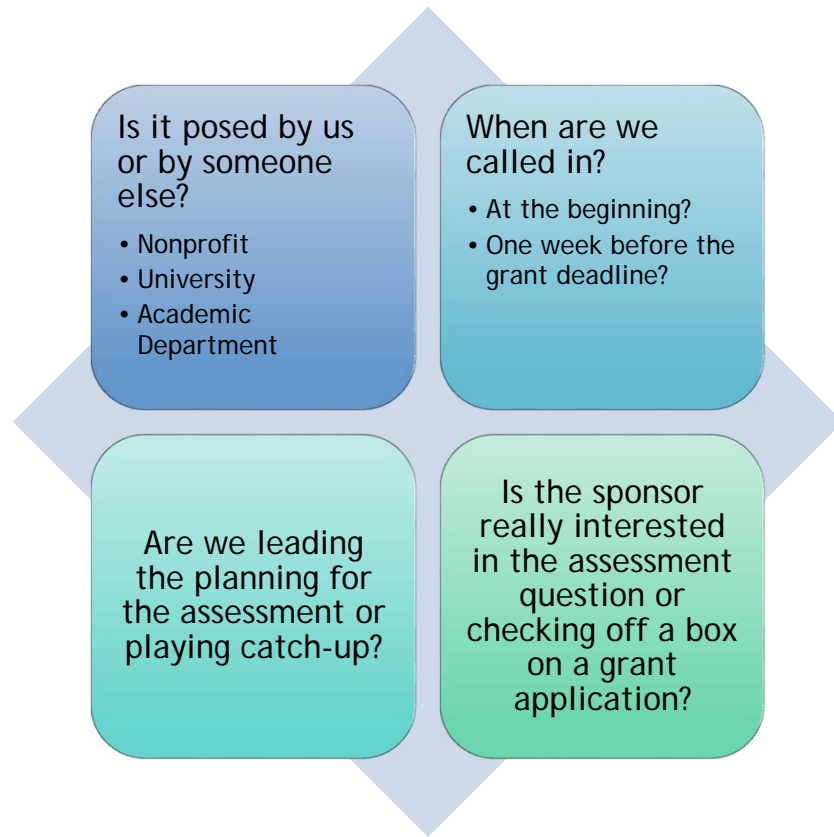


How Do You Plan a Assessment When the Questions Are Vague?

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Some General Questions about the Assessment Structure?



What general types of data can we collect?

- ▶ Quantitative (Numbers)
 - ▶ Counting
 - ▶ Use of a resource, tool, etc.
 - ▶ Demographic
 - ▶ Age, ethnic origin, gender, year in school, grades in current and previous courses
 - ▶ Achievement
 - ▶ Grades on test/quiz of interest
 - ▶ Opinion
 - ▶ Survey
 - ▶ Eye tracking
 - ▶ Areas of Interest
 - ▶ Time on task
 - ▶ Pathways
 - ▶ Corneal reflection measurements



- ▶ Qualitative (Rubrics and Coding)

- ▶ Opinion

- ▶ Survey

- ▶ Interviews

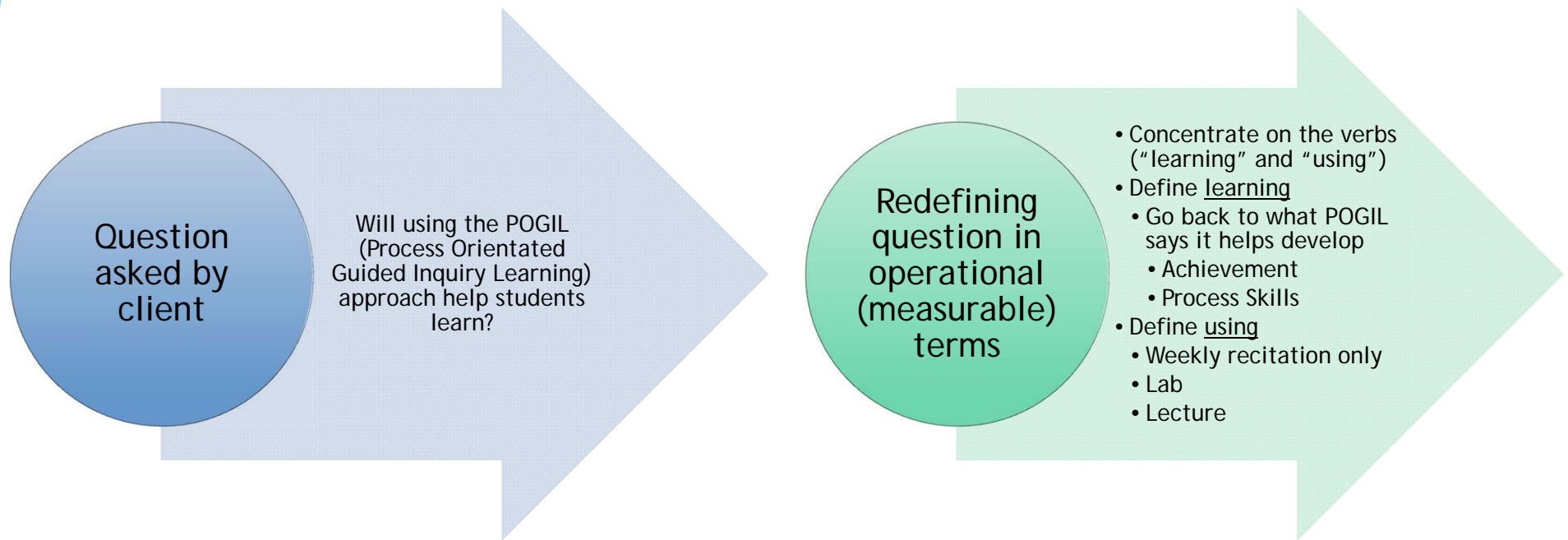
- ▶ Observations

- ▶ In classroom

Sometimes.... We are on the Outside of the project looking in

- ▶ Control of the Assessment
 - ▶ How much control of the assessment are we being given?
 - ▶ How much are we proposing?
- ▶ Our Action in the Assessment Project
 - ▶ Dig deeper into what the question could be
 - ▶ Sometimes, the client doesn't have a clear idea of what answers the assessment could provide
 - ▶ Are we keeping the client's question at the forefront
 - ▶ Including the client in what the assessment could provide?
 - ▶ What instruments will we use?
 - ▶ Just because we have an instrument, doesn't mean we should use it
 - ▶ Match each instrument to the data collected and the data to the original question

What should the Assessment Question be? (Example from POGIL assessment)



Rewrite of question with measurable parameters

Will using the POGIL (Process Orientated Guided Inquiry Learning) approach in either lecture or recitation, increase the Achievement and Process skills of students?

- ▶ First year
 - ▶ Survey when teachers used POGIL and what questions they asked on tests
 - ▶ Refine research question
 - ▶ Most used POGIL in recitation only
 - ▶ Some used it in both lecture and recitation
 - ▶ Some used it in lab only
 - ▶ Asked teachers to share questions used on tests and quizzes

Creating Instruments and ways of analyzing

▶ Instruments

- ▶ Use of problems that emphasized
 - ▶ Achievement
 - ▶ Process Skills
- ▶ What questions?
 - ▶ Questions submitted by teachers across a variety of institutions
 - ▶ Covered the 12 chemistry topics identified by College Board as essential for AP exams
 - ▶ Reviewed by DBER researchers
 - ▶ Multi part questions
 - ▶ Some parts were identified as testing achievement
 - ▶ Other parts identified as testing process skills
 - ▶ Selection of best questions with some rewriting involved to include both
 - ▶ Achievement
 - ▶ Process skills
 - ▶ Rewritten questions sent to teachers for review and comment
 - ▶ Tested with teachers' students
 - ▶ Results analyzed for validity and reliability

Sample

Institutions

- ▶ 11 institutions total
 - ▶ 8 four-year graduate universities (masters or PhD)
 - ▶ 2 four-year colleges (undergraduate only)
 - ▶ 1 two-year community college

Instructors

- ▶ 21 instructors total
 - ▶ Attempt to have both POGIL and Non-POGIL teacher at same institution
 - ▶ 10 POGIL instructors
 - ▶ 11 NonPOGIL instructors

Class size

- ▶ 15 small classes (less \leq 50)
- ▶ 6 large classes (greater \geq 50)

Students

- ▶ 2809 POGIL students
- ▶ 2102 NonPOGIL students

Results

Overall Scores*

- ▶ POGIL > NonPOGIL students (55% of the time)
- ▶ NonPOGIL > POGIL students (27%)
- ▶ POGIL = NonPOGIL students (18%)

Breakdown

- ▶ Achievement Skills Sub scores
 - ▶ POGIL > NonPOGIL students (45.3%)
 - ▶ NonPOGIL > POGIL students (27.3%)
 - ▶ POGIL = NonPOGIL students (27.3%)

Process Skills Sub scores

- ▶ POGIL students > NonPOGIL (45.3%)
- ▶ NonPOGIL > POGIL students (9.3%)
- ▶ POGIL = NonPOGIL students (45.3%)

*Results using "clean data" (11 out of twelve topics using the "best" question: NO ASSUMPTION VIOLATIONS, EQUIVALENCE VIOLATIONS (galt), ALL QUESTIONS HAVE ACHIEVEMENT AND PROCESS

Conclusions


- ▶ Overall, POGIL may have a small advantage over NonPOGIL
 - ▶ POGIL no statistically significant advantage on Achievement
 - ▶ POGIL has statistically significant advantage on Process Skills in some questions

Original question

Will using the POGIL (Process Orientated Guided Inquiry Learning) approach help students learn?

What we did

- ▶ Made question operational
- ▶ Results were fine grained enough to provide a validated and supported answer
- ▶ Had a “free hand” in how to investigate the question because
 - ▶ The client didn’t go beyond the original question
- ▶ Developed validated “instruments” that
 - ▶ Were specific to this assessment
 - ▶ Described process so it could be duplicated by other groups

- 
- ▶ What we didn't do
 - ▶ Compare scores of both groups on standardized ACS final exam
 - ▶ Not specific enough
 - ▶ Did not interview students
 - ▶ Sample would have had to be much smaller
 - ▶ Would not be able to investigate effect of POGIL across institutions in terms of size and level, POGIL vs NonPOGIL classes, across 12 topics of a full year of chemistry,
 - ▶ Would not have had contributions of as many teachers in the field

What should the Assessment Question be?

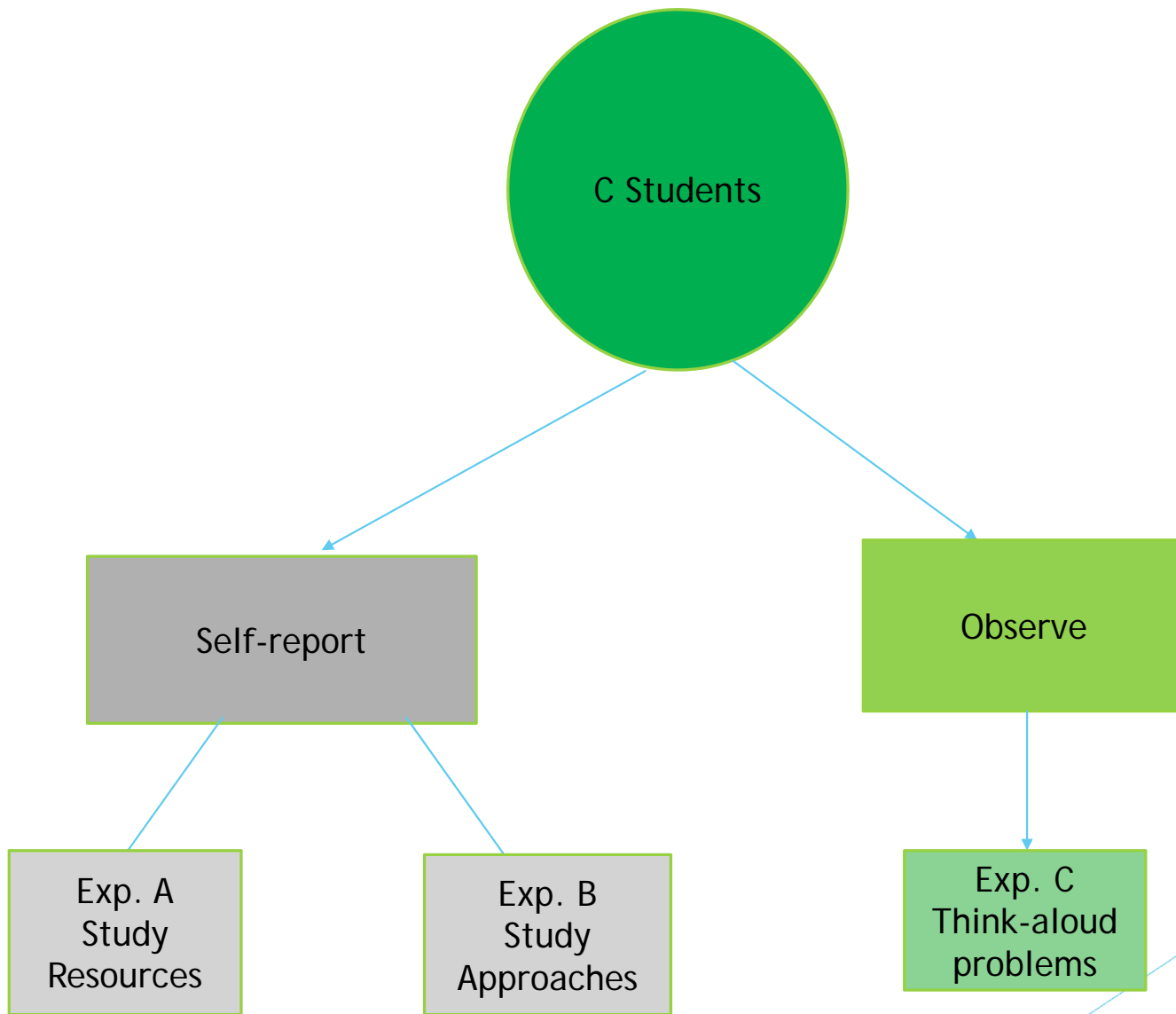
(Example from What makes a C student, a C student?)

USNA Assessment Question

What makes a C student, a C student?

- ▶ Why look into C students?
 - ▶ Input from Audience
 - ▶ The top students can learn on their own, they don't need us
 - ▶ The bottom students may not be ready academically or maturity-wise the first time through
 - ▶ The average or C student is the largest group and perhaps the group where the effectiveness of our teaching can reap the largest results

- ▶ What has to be defined?
 - ▶ C student
 - ▶ Determined after the fact using scores on 4 tests given during the semester
 - ▶ Two were common exams (written by faculty and administered to all students regardless of instructor)
 - ▶ Two were teacher-written exams administered to only specific instructors' classes
 - ▶ Verb "makes"
 - ▶ Based on what they do and how they do it
 - ▶ Self-reported
 - ▶ Choice of available study resources
 - ▶ Student self-description of how they learn
 - ▶ Observed behavior
 - ▶ Solving problems aloud



USNA Experiment A: Results on Resources chosen by students of three Achievement levels (A/B, C, D/F)

Population

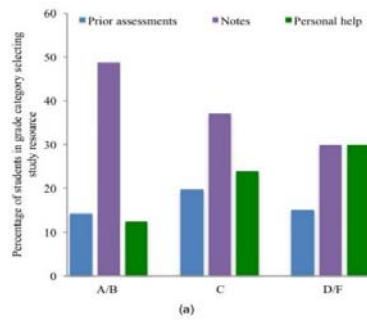
- ▶ 1015 freshman enrolled in General Chemistry (Fall 2013)
- ▶ 28 different instructors
 - ▶ Teach 2-3 sections of lecture and lab
 - ▶ 20 students per section
 - ▶ No teaching assistants
- ▶ Course design
 - ▶ One syllabus
 - ▶ One textbook
 - ▶ Common multiple choice exams administered
 - ▶ 6-weeks, 12-weeks, final exam

Experiment A : What resources do students with little time to study *choose*?

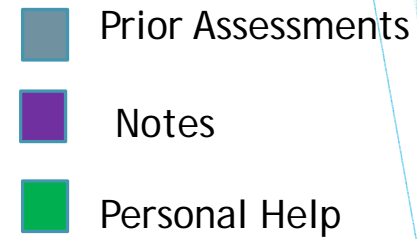
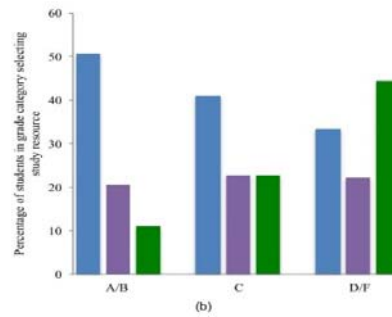
- ▶ Survey administered 4 times during semester
 - ▶ **Responses analyzed** according to achievement level in general chemistry (at end of the year)
 - ▶ A/B
 - ▶ C
 - ▶ D/F
 - ▶ **Self-reported use of study resources used to prepare for**
 - ▶ **Instructor exam**
 - ▶ Open ended and/or multiple choice questions
 - ▶ **Common Exams** administered by the Chemistry Department
 - ▶ Multiple Choice Questions only
 - ▶ **Three most commonly reported study resources**
 - ▶ Prior Common Exams (posted by the Chemistry Department on their website)
 - ▶ Notes --Student personal notes or Teacher notes posted on web/handouts
 - ▶ Personal help--peers, upper classmen, teacher or college-provided tutors

Choice of Main Study Method by Achievement

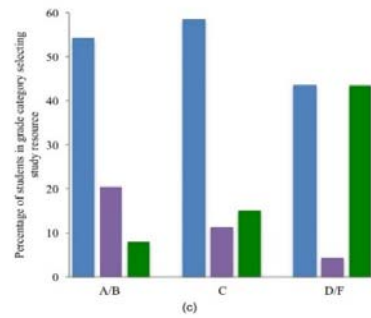
First instructor assessment



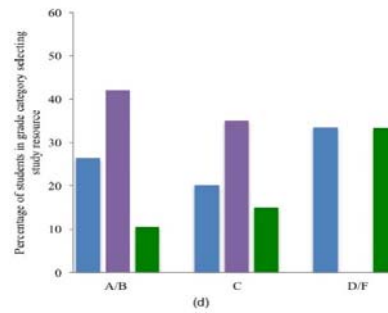
Six-week common exam



Twelve-week common exam



Last instructor assessment



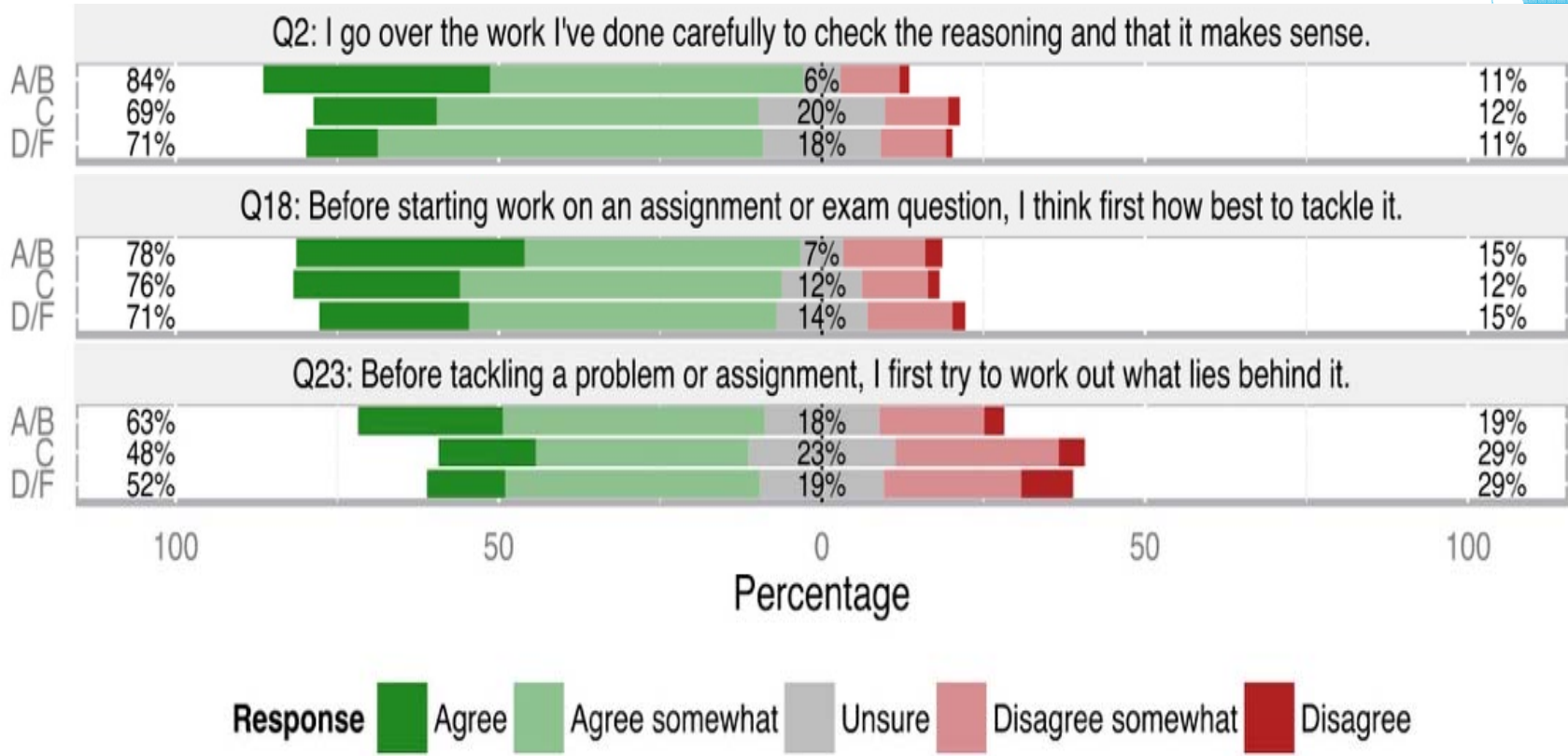
USNA Experiment B: *How Do Students Self-Report their Study Approach?*

- ▶ Theory of Study Approaches
 - ▶ Deep
 - ▶ Learners are **intrinsically** motivated and attempt to understand the underlying meaning of a problem
 - ▶ Generate connections between new ideas and what is already understood
 - ▶ Surface
 - ▶ Learners are **extrinsically** motivated and concerned with use of memorized facts and previously seen algorithms
 - ▶ Match attributes of new problem to those previously seen without analyzing the unique characteristics of problem

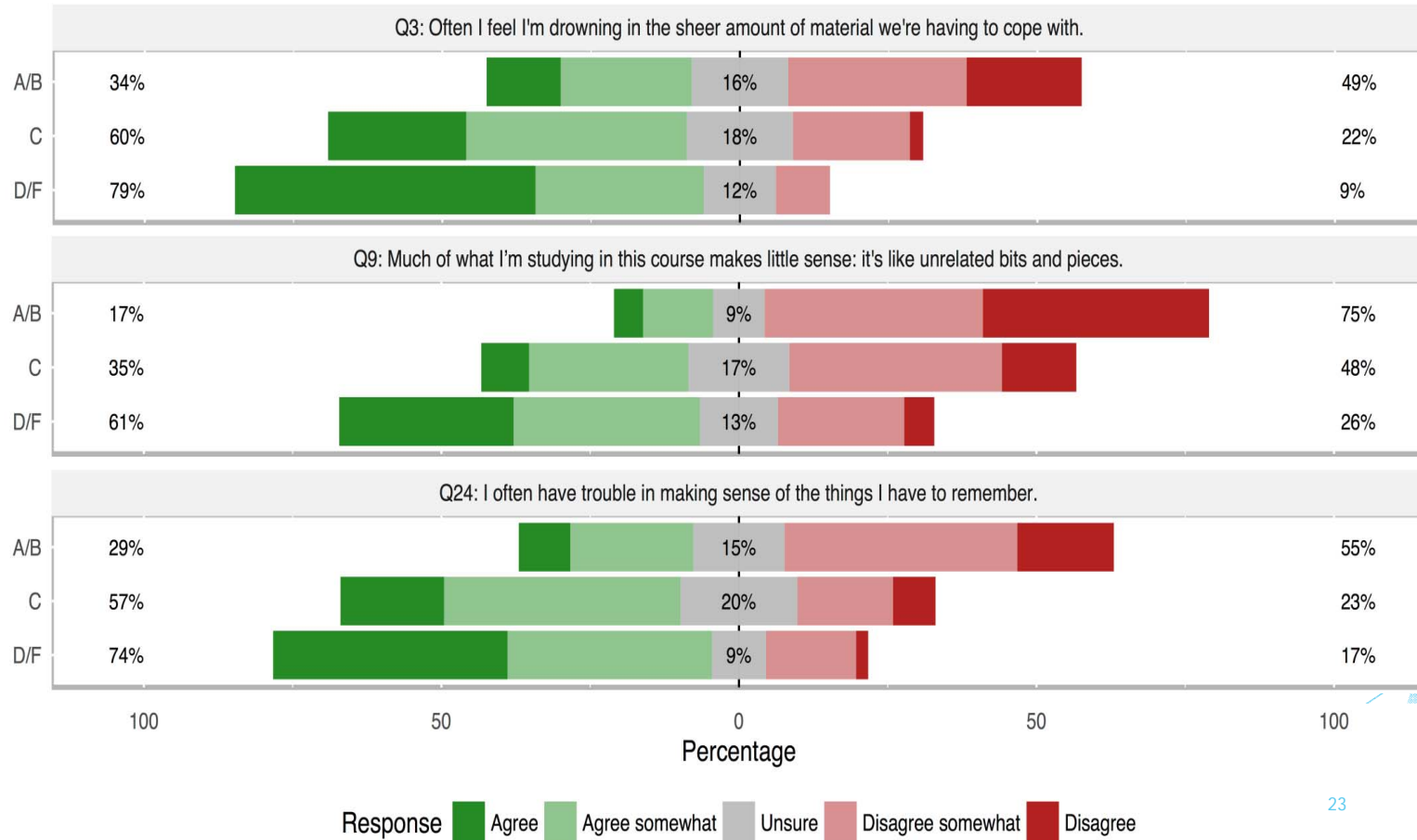
Methodology

- ▶ Survey
 - ▶ Modified Approaches and Study Skills Inventory for Students (M-ASSIST) survey
 - ▶ 12 items (6 Deep and 6 Surface) shown to be statistically important in determining students' approach to studying

Selected Deep Approach Items

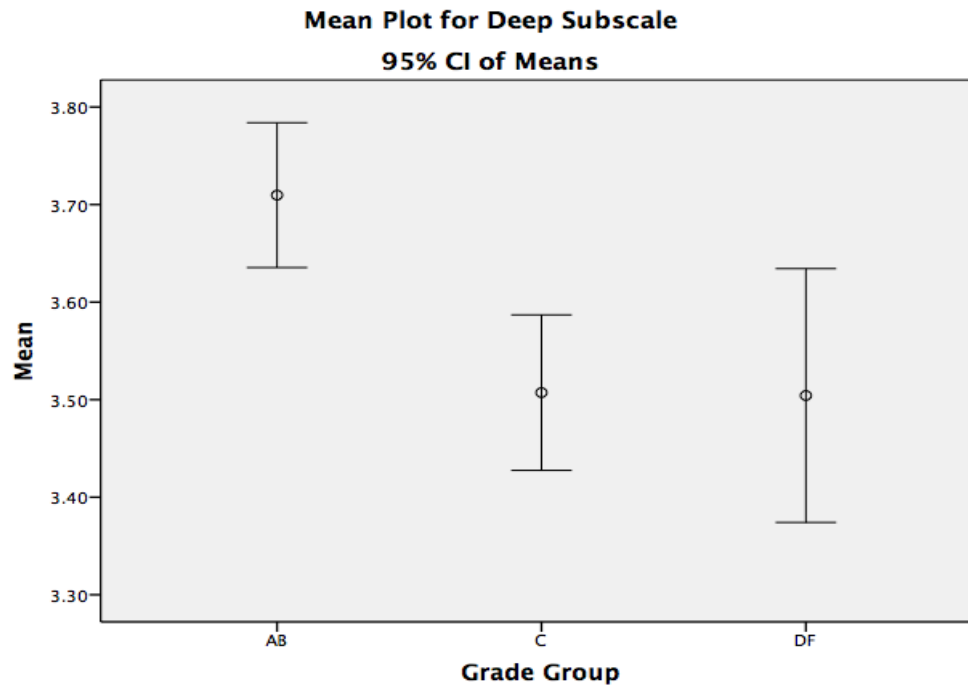


Selected Surface Approach Items



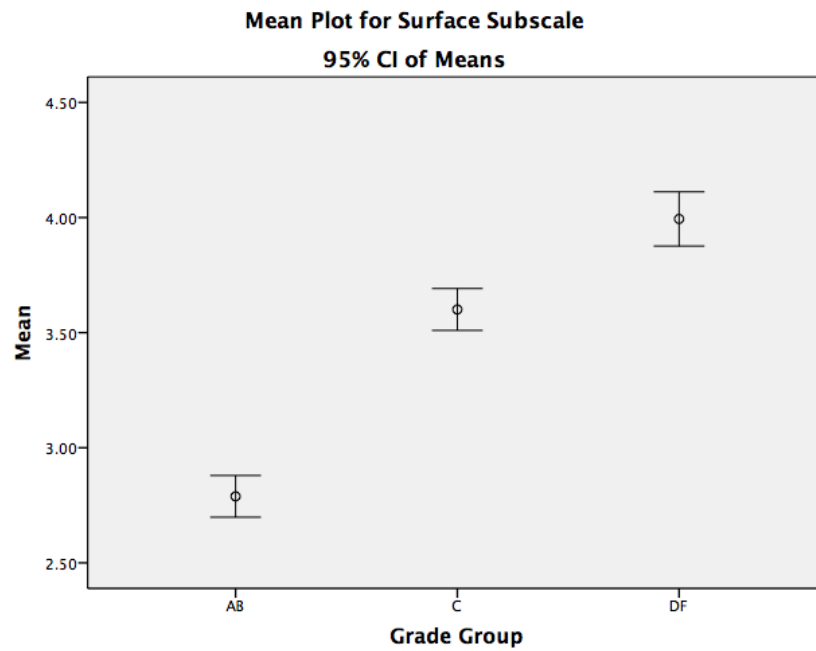
Analysis

Differences in response to Deep Approach Questions by achievement levels



Analysis

Differences in response to Surface Approach Questions by achievement levels



Current Project

USNA Project C: What deep vs. surface behaviors do students demonstrate when solving problems aloud?

Overarching question

- ▶ What makes a C student, a C student?

Sub-question

- ▶ What do we observe students of differing achievement groups doing when they solve problems aloud?

Project Parameters

Students

- ▶ 72 students interviewed within 5 days of completing a Common Chemistry Exam
 - ▶ Students taught by 21 different instructors
 - ▶ Representing all three achievement levels

Methodology

- ▶ 20 minute interviews
- ▶ Solve-aloud 4 problems from 12-Week Common Exam completed within the previous 5 days
 - ▶ Answer key was not released
- ▶ Problems
 - ▶ Two traditional problems
 - ▶ requiring mathematical determination of answer
 - ▶ Two conceptual problems
 - ▶ logic, no math

What sub-questions can we ask of this data to help address the overarching question?



What questions are we asking of this data?

- ▶ What approaches are evident in the 72 interviewees' think-aloud problem solving for
 - ▶ Traditional problems?
 - ▶ Conceptual problems?
- ▶ Will Average (C) students show a differential pattern of Deep and Surface approaches from
 - ▶ A/B students?
 - ▶ D/F students?
- ▶ Will students **change** between a predominately Deep to a Surface approach and vice a versa **depending on** whether the **problem** is
 - ▶ Traditional?
 - ▶ Conceptual?

Conclusion

Asking questions for an effective assessment

Effective Assessments depend on

- ▶ Question asked
 - ▶ Affected by
 - ▶ What client wants to investigate
 - ▶ Making question operational
 - ▶ Transforming verbs to parameters that can be measured
- ▶ Tools chosen
 - ▶ Data produced must address parameters in operational question
 - ▶ Tools may have to be designed for each question investigated
 - ▶ Validity and reliability checks
 - ▶ Not all tools possible should be used
 - ▶ Statistics used to analyze data
 - ▶ Sophisticated statistics should be used whenever possible to test global effects first
- ▶ Reflection
 - ▶ Does determined answer directly relate to question asked?

References

Constructing Researchable Questions

- Bunce, D. M. (2008). Constructing Good and Researchable Questions. In D. M. Bunce & R. Cole (Eds.), *Nuts and Bolts of Chemical Education Research*. Washington, DC: American Chemical Society/Oxford University Press.

Exp. A: Study Resources

- Bunce, D., Komperda, R., Dillner, D., Lin, S., Schroeder, M. J., Hartman, J. A. (2017) Choice of Study Resources in General Chemistry by Students Who Have Little Time to Study. *Journal of Chemical Education*, 94 (1), 11-18.

Exp. B: Self-reported student belief regarding study approach

- Bunce, D.M., Komperda, Schroeder, M. J., Dillner, D., Lin, S., Teichert, M. A., and Hartman, J. R. (2017) Differential Use of Study Approaches by Students of Different Achievement Levels. *Journal of Chemical Education* 94 (10), 1415-1424 (DOI: 10.102/acs.jchemed.7b00202).

Collaborators

Nuts and Bolts of Chemical Education Research Book

- ▶ Renee Cole, Iowa State University

POGIL project

- ▶ Dr. Kelly Neiles, Mt. St. Mary's College,
- ▶ Ms. Elizabeth Flens, The Catholic University of America
- ▶ NSF Award # 0618800

USNA Project

- ▶ Dr. Debra Dillner, USNA
- ▶ Dr. Maria Schroeder, USNA
- ▶ Dr. Shirley Lin, USNA
- ▶ Dr. Melonie Teichert, USNA
- ▶ Dr. JudithAnn Hartman, USNA
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