To start us off

You are Medical Education and/or Health Science faculty who wants to publish an education study.

For each scenario:

1. Identify the type of study (descriptive, correlational, causal-comparative, quasi-experimental).

2. Design a research question that would be considered “good”.

You are Medical Education and Health Science faculty who want to publish an education study.
For each scenario:
1. Identify the type of study (descriptive, correlational, causal-comparative, quasi-experimental).
2. Design a research question that would be considered “good”.

Scenario 1

Students who elect an interprofessional simulation elective are compared with those who do not on teamwork scores during clinical placements.

Scenario 2

Faculty examine whether students’ anatomy course grades are associated with performance on first clinical rotation evaluations.

Scenario 3

A PA program surveys second-year students about their confidence performing first aid techniques and reports mean confidence scores.

Scenario 4

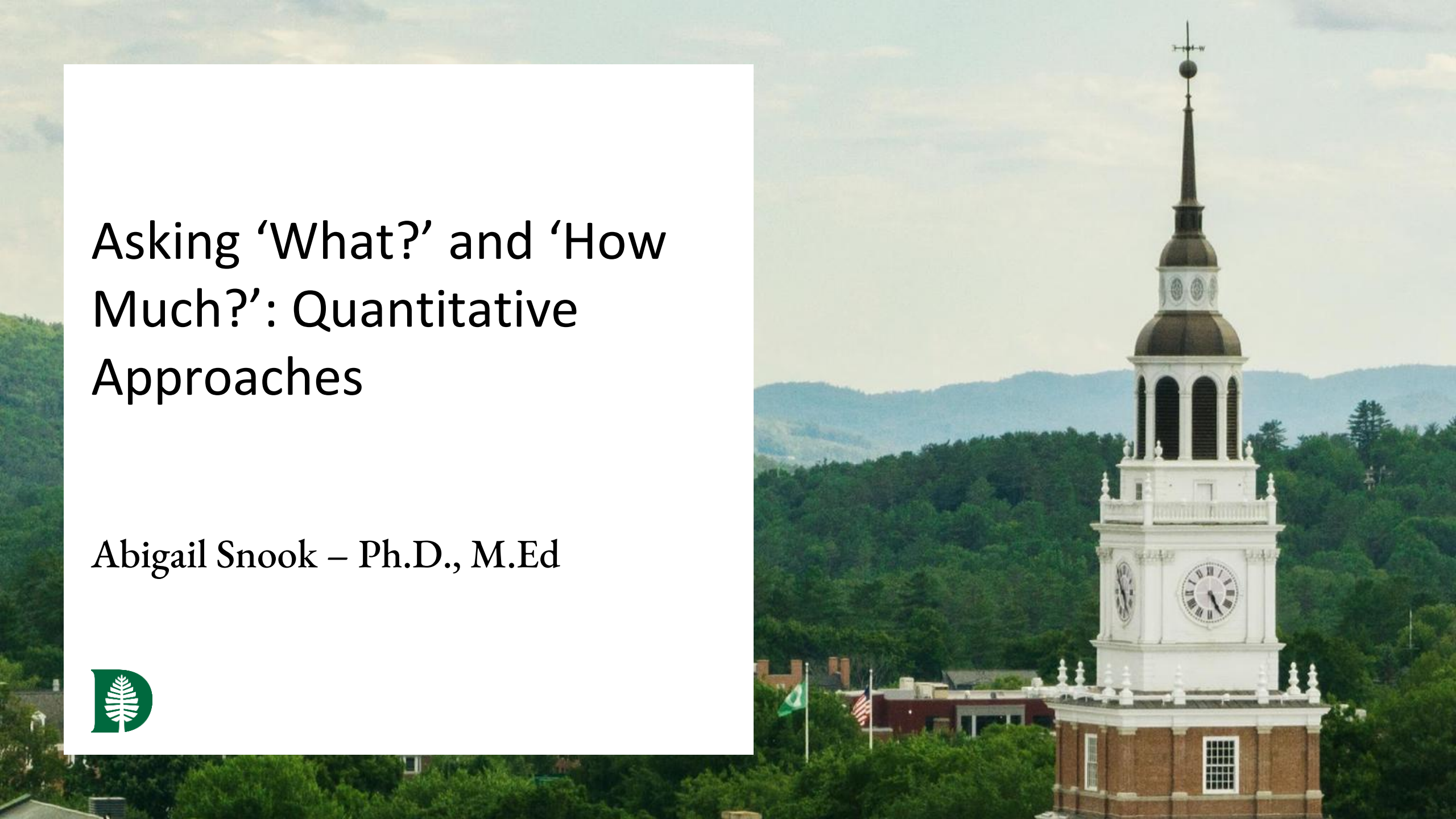
One cohort of nursing students receives a structured reflection curriculum during clinical rotations; the prior cohort did not. Clinical reasoning scores are compared at the end of the year.

Start thinking…

- What is the research question that you would like answered?
  - What teaching or curriculum issue do you want to study?
  - Why does this matter in your program?

Asking ‘What?’ and ‘How Much?’: Quantitative Approaches

Abigail Snook – Ph.D., M.Ed



Learning objectives

After this session, participants will be able to:

- Explain the core characteristics of quantitative research approaches
- Describe four common types of quantitative research designs:
  - Descriptive
  - Correlational
  - Causal-comparative
  - Quasi-experimental
- Identify what makes a “good” quantitative research question

Academic Pediatrics

PERSPECTIVE

Conducting Quantitative Medical Education Research: From Design to Dissemination

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Family Medicine

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ORIGINAL ARTICLE

Overview of Quantitative Research

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KEYWORDS: correlational, experiment, observation, quantitative research, study design, survey

ABSTRACT

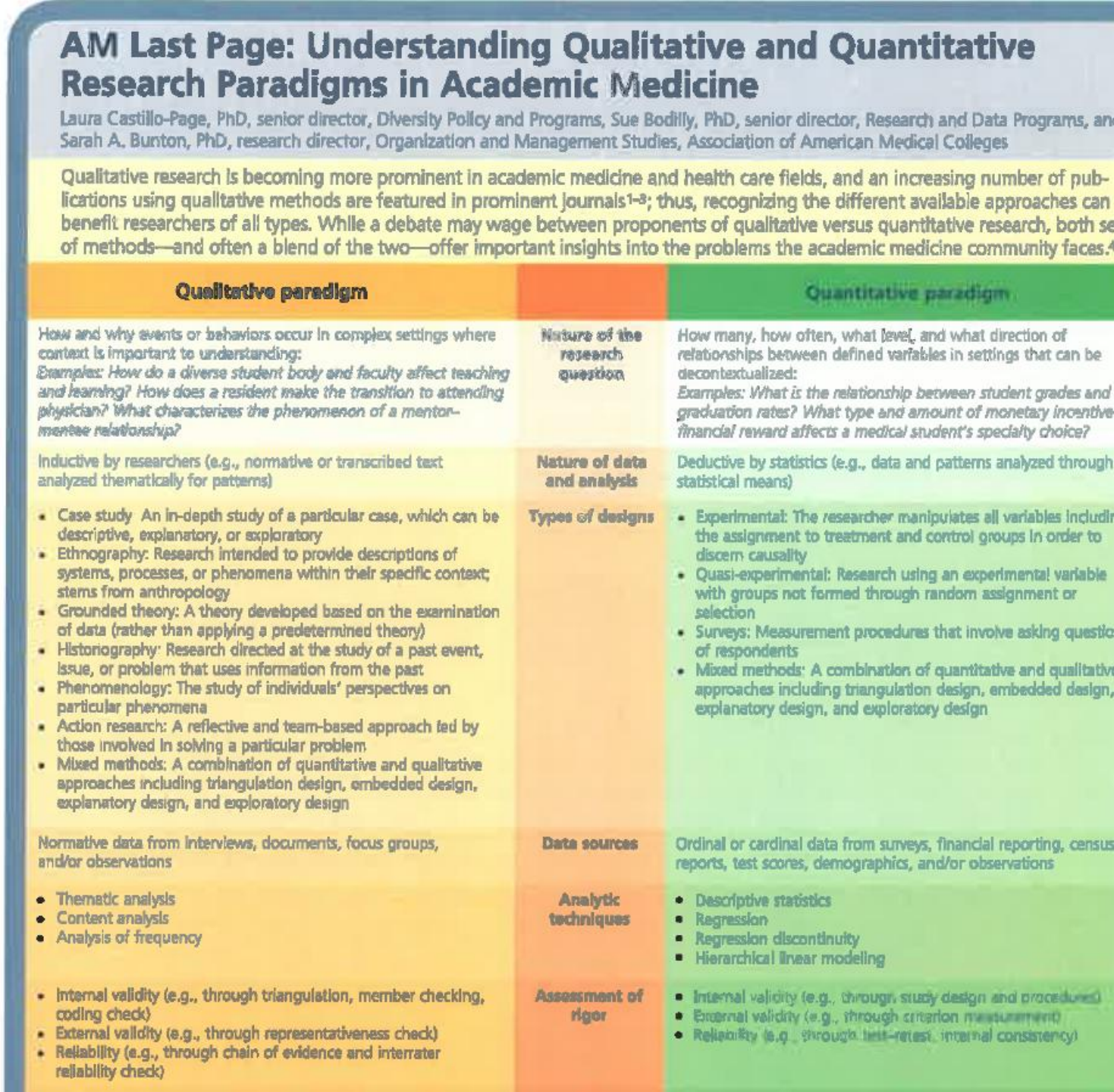
Quantitative research helps medical educators and researchers use data to understand and improve learning, teaching, and program outcomes. Applying statistical methods to summarize and compare results makes it possible to measure change, identify patterns, and evaluate educational efforts, such as new curricula, wellness initiatives, or assessment of programs. This article introduces key ideas for using quantitative methods effectively in medical and family medicine education, including how research questions connect to study design, common approaches such as experimental, quasi-experimental, and correlational studies, and practical ways to collect data through surveys, observations, or existing records. Examples from medical education illustrate how these methods can be used to evaluate programs, describe learner progress, and test innovations. The paper also outlines common challenges—such as drawing broad conclusions from small samples, confusing association with cause, or using measures that do not fully capture what is intended—and offers strategies to address these problems. The paper aims to help clinician-educators apply quantitative methods with greater confidence and clarity.

What is quantitative research?

Quantitative

- How many
- How often
- What level
- What direction

- ➢ Relationships between defined variables
- ➢ Settings that can be decontextualized



AM Last Page: Understanding Qualitative and Quantitative Research Paradigms in Academic Medicine

Laura Castillo-Page, PhD, senior director, Diversity Policy and Programs, Sue Bodilly, PhD, senior director, Research and Data Programs, and Sarah A. Bunton, PhD, research director, Organization and Management Studies, Association of American Medical Colleges

Qualitative research is becoming more prominent in academic medicine and health care fields, and an increasing number of publications using qualitative methods are featured in prominent journals[1–3]; thus, recognizing the different available approaches can benefit researchers of all types. While a debate may wage between proponents of qualitative versus quantitative research, both se of methods—and often a blend of the two—offer important insights into the problems the academic medicine community faces.[4]

Qualitative paradigm		Quantitative paradigm
How and why events or behaviors occur in complex settings where context is important to understanding: *Examples: How do a diverse student body and faculty affect teaching and learning? How does a resident make the transition to attending physician? What characterizes the phenomenon of a mentor–mentee relationship?*	Nature of the research question	How many, how often, what level, and what direction of relationships between defined variables in settings that can be decontextualized: *Examples: What is the relationship between student grades and graduation rates? What type and amount of monetary incentive financial reward affects a medical student's specialty choice?*
Inductive by researchers (e.g., normative or transcribed text analyzed thematically for patterns)	Nature of data and analysis	Deductive by statistics (e.g., data and patterns analyzed through statistical means)
• Case study An in-depth study of a particular case, which can be descriptive, explanatory, or exploratory • Ethnography: Research intended to provide descriptions of systems, processes, or phenomena within their specific context; stems from anthropology • Grounded theory: A theory developed based on the examination of data (rather than applying a predetermined theory) • Historiography: Research directed at the study of a past event, issue, or problem that uses information from the past • Phenomenology: The study of individuals' perspectives on particular phenomena • Action research: A reflective and team-based approach led by those involved in solving a particular problem • Mixed methods: A combination of quantitative and qualitative approaches including triangulation design, embedded design, explanatory design, and exploratory design	Types of designs	• Experimental: The researcher manipulates all variables includi the assignment to treatment and control groups in order to discern causality • Quasi-experimental: Research using an experimental variable with groups not formed through random assignment or selection • Surveys: Measurement procedures that involve asking questio of respondents • Mixed methods: A combination of quantitative and qualitativ approaches including triangulation design, embedded design, explanatory design, and exploratory design
Normative data from interviews, documents, focus groups, and/or observations	Data sources	Ordinal or cardinal data from surveys, financial reporting, census reports, test scores, demographics, and/or observations
• Thematic analysis • Content analysis • Analysis of frequency	Analytic techniques	• Descriptive statistics • Regression • Regression discontinuity • Hierarchical linear modeling
• Internal validity (e.g., through triangulation, member checking, coding check) • External validity (e.g., through representativeness check) • Reliability (e.g., through chain of evidence and interrater reliability check)	Assessment of rigor	• Internal validity (e.g., through study design and procedures) • External validity (e.g., through criterion measurement) • Reliability (e.g., through test–retest, internal consistency)

Quantitative

"it employs theoretically informed methodologies to test hypotheses and investigate relationships, patterns, and trends" (Ma & Lee, 2026)

- Uses numerical data
- Has clearly defined variables
- Uses measurable outcomes
- Follows structured design
- Uses systematic sampling (sometimes)
- Applies statistical analysis
- Tests relationships or differences
- Seeks generalizable findings (sometimes)

Variations of quantitative research

- Descriptive, causative, associative
- Small, evaluation study vs. generalizable
- Design
- Data collection – primary data, secondary data, observation, survey
- Theory-driven (confirmatory) vs. data-driven (exploratory)

Challenges in quantitative research

- Assuming and using words that indicate “causation”
- Unequal samples sizes are OK
- Quality of measurement instrument – validity, reliability
- Parametic and non-parametric data (Likert scales) – what test to use?
- p values – use confidence intervals, effect sizes, model fit indicators
- Social desirability bias

So…

A School of Medicine implements a new structured faculty feedback training program for clinical preceptors. The Dean wants to determine whether the intervention improves the quality of feedback delivered to third-year medical students. Faculty at one clinical site receive the training, while faculty at a different site continue usual practice. At the end of the clerkship, students complete a validated feedback-quality scale scored from 1–5. Mean scores between sites are compared using statistical testing.

Which study design best describes this investigation and necessarily requires quantitative analysis?

A. Qualitative descriptive study
B. Causal-comparative (ex post facto) study
C. Quasi-experimental study with non-equivalent control group
D. Phenomenological study

Types of quantitative research

Descriptive

Correlational

Causal-comparative

Quasi-experimental

Descriptive studies

Purpose: Systematically describe characteristics, behaviors, or educational phenomena.

Can answer: how, what, when, where but NOT why

❌ No intervention

❌ No comparison

❌ No causation

Examples in Medical Education:

- Prevalence of burnout among residents
- Distribution of assessment methods across clerkships
- Faculty adoption rates of AI tools

Common designs: surveys, data sets

Report: counts, percentages

Correlational studies

Purpose: Examine statistical associations between variables

❌ No intervention

❌ No comparison

❌ No causation but ✅ Yes to association

Examples in Medical Education

- Relationship between clinical preceptor feedback quality and learner performance
- Association between sleep deprivation and in-training exam scores
- Correlation between simulation exposure and procedural confidence

Common designs: measurement tools for each variable, surveys

Report: Pearson/Spearman correlations, linear or logistic regression, multivariable modeling

Causal-comparative studies (a.k.a. ex post facto)

Purpose: Compare pre-existing groups to examine outcome differences

❌ No intervention, ❌ No randomization

✅ Comparison

⚠️ Limited causation as non-equivalent groups

Examples in Medical Education:

- Board pass rates: PBL vs traditional curriculum graduates
- Burnout levels: Residents who work >60 hrs/week vs <60 hrs/week
- Clinical performance: Students with vs without prior healthcare experience

Common designs: surveys, polls, test scores, etc.

Report: p values, confidence intervals, effect sizes, non-parametric stats (Likert scales)

Quasi-experimental studies

Purpose: Evaluate the effect of an educational intervention. Often pre-existing groups receiving different treatments, often no control or non-equivalent control

✅ Yes, intervention introduced, ❌ No random assignment

✅ Comparison – pre/post or with control

⚠️ Causation - Stronger than observational, weaker than RCT but vulnerable to maturation, history effects, and selection bias

Examples:

- Implementation of competency-based assessment model, prior year's assessment serves a control
- Introduction of simulation curriculum, pre/post
- Pre/post faculty development intervention

Common designs: One-group pretest–posttest, Non-equivalent control group

Report: t tests, confidence interval, effect size, non-parametrics, ANOVA

Comparing study designs

Descriptive

No intervention
No randomization
No comparison
No association
No causation

Survey prevalence

OR

Correlational

No intervention
No randomization
No comparison
Yes to association
No causation

Relationship analysis

OR

Causal comparative

No intervention
No randomization
Yes to comparison
No association
Limited causation

Compare pre-existing groups

OR

Quasi-experimental

Yes to intervention
No randomization
Yes comparison
No association
Stronger causation

Pre/post intervention

OR

Experimental

Yes to intervention
Yes to randomization
Yes to comparison
No association
Yes to causation

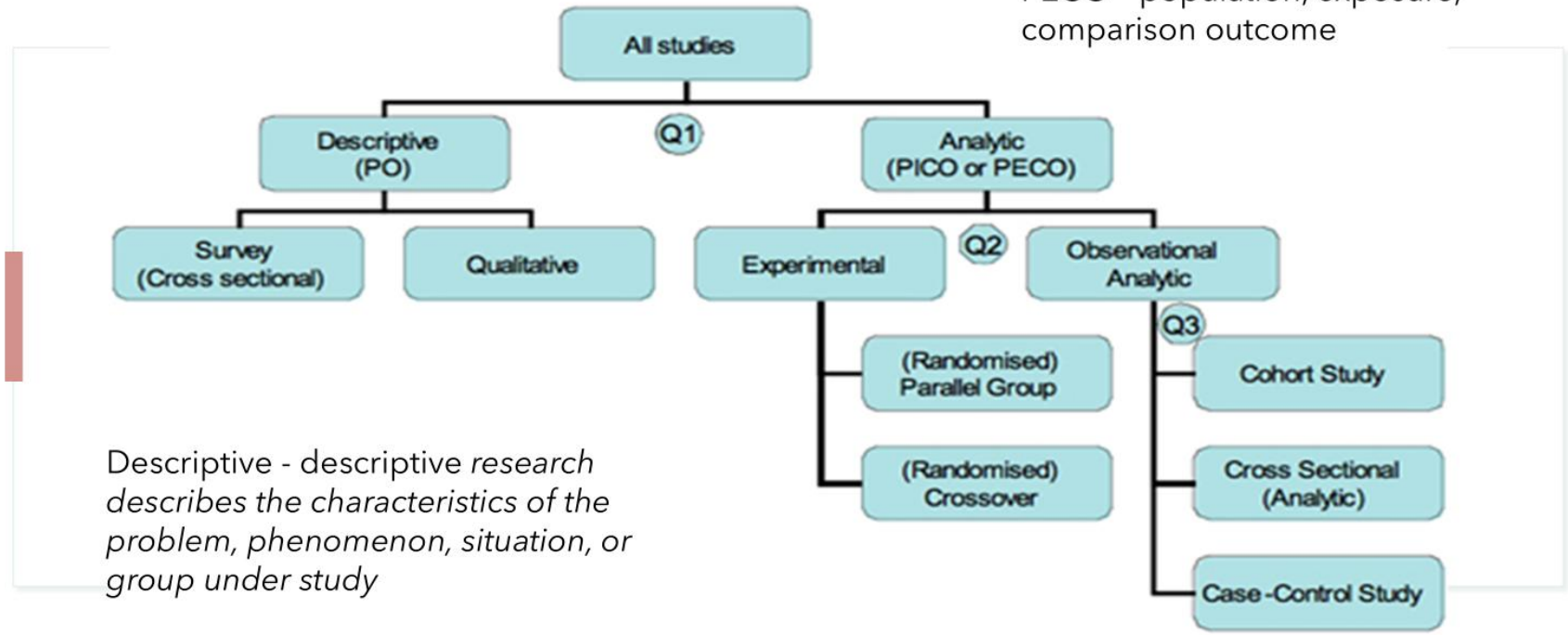
RCT

Increasing causation

Centre of Evidence-Based Medicine

Study design - https://www.cebm.net/2014/04/study-designs

PICO – population, intervention, comparison, outcome
PECO – population, exposure, comparison outcome



Descriptive - descriptive *research describes the characteristics of the problem, phenomenon, situation, or group under study*

Where are the terms “correlational”, “causal-comparative”, and “quasi-experimental”?

Terms – educational vs. epidemiology

Educational Research Term	Epidemiology Equivalent	Observational or Experimental?
Correlational	Cross-sectional analytic or cohort	Observational
Causal-comparative	Case-control or retrospective cohort	Observational
Quasi-experimental	Non-randomized trial	Experimental

Quiz yourselves – what is the study design (descriptive, correlational, causal-comparative, quasi-experimental)?

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Descriptive, correlational, causal-comparative, or quasi-experimental?

1. Relationship Between Emotional Intelligence and Clinical Performance in Medical Students
   - EI scale + clinical evaluation scores.
2. Empathy Levels in Students From Rural vs Urban Backgrounds
3. Sleep Patterns of Nursing Students During Clinical Rotations
   - Self-reported sleep diaries across one semester
4. Introduction of Reflective Journaling to Improve Clinical Reasoning
   - Pre/post rubric scoring.

1. Correlational
2. Causal-comparative
3. Descriptive
4. Quasi-experimental

Example: Burnout in medical student education

Descriptive:

What is the prevalence and severity of burnout among third-year medical students during core clinical clerkships?

Correlational:

Is perceived workload associated with burnout scores among medical students during clinical rotations?

Causal-comparative:

Do medical students in pass/fail preclinical curricula differ in burnout levels compared to students in graded preclinical curricula?

Quasi-experimental:

What is the effect of implementing a structured mindfulness-based stress reduction (MBSR) program on burnout scores among second-year medical students?

From the beginning … (activity)

- What is the research question that you would like answered?
  - What teaching or curriculum issue do you want to study?
  - Why does this matter in your program?
- What variables are important? How can they be measured?
- Write the research question down on your handout
- Modify it to be a
  - As a descriptive study
  - As a correlational study
  - As a causal-comparative study
  - As a quasi-experimental study

Developing a research question

A good quantitative question

- Clearly identifies the population
- Clearly states variables
- Uses measurable outcomes
- Matches the design
- Avoids inappropriate causal claims

Weak:

- "Does simulation make students better clinicians?"

Stronger:

- "Does participation in a high-fidelity simulation module improve OSCE scores among second-year physiotherapy students?"

Even stronger:

- "Among second-year physiotherapy students, does participation in a high-fidelity simulation module lead to higher OSCE scores compared to traditional skills lab training?"

High-quality medical education research

- Glassick's criteria for scholarship
  - **clear goals, adequate preparation, appropriate methods**, significant results, effective presentation, and reflective critique

- Before, reflect on own skills and what potential collaborators could contribute
- Address a compelling and widely shared or recognized problem
- Apply a conceptual framework

Abramson, 2016

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Table 1. Examples of Conceptual Frameworks Used in Medical Education

Conceptual Framework	Description	Example
Bandura's Social Cognitive Theory[15]	• People learn from one another by observing and imitating behavior of others. • Self-efficacy is an important prerequisite guiding behavior. • Self-efficacy can be supported by observing role models, having opportunities to practice behavior, and receiving feedback on performance.	Used cross-sectional surveys to explore factors that supported self-efficacy with family-centered care among third-year medical students during their pediatric clerkship.[16]
Ericsson's Theory of Deliberate Practice[17]	• Individualized training activities are designed to improve specific aspects of individual's performance through repetition, immediate feedback, and successive refinement.	Prospective pre–post intervention study of pediatric resident rapid cycle deliberate practice of resuscitation skills with immediate feedback and opportunity to "pause, rewind 10 s, and try again" in simulated cardiopulmonary arrest scenarios.[18]
Kolb's Experiential Learning Cycle[19]	Learning happens through transforming experience through 4-stage learning cycle: • Concrete experience: do something. • Reflective observation: think about what you did. • Abstract conceptualization: make sense of what you experienced through developing theories. • Active experimentation: put what you learned into practice.	Development of curriculum to teach social determinants of health using experiential learning (eg, field trip to food bank), followed by reflection on experience and development of theory through abstract conceptualization (residents asked to reflect on learning experience and how it will influence their clinical practice through "Memo to Myself" exercise), and testing their hypotheses (apply what they learned to their care of underserved patients in clinic).[20]

For a clear and focused research question

- Apply PICOTS if analytic
  - **p**opulation, (**i**ntervention/exposure), (relevant **c**omparison groups), **o**utcomes assessed, **t**iming, and **s**etting
- Apply POTS if descriptive
- I-SMART to measure strength of research question

Your research question (clear goals) Abramson, 2016

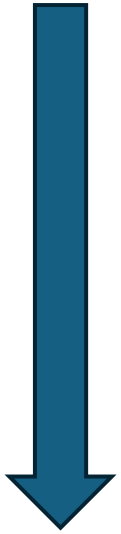
Table 2. Elements of I-SMART Research Question

Description	Example
Important	• Is question important to you and others in your field?
Specific	• Is question specific?
	• Can it be distilled down further?
	• Will it stand on its own?
Measurable	• Is there measurable outcome (or outcomes) for study?
Achievable	• Can you collect data variables necessary to study outcome you wish to measure?
	• Do you have resources (research team, mentorship, funding, time, etc) to successfully complete your project?
Relevant (not rehashing)	• Will results add new information to literature?
	• Will results add to depth and breadth of current literature, or will it simply restate what is already known?
Timely	• Can study be completed in time frame that is reasonable for you? For audience? For granting agencies (if applicable)?

Consider Kirkpatrick's learning evaluation model

Abramson, 2016

Level	Description	Question
1	Reaction	• "Did they like it?" • "What do they plan to do differently based on what they learned?"
2	Learning (attitudes, knowledge, skills)	• "What did they learn?" • "How much did they learn?"
3	Behavior	• "Did it change behavior?"
4	Patient outcomes	• "Did behavior change affect patients?"



Researchers should aim for as high a number as possible

Change in attitudes ≠ change in behavior

High-quality medical education research

- Glassick's criteria for scholarship
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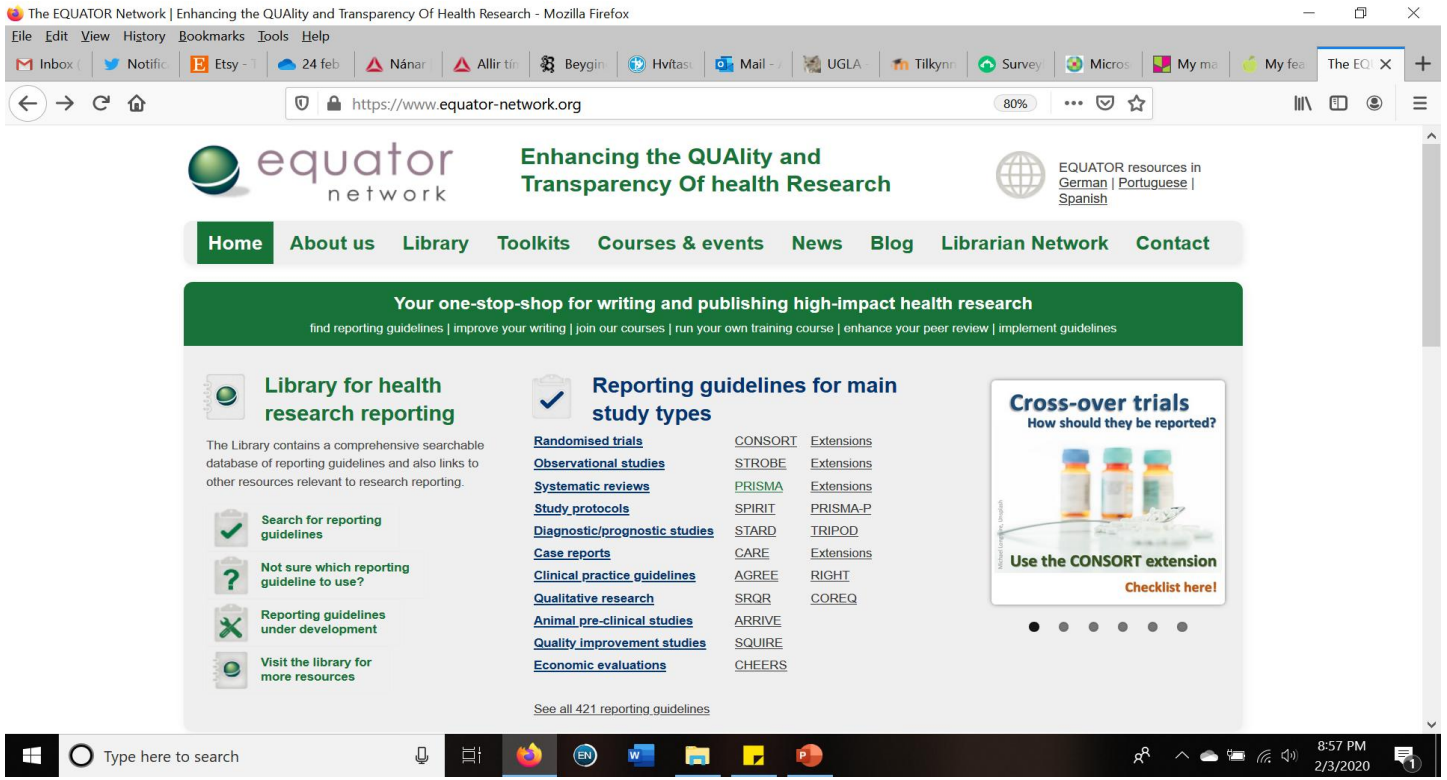
- Literature review
- Acquiring necessary skills, resources, collaborators
- Ensuring IRB approval

High-quality medical education research

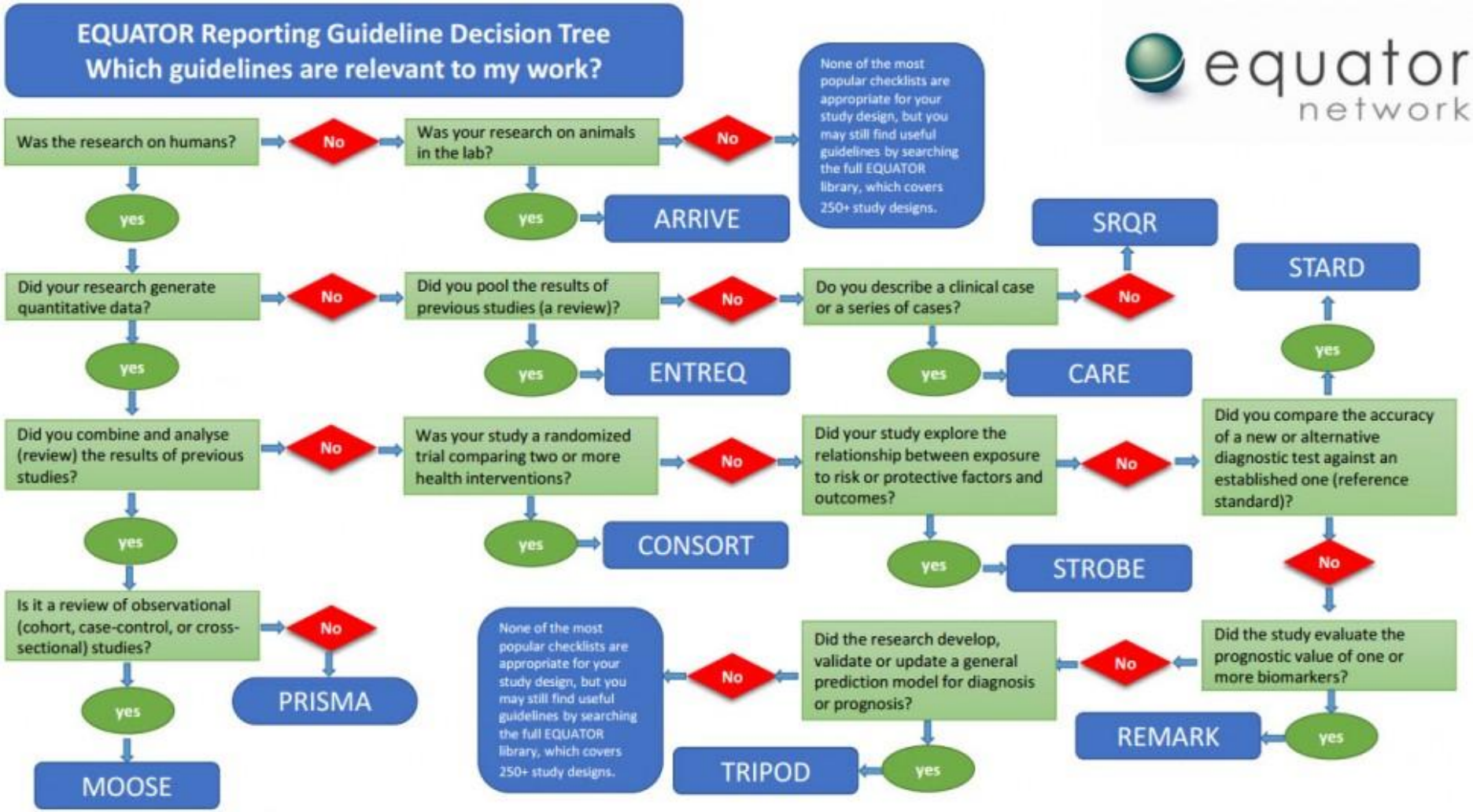
- Glassick's criteria for scholarship
  - **clear goals,** adequate preparation**, appropriate methods**, significant results, effective presentation, and reflective critique

- Study design and reporting guideline
- Sample size planning – if small, can you add multiple sites or multiple timepoints?
- Registering at ClinicalTrials.gov

Use reporting guidelines



www.equator-network.org


EQUATOR Reporting Guideline Decision Tree
Which guidelines are relevant to my work?
equator network
Was the research on humans?
No
Was your research on animals in the lab?
No
None of the most popular checklists are appropriate for your study design, but you may still find useful guidelines by searching the full EQUATOR library, which covers 250+ study designs.
yes
yes
ARRIVE
Did your research generate quantitative data?
No
Did you pool the results of previous studies (a review)?
No
Do you describe a clinical case or a series of cases?
No
SRQR
yes
yes
ENTREQ
yes
yes
CARE
STARD
Did you combine and analyse (review) the results of previous studies?
No
Was your study a randomized trial comparing two or more health interventions?
No
Did your study explore the relationship between exposure to risk or protective factors and outcomes?
No
Did you compare the accuracy of a new or alternative diagnostic test against an established one (reference standard)?
yes
yes
CONSORT
yes
yes
STROBE
No
Is it a review of observational (cohort, case-control, or cross-sectional) studies?
No
None of the most popular checklists are appropriate for your study design, but you may still find useful guidelines by searching the full EQUATOR library, which covers 250+ study designs.
Did the research develop, validate or update a general prediction model for diagnosis or prognosis?
No
Did the study evaluate the prognostic value of one or more biomarkers?
yes
PRISMA
No
TRIPOD
yes
REMARK
yes
MOOSE

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➢ Picking the statistics test that matches your question

Statistical tests (Abramson et al., 2016)

Table 5. Common Statistical Tests Used in Medical Education Research*

What Are You Trying to Determine?	Example Question	Statistical Methods	How Should Results Be Reported?
Summary values for random variable with bell-shaped distribution	What is average number of patients who third-year medical students take care of on general inpatient wards?	Estimated mean and SD from sample	Mean (95% CI) and SD estimates
Midpoint value of rank-ordered list (minimizes influence of extreme values; useful for ordinal data)	What is median medical school educational debt of pediatric residents?	Median	Median (often accompanied by minimum and maximum value and/or 25th and 75th percentiles)
Most common value (useful for nominal or ordinal data)	What is most common subspecialty pediatric residents enter after residency?	Mode	Mode
Compare observed vs expected values (categorical variables)	Is study population of pediatric residents similar to all pediatric residents in United States in regards to gender?	Chi-square test	*P* values
Compare means of 2 independent groups (data normally distributed)	Does interactive Web-based module on EKG interpretation improve residents' ability to accurately interpret EKGs compared to lecture on EKG interpretation?	Unpaired *t* test	Differences in means (95% CI) and *P* value, possibly adjusted for multiple comparisons
Compare means of 2 paired groups (eg, pretest and posttest) (data normally distributed)	Does EKG module improve residents' ability to accurately interpret EKGs?	Paired *t* test	Differences in means (95% CI) and *P* value, possibly adjusted for multiple comparisons
Compare means of 3 or more groups	Is there difference in medical school debt for residents who choose to practice in rural, urban, or suburban areas?	Analysis of variance or multiple regression	(Adjusted) mean differences (95% CI) and *P* value, possibly adjusted for multiple comparisons
Correlation (data normally distributed [parametric])	How well do resident self-assessments of intubation skills correlate with faculty assessment?	Pearson product-moment correlation coefficient	Correlation coefficient and 95% CI
Correlation (data not normally distributed [nonparametric])	How well does resident performance on in-training examination correlate with their performance on American Board of Pediatrics certifying exam?	Spearman's rank correlation coefficient	Correlation coefficient with 95% CI
Association (interval and ordinal data)	What are factors associated with USMLE step 1 scores?	Linear regression	Regression coefficient with 95% CI
Association (binary data)	What are factors associated with passing American Board of Pediatrics certifying exam on first attempt?	Logistic regression	Odds ratio with 95% CI

CI indicates confidence interval; EKG, electrocardiogram; SD, standard deviation; and USMLE, United States Medical Licensing Examination.
*Interval indicates data where difference between two values is meaningful (ie, age); ordinal, data where there is sense of order, but consecutive values may not be equally spaced (ie, Likert scales: 1 = strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree); and nominal–categorical, data in which there is no inherent order (ie, cardiology, pulmonary, general pediatrics).

Developing YOUR research question

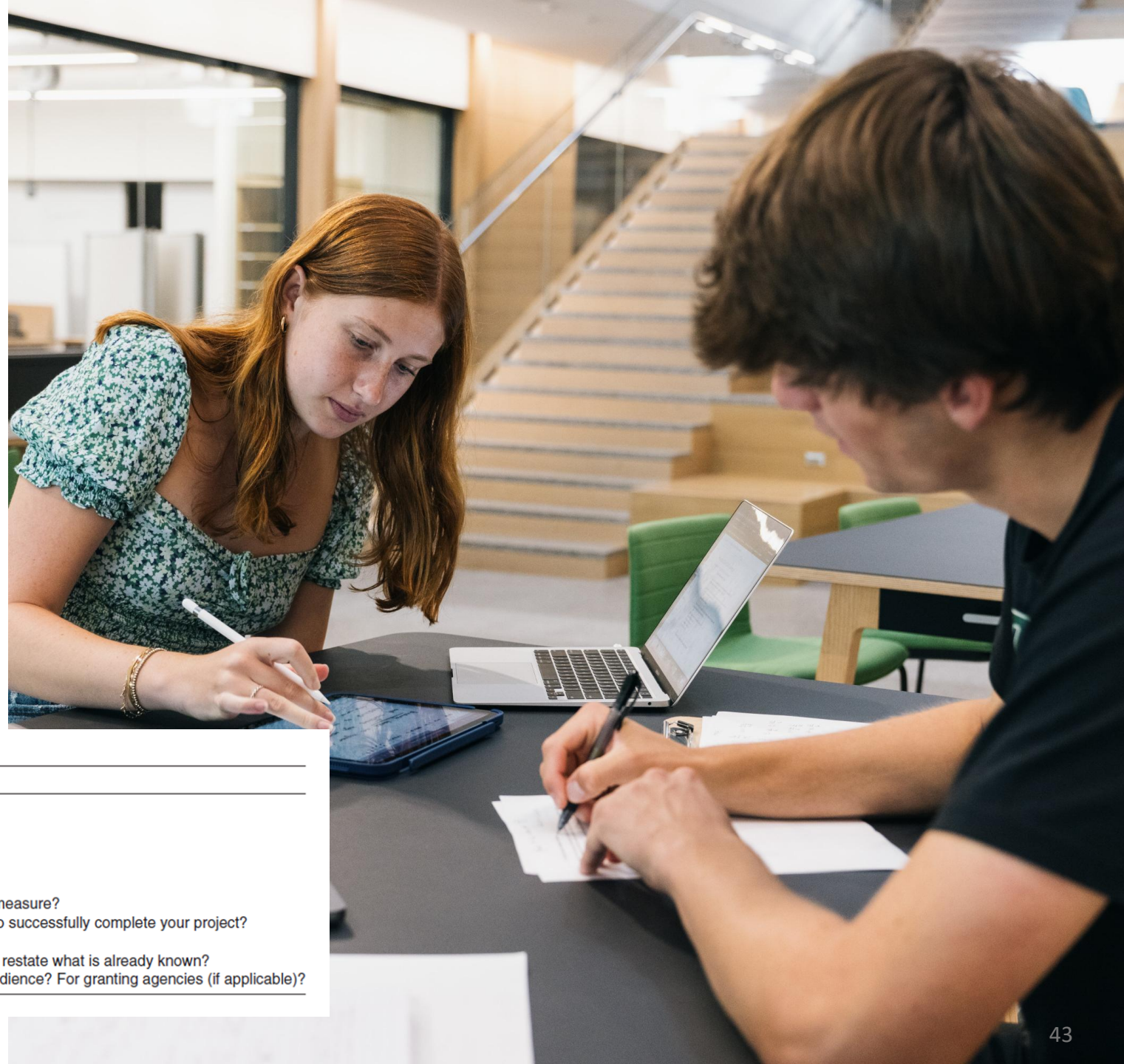
Your research question

Review your research question in descriptive, correlational, causal-comparative, quasi-experimental form.

- Which version is strongest?
- Which is most feasible?
- Which requires the most resources?
- Which risks over-claiming causality?
- Modify your question to make it what you want to do. Consider a conceptual framework that would work with your study.
- Be prepared to share.

In groups (activity)

- Share your research question
- Help each other to make it better by using I-SMART



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Timely	• Can study be completed in time frame that is reasonable for you? For audience? For granting agencies (if applicable)?

Coming back together

- How was the process of applying I-SMART to your research question?
- Do you have a good research question now?

Thank you

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Education and research consultant

References and resources on handout