Turning Good Ideas into Publishable Educational Research

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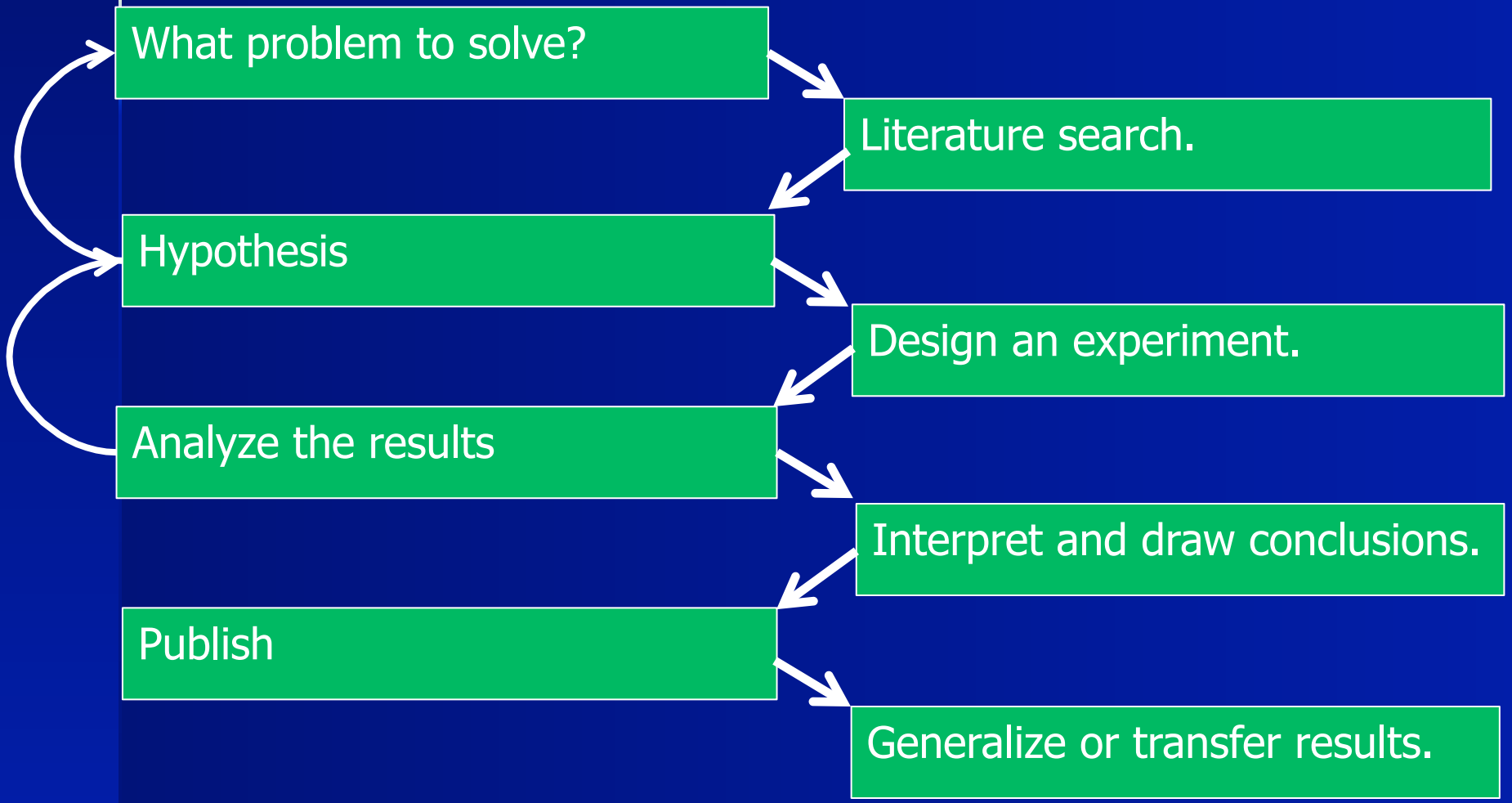
If you're here…

- You are interested helping students learn
- You have good ideas
- You may or may not know how to turn your ideas into publishable research

Who is my audience?

- Who here has published in TOE or JEE in the last 8 years?
- You are my facilitators!
- Gather in groups!

Pedagogical Scientific Method



Typical Pedagogical Research Categories

Developing a new technological application

Applying cognitive learning theory to a new situation

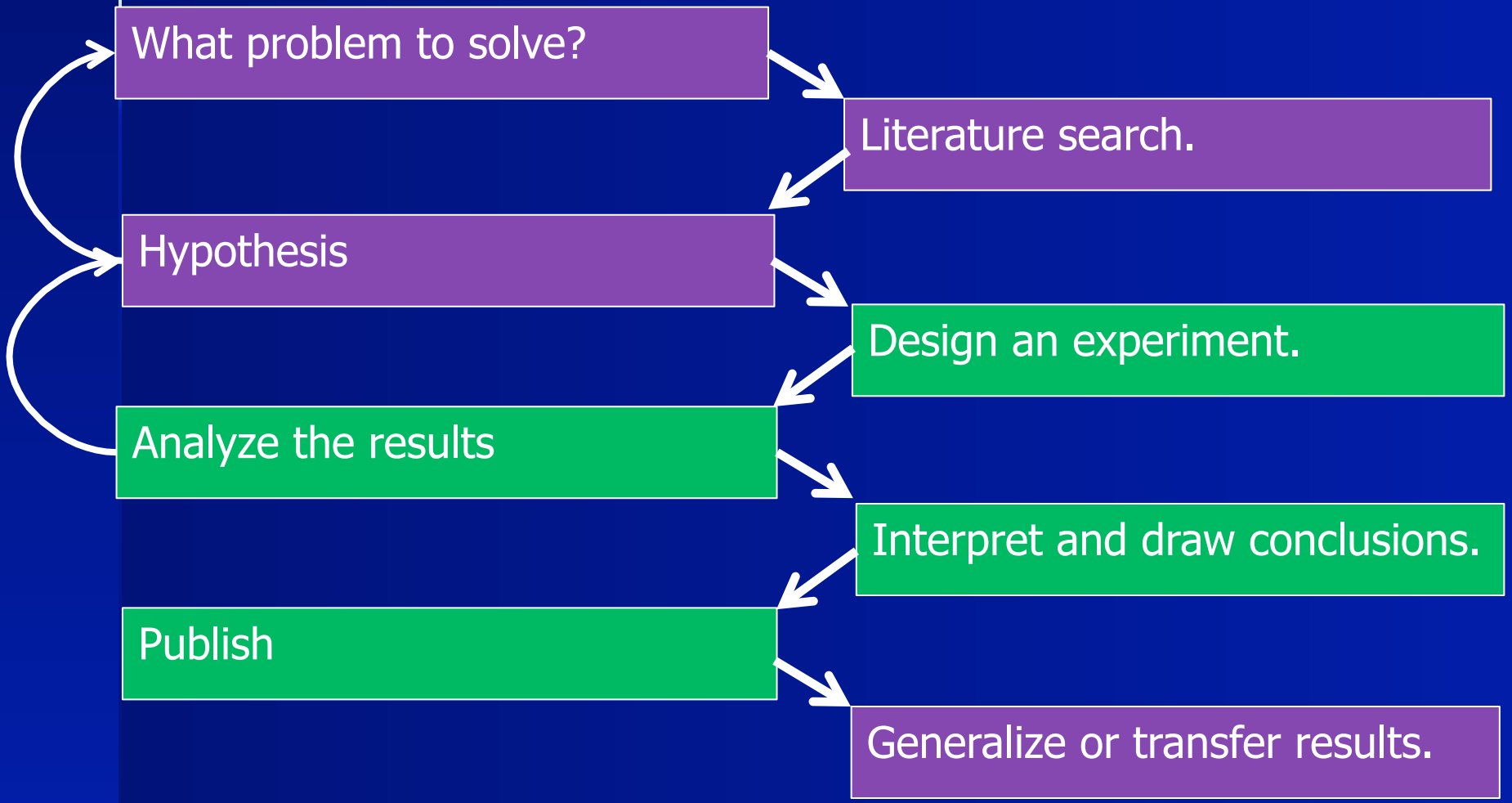
Applying existing teaching methods to a new situation

Developing a new course

Group "Pair-and-share"

- Choose a topic for each group.
- Which category does it fall into?
  - Using/developing a new technological application
  - Apply existing cognitive learning theories to new situations
  - Apply existing teaching methods to a new situation
  - Developing a new course
  - other

Pedagogical Scientific Method



Turning Research into a Publication - Introduction

- What is the problem?
- What has been done before me to solve the problem?
- What is wrong with what has been done before me?
- How will my solution fix the problem in a new or better manner?
- What is the final hypothesis?

Using/developing a new technological application

"We developed a new software program / hardware emulator to use in this course."

- What problem are you trying to solve with this new technology?
- What has been done before me? Literature search.
  - Is there similar technology out there that solves a different problem?
  - Other technologies trying to solve this problem?
  - What is the cognitive science literature supports your hypothesis?
- State the final provable hypothesis as a solution to the problem.

Example 1: "We developed a new software program / hardware emulator to use in this course."

- Problem: Students have difficulty with the abstract nature of signals and systems.
- Lit Search: Cognitive learning theory suggests that hands-on activities help students gain confidence and/or skills in abstract reasoning. Other hands-on experiences exist, but not showing significant success [ref].
- Hypoth: We are developing a new board to give students hands-on experiences with going between the time and freq domain to improve their confidence (their skills) with signals and systems.

Example 2: "We evaluated whether or not this existing teaching technique improves student confidence/skills with this material."

- Problem: Students are terrified of analog circuits.
- Lit search: Engineering students tend to take a surface approach to learning. Encouraging them to take a deep approach to learning can encourage confidence and long-term retention [ref].
- Hypoth: Intuitive explanations help students take a deep approach to learning improving their confidence with analog circuits.

Example 3: "We tried the use of clickers to increase active learning in a small school environment."

- Problem: Does active learning with clickers improve student learning similarly in a small school environment? Are the methods transferable?
- Lit Search: What is the environment in which the previous work was done? What were the results? [ref] How is this environment different?
- Hypoth: Clickers are/are not as useful in the small school setting.

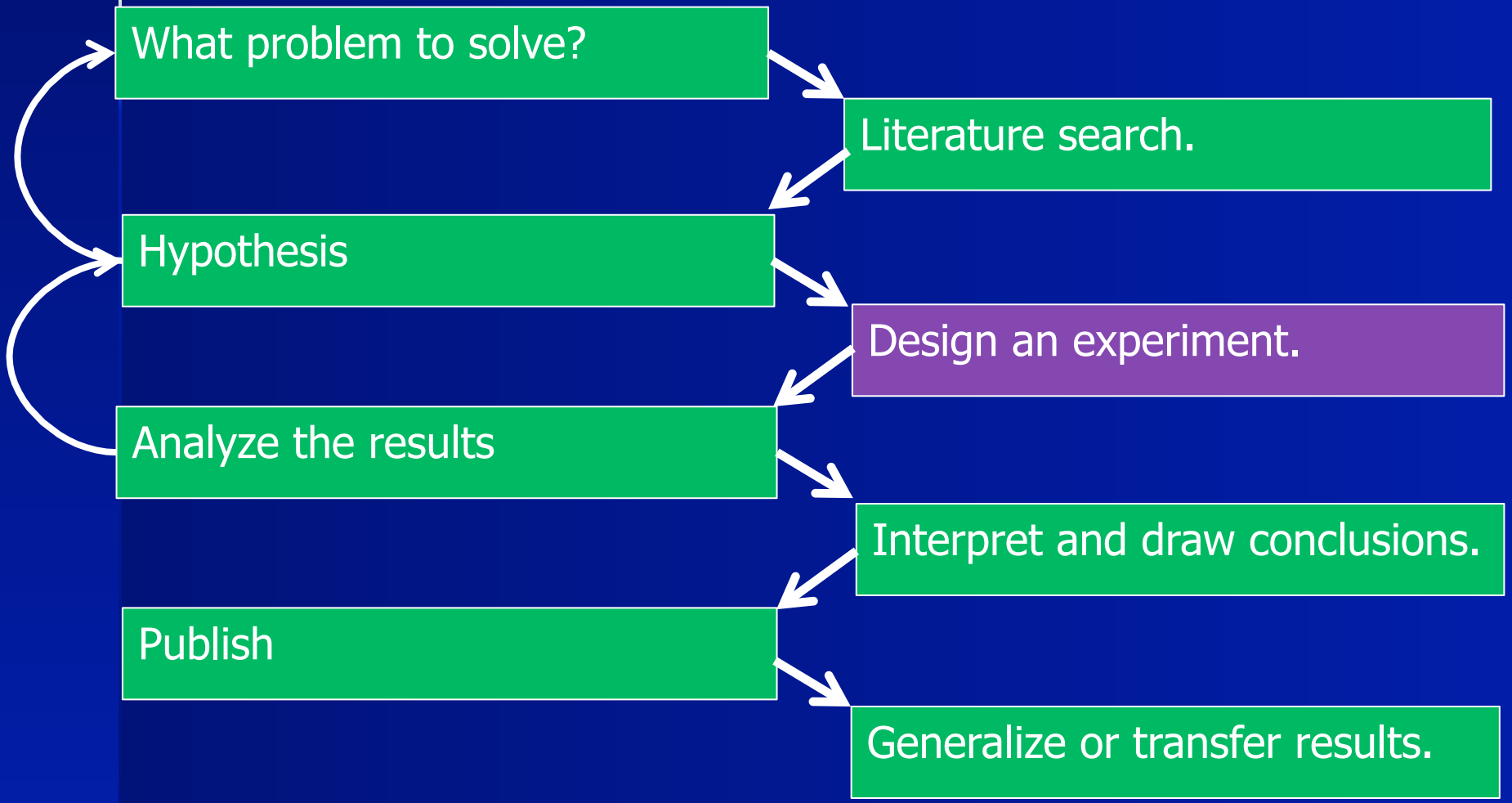
Example 4: "We created a new course that makes this graduate-level topic accessible to undergraduates."

- Problem: Industry (grad schools) would like to have undergraduates with experience in test and product engineering, but there are few existing courses.
- Lit Search: What similar courses exist [ref]? How is yours different?
- Find hypotheses about the new course that are measurable.
  - "This course helps undergrad students master these topics to this level, preparing them for grad school."
  - "Students were able to master this industrial skill set and reduced their time to being productive."
  - "This course that got more students to enter this field."

Group "Pair-and-share"

- Discuss how you can organize your introduction for your topic.
  - What problem are you trying to solve?
  - What could you search for in the literature?
  - What is a potential hypothesis?

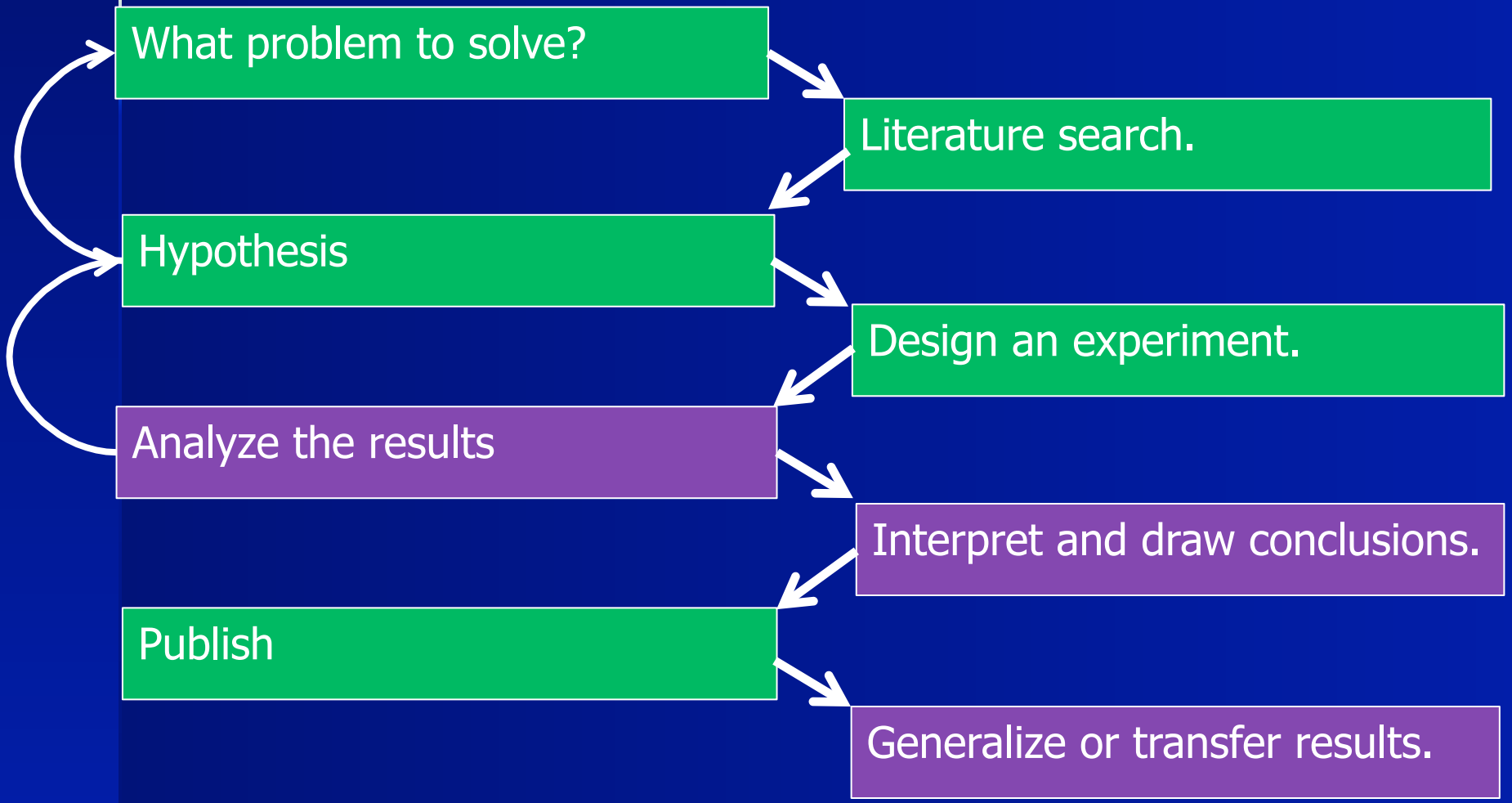
Pedagogical Scientific Method



Turning Research into a Publication – Project Description

- Be sure to describe the details of the experimental environment
  - What class/summer project was this used in?
  - Student demographics (EE, CmpE, non-majors, Seniors, Freshman, etc)
  - Number of participants
  - Background of students
  - Course structure (e.g. lecture/lab breakdown, number of weeks in the term, etc.)

Pedagogical Scientific Method



Turning Research into a Publication - Assessment

Assessment must employ scientific methods

Control

Quantitative measures
Statistical analyses

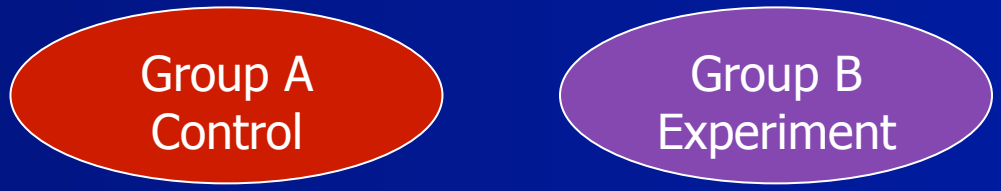
Qualitative measures
Establish trustworthiness

Measurements
support hypothesis

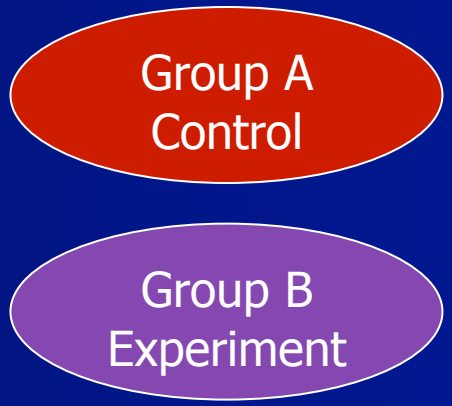
"students said they liked it on my end-of-the-quarter evaluations" is not sufficient for a journal

How do I get a control group?

I.

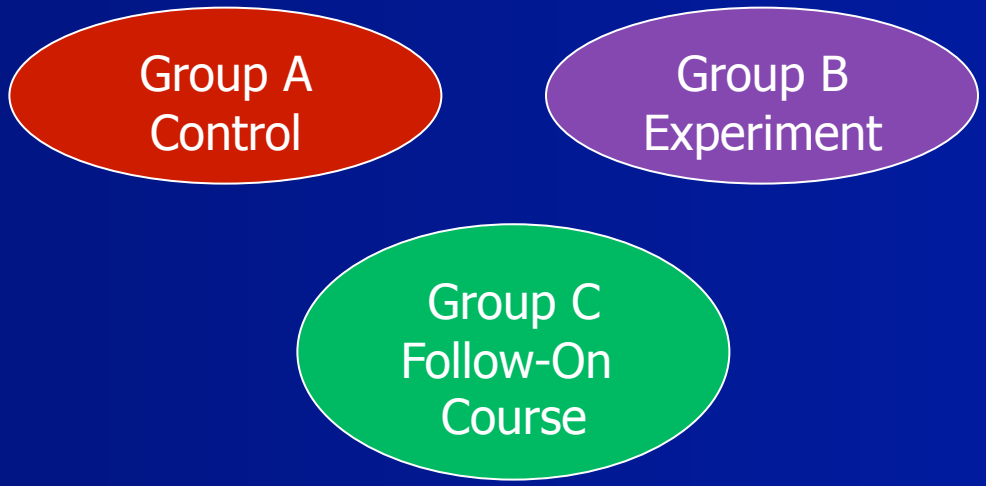


II.



How do I get a control group?

III.



Can use group C for multiple measurements

How do I get a control group?

- Difficult research category is the "developing a new course"
  - Compare to other universities teaching similar course
  - Survey employers or grad schools: "Do students with this course have better entering skills?"
  - Compare number of graduates going into the field
  - Use a set of rubrics to define an expected skill set

What Measurements Do I Take?

- What am I measuring?

Learning?

- Measure improvement in student performance

- Students cannot assess their own learning

Perceptions?

- Students feel their learning, confidence, has improved

- All student surveys measure perceptions

Measuring Learning

- Accepted examples
  - Tracking performance in follow-on courses
  - Comparing performance on an exam
  - Time to get up to a certain level of proficiency
  - Difficulty of successful design projects or success of a difficult design project
  - National concept inventory tests
  - Surveys of employers/grad schools

Measuring Perceptions

- Student pre- post- course surveys

Quantitative example: 5-point Likert scale

. My instructor explained circuit behavior in addition to circuit analysis.
Agree Strongly, Agree Slightly, Unsure, Disagree Slightly, Disagree Strongly
2. My instructor explained circuits primarily through numerical examples.
Agree Strongly, Agree Slightly, Unsure, Disagree Slightly, Disagree Strongly

Qualitative example: Open-ended question

Multiple examples were given from the instructor's industrial experience throughout the quarter. How did these examples impact your learning of the material?

Measuring Perceptions

- Number of students going into the field
- Focus groups
  - A dialog with a small group of students
  - Need an external person to do focus group
  - Qualitative

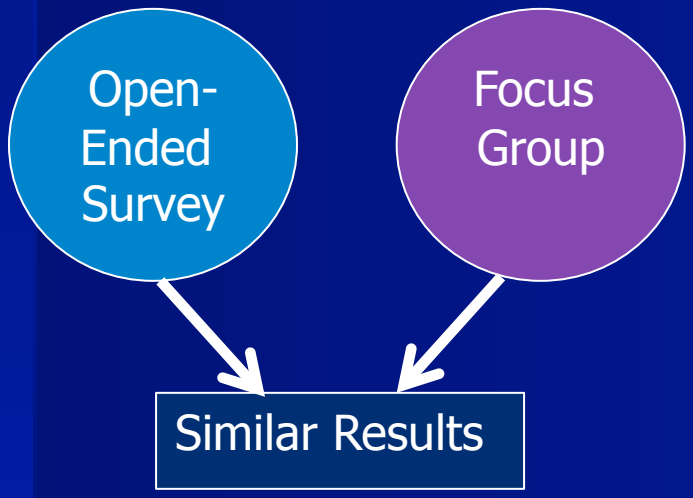
Interpreting Results

- Analysis of Quantitative Measures
  - Perform statistics comparing control and experimental data
    - Paired T-test: compares student X pre to student X post for each student and calculates the probability that there is no change between the means
    - ANalysis Of Variation (ANOVA): compares multiple groups (random group A to random group B to random group C)
    - Both tests result in a p-value, which is the probability that the difference in the 2 data sets is 0, or due to random chance
  - Human studies accept p-values of <=0.05

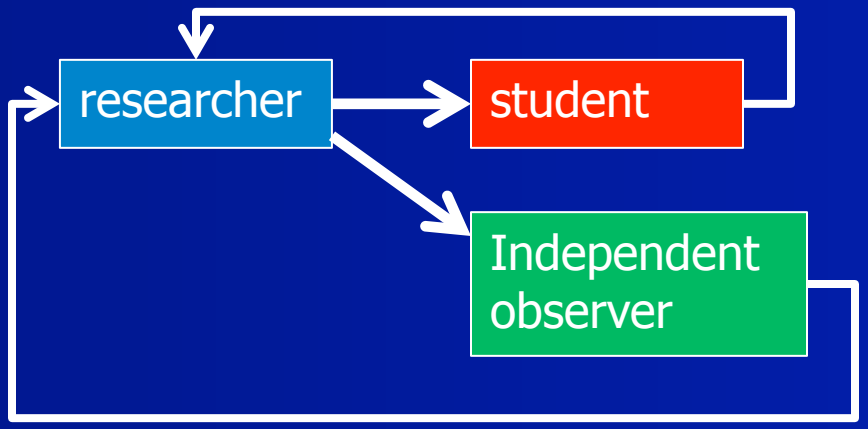
Interpreting Results

- Analysis of Qualitative Measures
  - Identify and categorize common themes
  - Establishing trustworthiness

Triangulation



Member checking and peer examination



Small Number Studies

- Ideally, get large numbers to validate the statistics
- What if I don't have large numbers?
  - If multiple small-number experiments suggest the same result, conclusions can be strong
  - p-values of <=0.07 in small studies indicates a significant difference *may* exist with larger numbers.
  - If most/all assessments trend in the same direction, the data suggests that a significant difference *may* exist with larger numbers

Conclusions

- Choose the hypothesis that makes assessment meaningful

This teaching technique improved student learning.

This teaching technique improved student confidence.

- Tie results back to cognitive sciences literature
  - *"This experiment presented another example of the impact of active learning in the classroom."*

Group "Pair-and-share"

- Discuss how you can assess your topic.
  - What control group can you use?
  - What measures can you make?
  - What hypothesis is appropriate for your measurements?

List of Resources in the Appendices

- Useful pedagogical research articles
- Sample rubric for assessing the difference on a test
- Sample student survey questions
- Sample focus group questions
- Sample IRB and Informed Consent forms