Designing a Research Study

Computer Science Education

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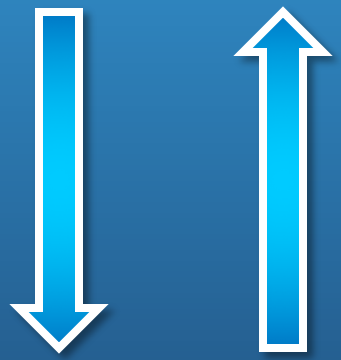
What to Research?

What question(s) do we want to answer?



What do we already know?

What to Research?

- What question(s) do we want to answer?
  - *I want to find out whether the use of a learning system that incorporates social media capabilities and gamification will increase student learning and retention in CS*
- **Step 1**: Think about something you have
  - What do students do with each other?
  - What do you do when interacting with students?

We're ready to do our study, right?

Hmmm, maybe not…

What to Research?

- What do we already know?
  - We know that following has been found:
    - Greater student engagement = > greater learning and retention
    - Social media has strong engagement in XXX
    - The use of achievements in games => resilience & increased effort when failure occurs
    - Having students work together on problems increases learning
    - . . . Etc.

What to Research?

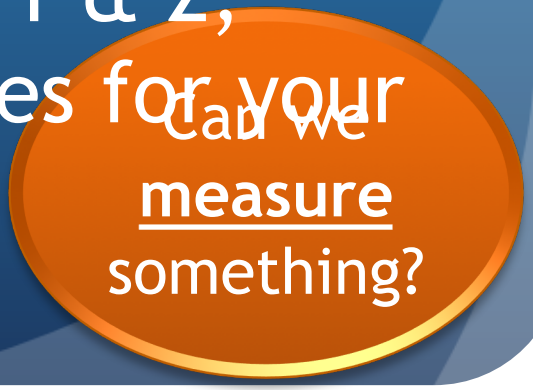
- What do we already know?
- **Step 2**: Take a look at what you came up with in Step 1. Make a list of **relevant areas or topics** of research that may **impact** your **question** of interest. Then either:
  - Indicate what we know about that area *or*
  - Flag it as an area to review the literature to determine what we know

What to Research?

- Formulate Goals/Objectives
  - We want to determine whether the use of team-based achievement goals increases student learning of software testing techniques

Step 3: Putting together Steps 1 & 2, formulate some goals/objectives for your idea

- Formulate Research Questions
  - Is it testable?



What to Research?

Can we **measure** something?

- Formulate Research Questions
  - **Is there a significant difference** *between student learning of software testing techniques for students that used SEP-CyLE's team-based achievement goals capabilities and those who did not?*

Cause & Effect

  - **Is there a significant relationship** *between the level of achievement a team is able to successfully achieve and how well the students in that team are able to correctly apply software testing techniques?*

Relation ships

Types of Significance

- Statistical Significance
  - Helps you learn how likely it is that these changes occurred randomly and do not represent differences due to the program
  - *p* values
- Substantive Significance
  - Helps you understand the magnitude or importance of the differences
  - Effect Size

How to test our RQs

Is there a significant difference *between student learning of software testing techniques for students that used SEP-CyLE's team-based achievement goals capabilities and those who did not?*

Step 4: Now translate your goals/objectives into research questions

How to test our RQs

Is there a significant difference *between student learning of software testing techniques for students that used SEP-CyLE's team-based achievement goals capabilities and those who did not?*

How will we test it?

- How do we define student learning?

Now we're ready to do our study, right?

Hmmm, maybe not…

- *Ability to correctly conduct appropri… software testing techniques when given a sample scenario*

How to test our RQs – Make it Measurable

Step 5: Determine how will you will test your research questions?

Now we're ready to do our study, right?

even be measured)?

Actually, there is more…

What is Experimental Design?

An experiment is defined as a research process that:

- allows study of one or more variables
- which can be manipulated under conditions that permits collection of data
- that show the effect of such variables in a *clear, unconfused* fashion

Cause & Effect

Key issues – Experimental Control

- Comparison Groups
  - Experimental or Treatment Groups
  - Control Group
- Random Assignment
  - Quasi-Experimental Design
- Pretests/Posttests

Critical!

Is there a **significant difference** *between* …

Experimental Group –	Pretest	Treatment	Posttest
Control Group –	Pretest		Posttest

Good Experimental Design

Group	Semester	Pretest	Treatment	Posttest
Control	Fall	Yes	No	Yes
	Spring	Yes	No	Yes
Experimental	Fall	Yes	Yes	Yes
	Spring	Yes	Yes	Yes

Step 6: Describe and plan how you would incorporate the use of control and experimental groups in your specific situation. Make a table representing this (may include classes, semesters, etc.)

<u>What</u> happens if the Control and Experimental groups are in different semesters?

Compare Pretests to (hopefully) show the groups are equivalent

Common Myths

- **Myth 1**
  - *"Collect whatever data you can, and as much of it as you can. You can figure out your questions later. Something interesting will come out and you will be able to detect even very subtle effects"*
  - **Reality** - NO! Generally collecting lots of data without a plan just **gets you lots of garbage**, and you may even go hunting to try to come up with questions to ask based on the data you collected instead of your goals.

Common Myths

- **Myth 2**
  - *"It's better to spend time collecting data than sitting around thinking about collecting data, just get on with it"*
  - **Reality** - A well designed experiment will save you tons of time.

Common Myths

- **Myth 3**
  - *"It does not matter how you collect your data, there will always be a statistical 'fix' that will allow you to analyze that."*
  - **Reality** - NO WAY! You may end up with data that you **can't make any conclusions with** because there are so many flaws with the design. Big problems are non-independence and lack of control groups.

Common Mistakes

- No control group
- No pretest
- Confounding variables not controlled or accounted for
- Attrition
- Inappropriate conclusions
- Causal conclusions in correlational studies
- Invalid, ambiguous or mismatched measures for the questions being asked
- Only looking at main effects and not interactions
- Experimenter bias (cultural, gender, etc.) and "nonsense" conclusions
- Inappropriate data analyses

Working with Human Subjects

- Need IRB approval
- Cannot force or coerce students to participate
- Participants may leave the study at will
- Privacy concerns
- Benefits outweigh the risks to participants (prefer no risks)