.2%	24.6%
Practice engineering design	54.1%	39.3%
Learn from failure	54.1%	13.1%
Develop specific psychomotor skills (ex: titration, opening valves manually, etc)	45.9%	16.4%
Identify health, safety, and environmental issues related to the laboratory experiment	45.9%	11.5%
Other	29.5%	6.6%
Develop sensory awareness of chemical processes (ex. What a cavitating pump sounds like)	14.8%	3.3%

Some “Other” Course Outcomes

- “Gain engineering intuition”
- “be able to apply concepts learned in the fluid mechanics and heat transfer courses to design, plan, and conduct experiments”
- “learn troubleshooting” (two responses)
- “make, test and justify assumptions”
- “Provide examples of global, social, and/or economic impact of the unit operations studied”
- “Demonstrate effective leadership skills”

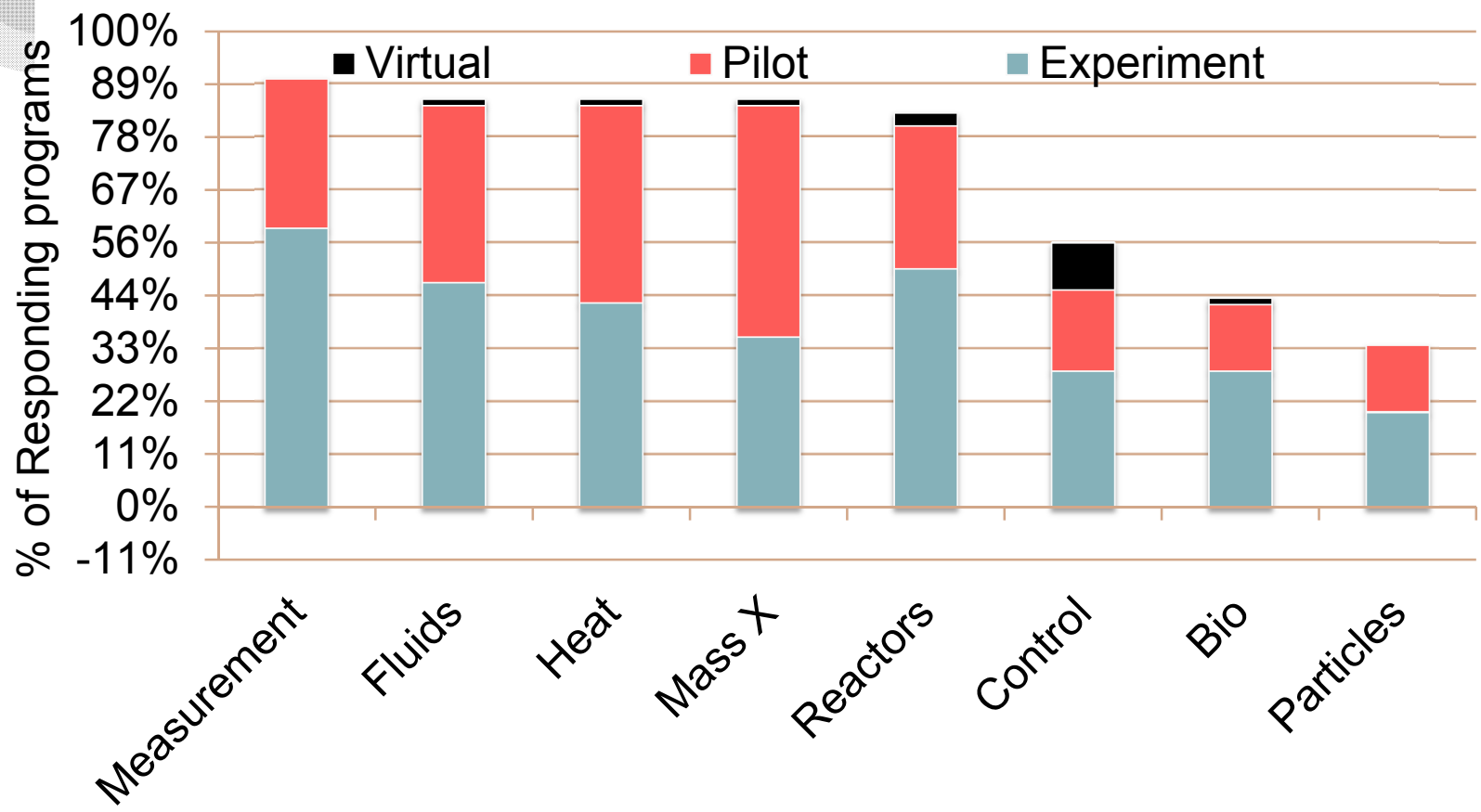
ABET Outcomes Assessed Through Course

Outcome	%Respondents
Writing/Communications	96.6%
Safety	70.7%
Ethics	41.4%
Evaluation of Information Sources	34.5%
Knowledge of Environmental/Political/Social Impacts	13.8%
Regulatory Understanding/Compliance	12.1%
Other	10.3%

Most Common “Other” Responses

- Ability to function on teams
- Ability to design and conduct experiments

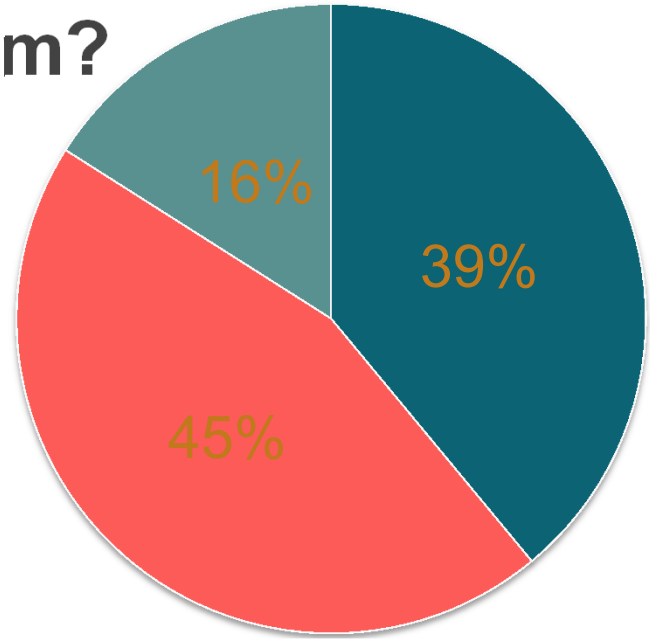
Which experiments?



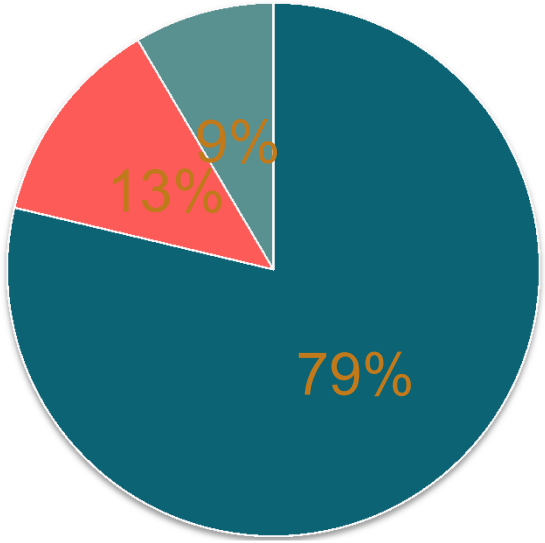
Fewer than 1/3 of schools

- Particle processing
- Manufacturing
- Other: Fuel cell, nano fabrication, membrane separation

Where's the equipment from?

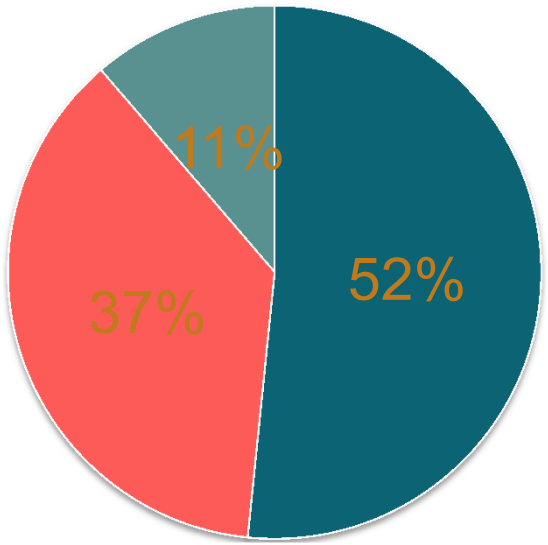


- Lab equipment supply
- Built in-house
- Donated by industry/etc



- All equipment is in-place
- Students do some construction
- Students must do substantial construction

Where are the procedures from?



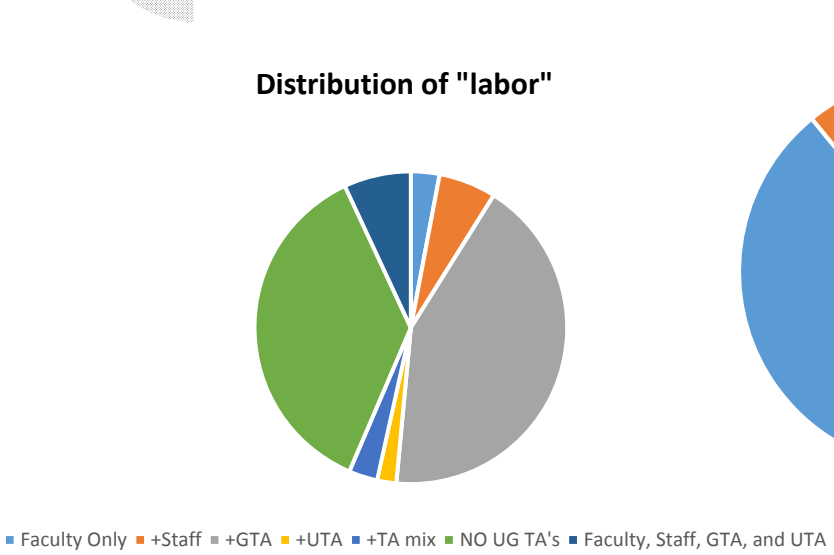
Mass Transfer Systems

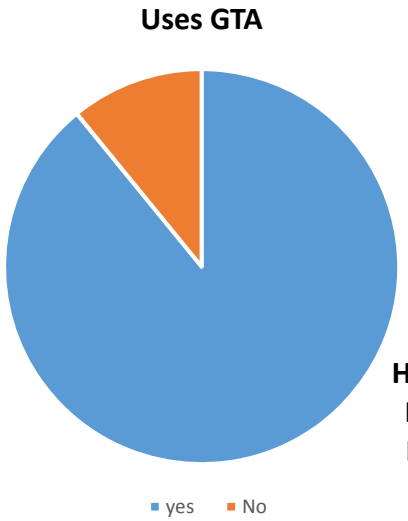
- Stripping: CO_2/water or CO_2/water-NaOH
- LLE: acetic acid from mineral oil to water; DI/MEK/Isopar M
- Distillation: ethanol/water; isopropanol/water; methanol/water; Isopropanol/butanol
- Salt dialysis
- O_2 during fermentation
- Caffeine extraction
- Desalination reverse osmosis

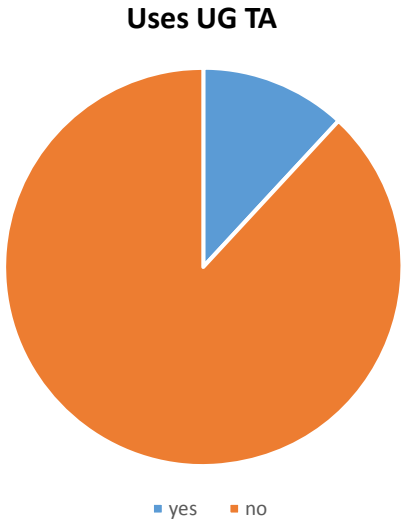
Reaction Systems

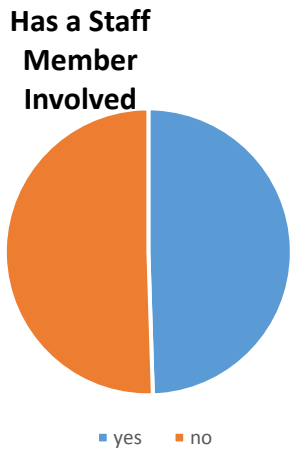
- Decolorization of crystal violet with NaOH
- Hydrolysis of acetic anhydride to acetic acid
- Yeast growth
- Tripsin (enzyme kinetics)
- Saponification
- Whey protein and bleach

Distribution of “labor”





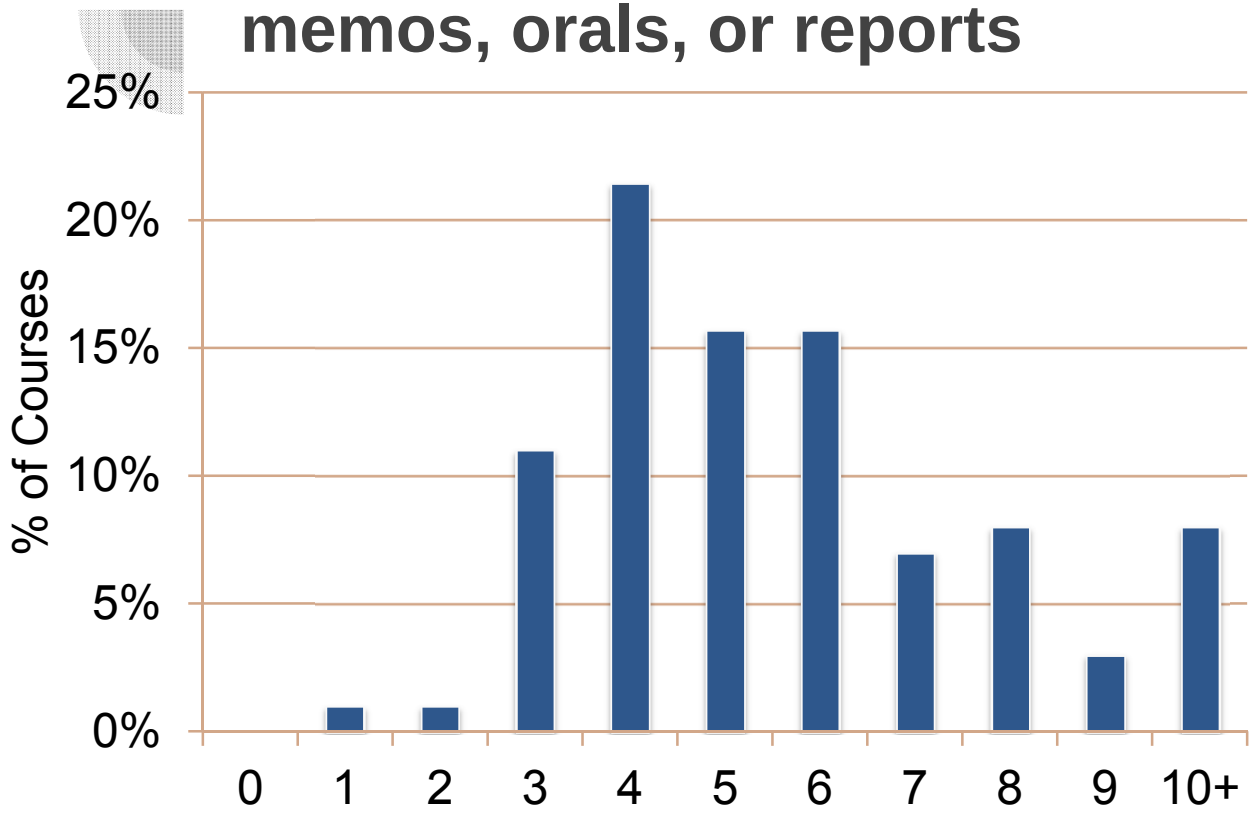




100% said faculty teach the sections

Communication & Teamwork

Most courses produce 4 to 6 summative memos, orals, or reports



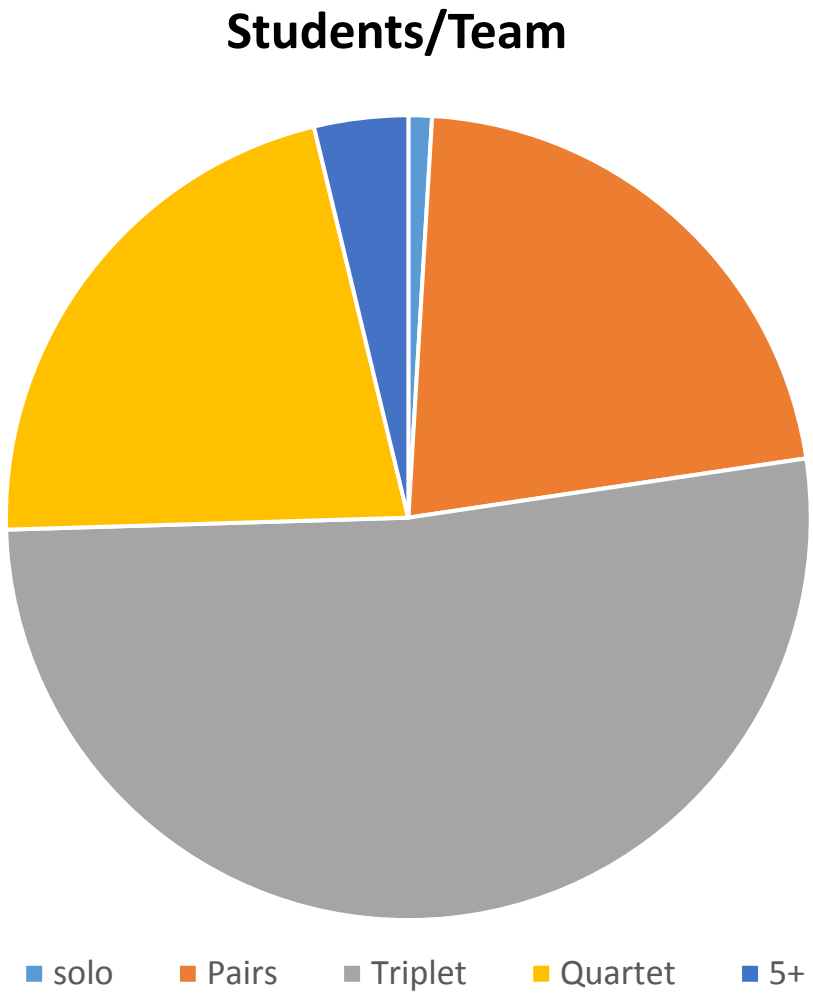
Average: 4

Median: 5

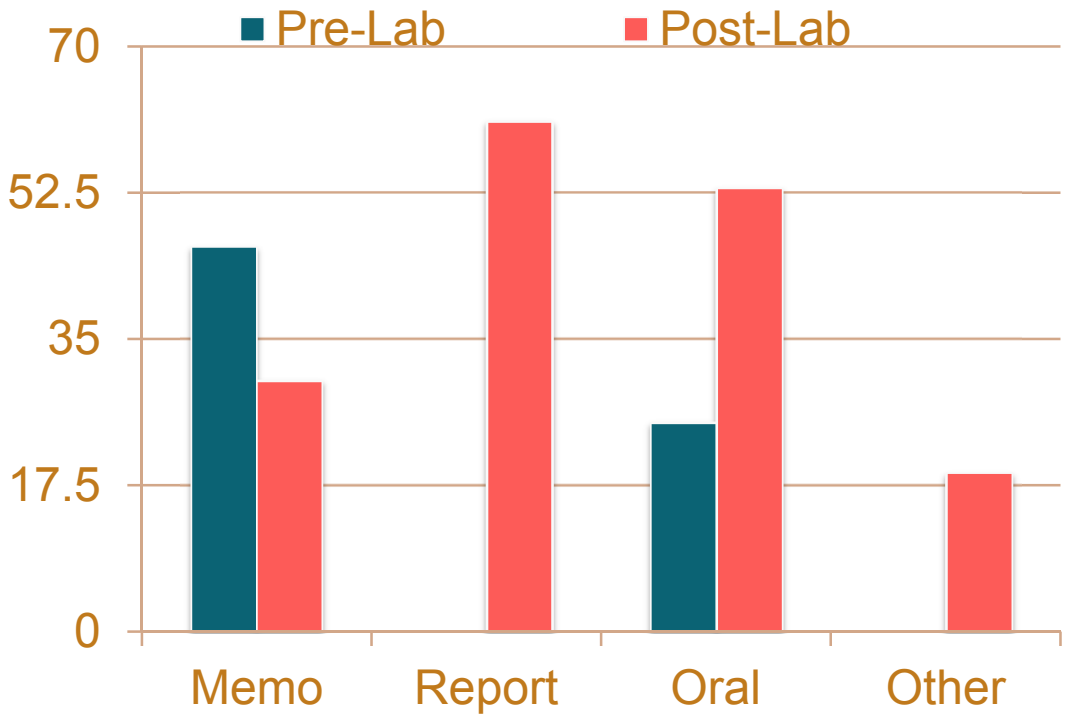
66 responses

Team size

Majority three students, but others common too



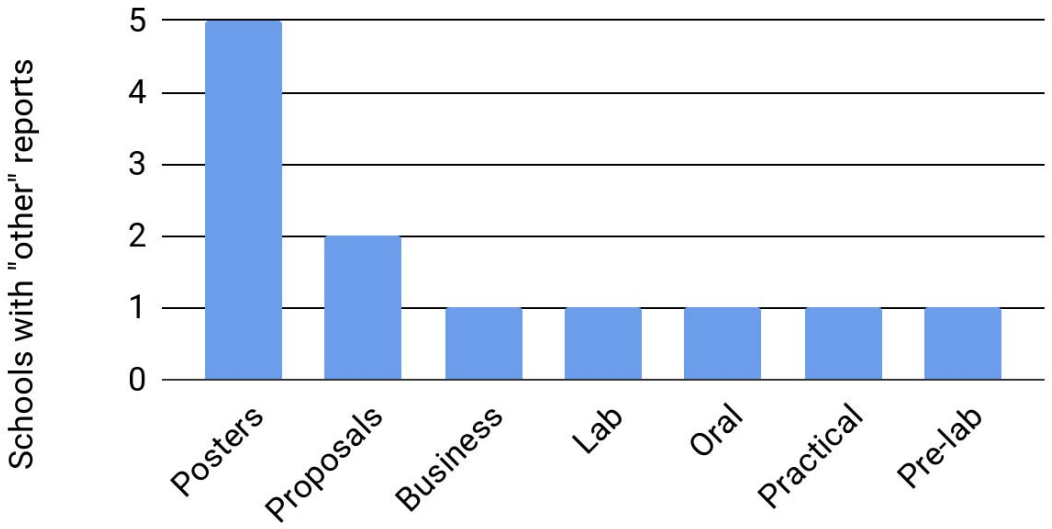
Communication is required both before and after labs



Memo = Business, ~5 pg or less
Report = Paper, >5 pg
Pre-lab
memos > orals
Post-lab
reports ≈ orals > memos

68 responses

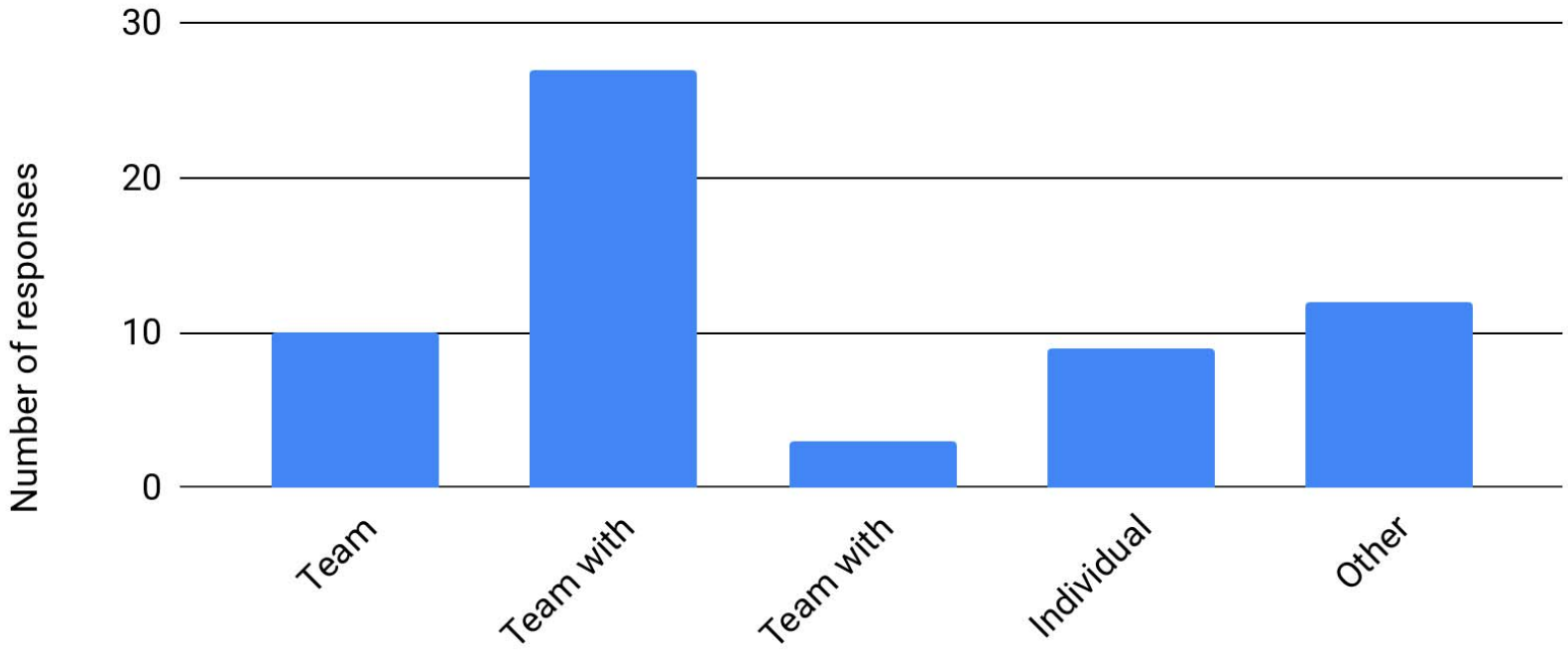
OLD Proposals and posters were the most popular “other” communication



5 Posters
2 Proposals
1 each:

Business proposal
Lab notebook
Oral progress report
Practical final exam
Pre-lab discussion

Team reports with team participation adjustments are most frequent



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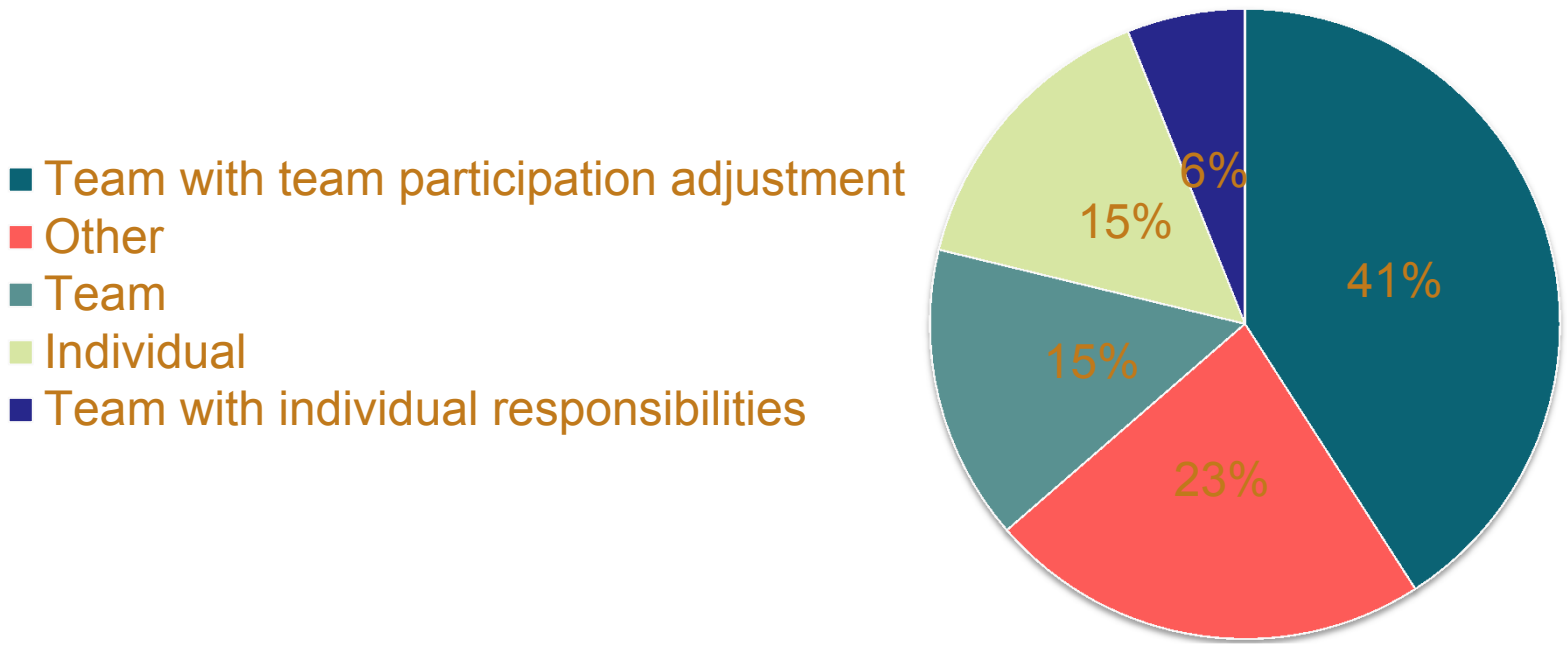
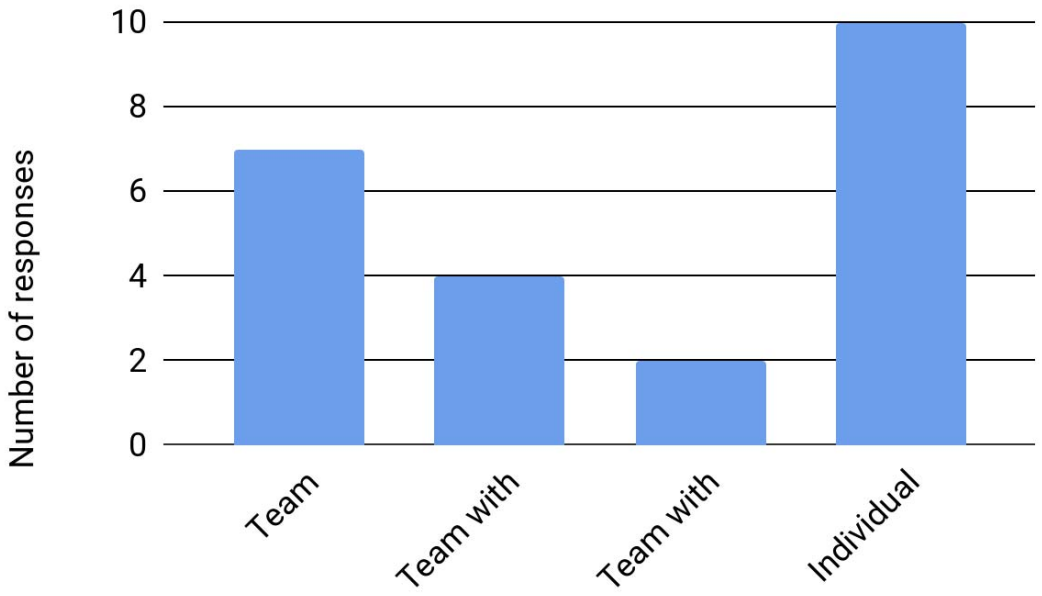


Ten “other” report responsibilities were some team *and* some individual

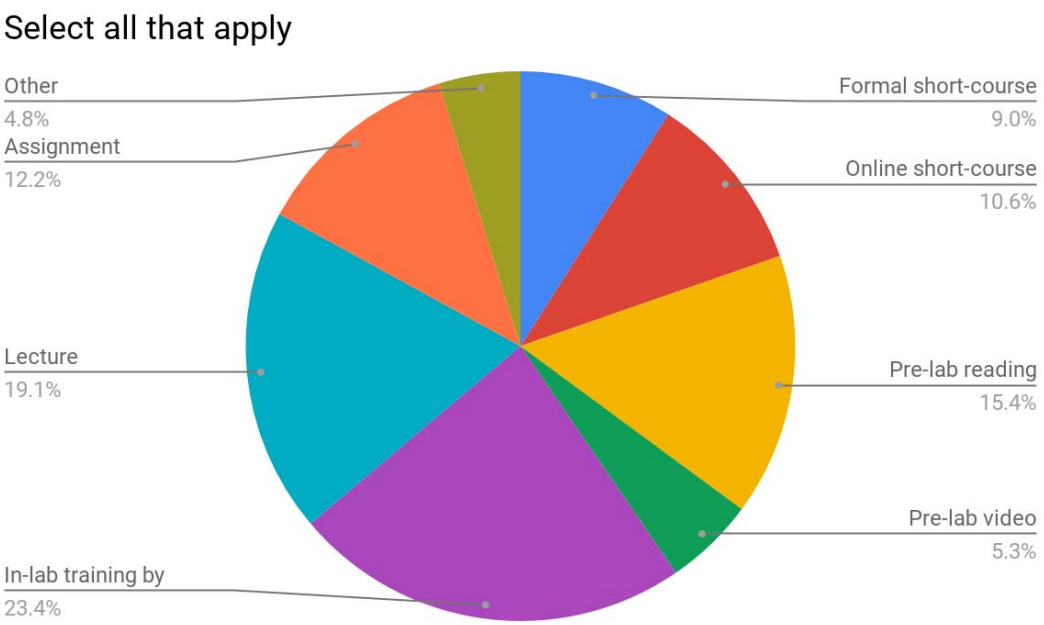


Also:
1 Team report with section leader adjustment

1 Each report partly team, partly individual

Safety

How we teach safety in Unit Ops



Formal short-course includes in-person instruction by EHS Office or equivalent

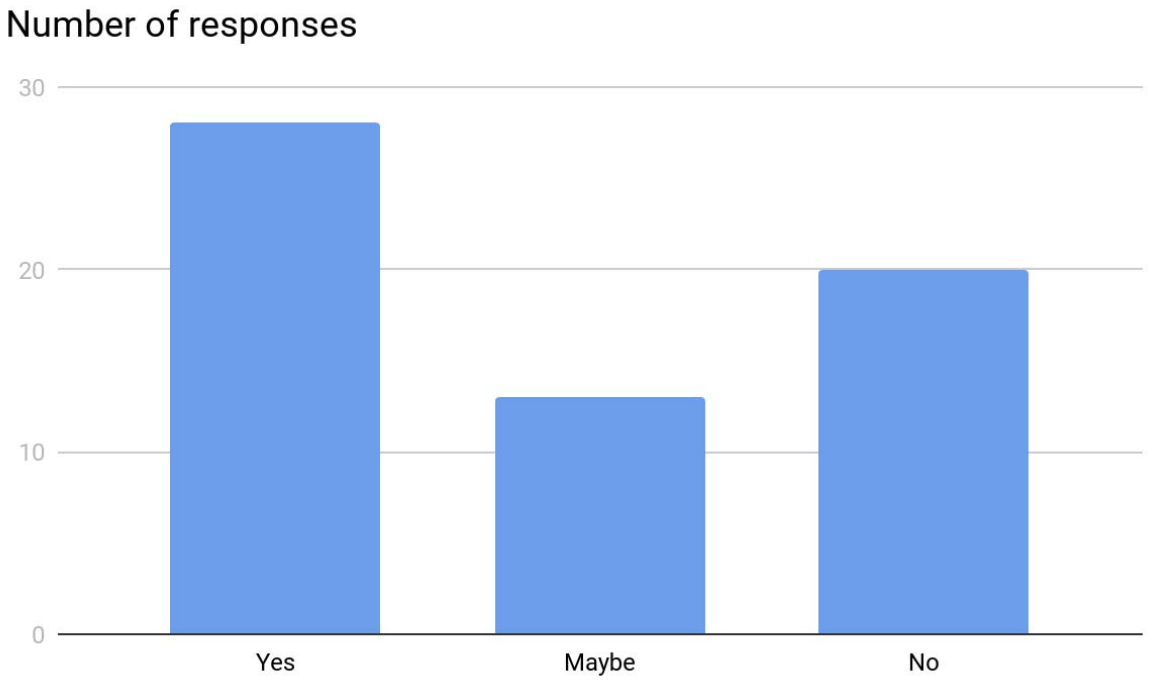
Online short-course includes web-based training provided by EHS Office or equivalent

Other includes SAChE Modules and workshops outside lab hours

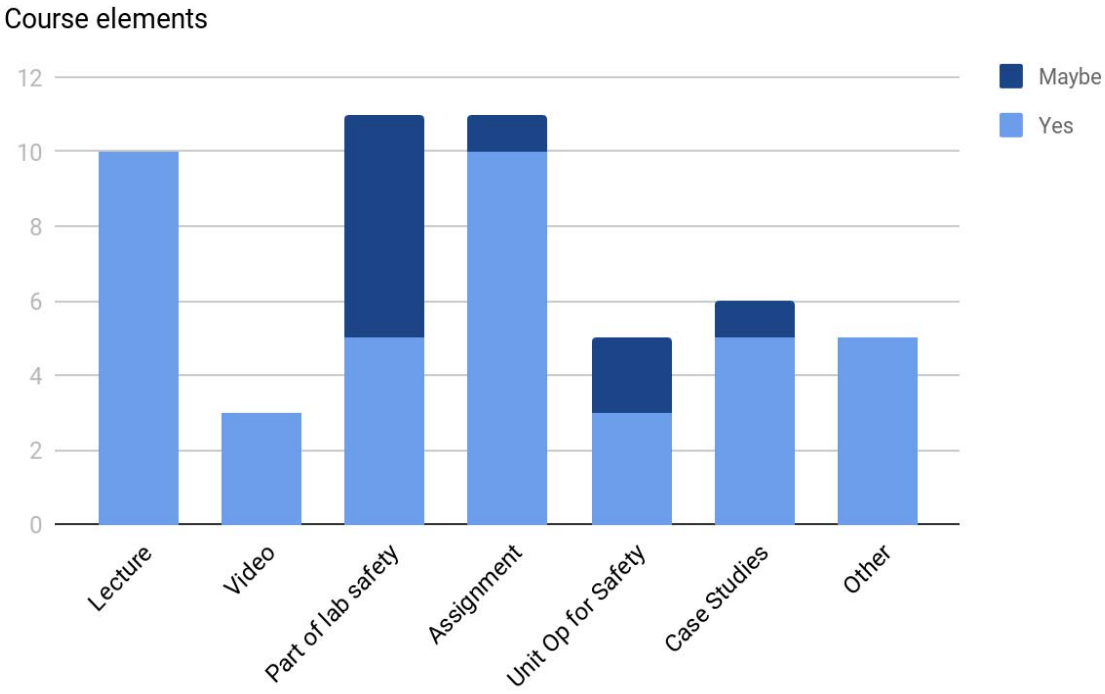
Commonly combined: Pre-lab assignments, in-lab training, and lecture

Is Process Safety included in laboratory safety training?

●Maybe = depends on instructor / we're working on it



Yes, we include process safety through



Unit Op: lab has a dedicated process safety component to it, or may have been modified to focus on a process safety aspect (pressure relief, controls, MOC)

Case Studies may include the use of CSB videos or other coverage of industrial incidents

Other includes any discussion or training around process safety topics (pressure relief, controls, MOC, SOP)

Profuse thanks and acknowledgements to all participating chairs / faculty!

- And the awesome volunteers who make the survey and its analysis happen!