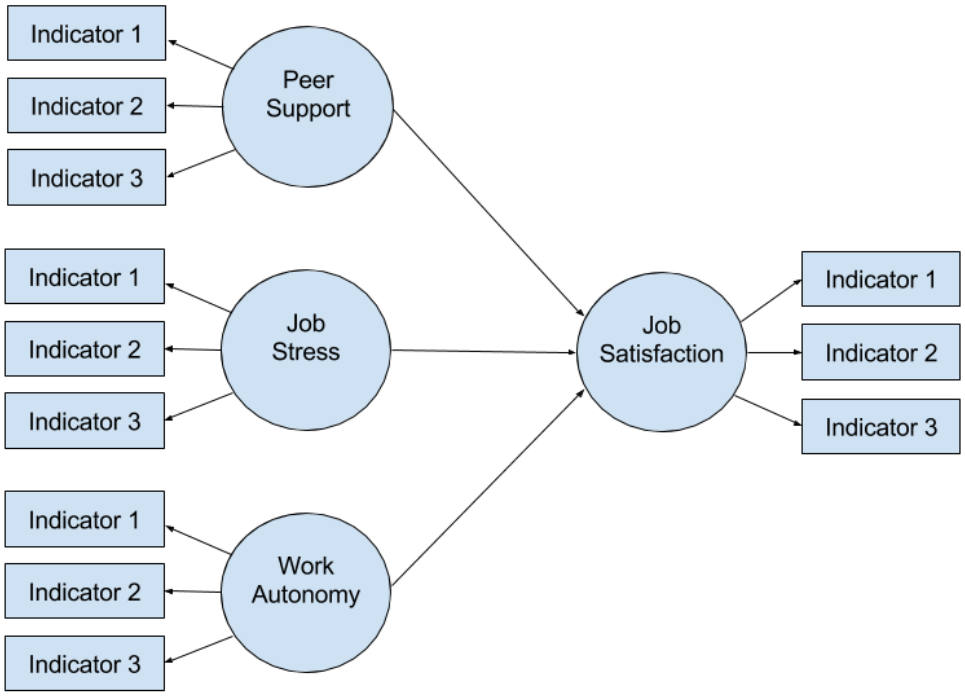
01a: Course Overview, Measurement, and Variables

1. Test and Instrument/Scale Development

In this course we will learn skills that will allow us to:

- develop content-valid classroom tests,
- select or develop relevant scales to measure constructs (i.e., latent variables, see Figure 1 below),
- read, produce, and assess evidence for reliability for scores from tests or scales,
- read, produce, and assess evidence for validity for scores from tests or scales,
- present reliability and validity results in an understandable, yet academic, manner, and
- learn about modern methods of measurement such as Rasch (pronounced like rash) and Item Response Theory models.

Figure 1: One possible model for Job Satisfaction.



2. Measurement, Assessment, and Evaluation

Measurement

Systematic procedure for assigning numeric values or labels to distinct units or characteristics associated with a given variable; or, quantifying or assigning a number to express the degree to which a characteristic is present or assigning labels to characteristics to express distinctions that are present in a variable. Measurement results in an observation of some phenomenon (e.g., current temperature is 86F or 36C, his test score is 7 of 10 correct, her anxiety score is 12 from a maximum of 15).

Short definition: Systematic process of assigning labels or numbers to categories of a variable.

Examples

- Height — We observe that David is 6'3" (1.9 meters) tall.
- Weight — Joe noted his morning weight to be 225 lbs. (16.07 stones or 102 kilos).
- Political Party Affiliation — Gunther's voter registration is with the Republican party.
- Math Test Score — Marijke scored 98% correct on the math test.
- Sex — Questionnaire item: "What is your biological sex? Mark one."
  _____ Female
  _____ Male, etc.

Evaluation

Assignment of value or importance to something that was measured; evaluation results when one attaches value to the measurement of some phenomenon, thus evaluation is the process of making value judgments based upon information that is combined with measurement. Usually measurement scores are compared against a standard of some sort to make value judgements for evaluation purposes (e.g., his score is better than 98 percent of students so he did very well; her reading efficacy scores are very low suggesting she has little confidence in her reading ability).

Examples

- Height and Weight — Shorter and lighter individuals are better suited to be jockeys.
- Test Score = 98% — High scores indicate mastery of tested content and therefore suggests readiness to proceed to advanced content.
- Test Score = 32% — Low scores indicate poor understanding of tested content and therefore low scorers should restudy content before moving to advanced material.
- Test Anxiety — High test anxiety is problematic since it may lead to self-debilitating behavior that could negatively affect test performance.
- Letter Grading Scale — A = 90% to 100%
B = 80% to 89.99%
C = 70% to 79.99%
D = 60% to 69.99%
F = 0% to 59.99%
Assigning letter grades is a form of evaluating student performance, e.g., 93% represents greater achievement and understanding than 88%.

Assessment

Assessment is a collection of measurements, or measures, used to determine whatever phenomenon is being studied. Note that assessment does not include making judgments, which is reserved for evaluation. Assessments can take several forms including tests, performances, interviews, and observations.

Examples

- Reading Skill — Student reading test scores and teacher observations of student reading performance during voiced readings used to evaluate student reading skill.
- Mathematics Skill — Assessed via a battery of tests ranging across multiple math domains.
- Cardiovascular Endurance — Her cardiovascular endurance was assessed by her performance on a 12-minute run test, VO2 max testing, and exercise stress testing.

In summary, **measurement** is the process of obtaining a score or label for a category of variable, **assessment** is the use of multiple measures to collect varied information about a variable or phenomenon, and **evaluation** is making judgements about a score or scores obtained from measurement or assessment, usually be comparing that score or scores against some standard.

3. Roles for Measurement and Evaluation in the Classroom

Formative Evaluation

Used to monitor learning progress during instruction, and to provide continuous feedback to both student and instructor concerning learning successes and failures; such feedback assists students in identifying weaknesses that need correction, and helps instructors determine appropriate remedial work for students and identify instructional areas in need of modification. This type of evaluation provides indications of student understanding/achievement and helps to monitor instructional effectiveness. Formative evaluations result most from continuous assessments, both formal (classroom quizzes, seatwork, etc.) and informal (watching student behavior, questioning, etc.).

Summative Evaluation

These evaluations, based on formal assessments, are primarily used to assign achievement grades or certification of mastery, and so usually they occur at the end of a course or unit of instruction. Summative evaluations most typically determine the extent to which instructional objectives have been; summative evaluations can also be used judge the appropriateness of course objectives and the effectiveness of instruction.

Diagnostic Evaluation

This type of evaluation is used when standard formative evaluations do not adequately determine learning problems for students; that is, if a student continues to fail even after prescribed instructional alternatives are used, then a more detailed diagnosis is needed. The primary goal of diagnostic evaluations is to determine the causes of learning problems and to formulate a plan for remedial action. Finally, diagnostic evaluations are used to determine those skills necessary for achievement that students may lack; identifying such poorly developed skills will lead to better remedial action to assist students with learning

Preliminary Evaluation

Refers to initial judgments concerning new students, with such judgments based primarily upon instructor-student interactions.

4. Maximum and Typical Performance

Typical Performance

In classroom settings typical performance is indicative of day to day output or behavior; usually this type of performance is not desired in testing situations, so achievement tests that tap this type of performance are seldom used. Usually, instruments that measure typical performance deal with attitudes rather than achievement (e.g., measuring anxiety, efficacy, motivation, etc.).

Maximum Performance

Top-level performance; performance that typically results when highly motivating or important tests are used; most formal measures or assessments elicit maximum performance. Tests on which grades are based should also assess maximum performance.

5. Variables

Variables

A **variable** is anything that varies and has more than one unique category.

Examples

- Age in years = 1, 2, 3, 4, 5, 6, …, 48, 49, 50, etc.
- Weight in pounds = 0, 1, 2, 3, etc.
- Test Scores = EDUR 8131 test scores may range from 0% to 100% correct.
- Sex: Biological distinction with Female and Male being most common categories of sex.
- Gender: Psychological state often measured on scale that ranges from feminine to masculine with multiple steps between these anchor points.

Sometimes students think that a variable is something that changes. This is a common conclusion since many are familiar with experimental studies in which levels or conditions of a variable are manipulated or changed so the effects of that manipulation can be observed (e.g., determining/manipulating which reading intervention program students use to learn how student reading achievement improves over time). Change, however, is not a necessary condition for a variable.

Examples

- Race is a variable but does not change for an individual. Race is a variable because it varies across individuals.
- Eye color does not change for an individual but does vary across individuals.
- Sex chromosomes also do not vary, they remain either XY or XX, but do vary across individuals.

A **constant** occurs when only one category of a variable is present for a study situation.

Examples

- If everyone in this class is female, is sex a variable in this class?

If only females are present, then sex is a constant in this class.

- Students in urban areas whose parents are educators will perform better in mathematics than students whose parents are not educators.

Variables

1. Parent's occupation (educator vs. non-educator).
2. Math performance

Constants

1. Urban location (no other location type mentioned)
2. Students (these individuals are not compared against non-students)

Exercise

What are the variables in these hypotheses?

1. There is no difference in Body Mass Index (BMI) between females and males?

Answer: Two variables: Sex and BMI

Why are female and male not variables?

Answer: These are categories of the variable sex. It is easy to confuse categories with variables, so watch for this when identifying variables or writing hypotheses.

2. The higher one's level of academic self-efficacy, the lower will be one's test anxiety (note that academic self-efficacy and test anxiety are measured on a 20-point scale ranging from 1 = low to 20 = high).

Answer: Two variables: Academic Self-efficacy and Test Anxiety

3. Below is a description of students in a classroom; which are variables or constants?

- Age = all students are 21 years of age
- GPA = ranges between 1.65 and 3.86 for students in class
- Race/Ethnicity = students are either Asian, Pacific Islanders, or Amer. Indian
- Transportation to class = all students walk to class

Answer:
Age = constant
GPA = variable
Race = variable
Transportation to class = constant

6. Scales of Measurement

There are four scales of measurement: Nominal, Ordinal, Interval, and Ratio. Each are described below.

Nominal

Just categories present with no inherent rank among categories, so there is no inherent way to rank or sort categories of the variable.

Examples

- Sex (female vs male)
- Race/Ethnicity (Asian, Amer. Indian, Black [Afr. Amer.], Latino/Latina, etc.)
- Type of flower (daisy, rose, dandelion, petunia, etc.)

Ordinal

Categories present, but also with inherent rank among categories so one could sort categories from less to more, worst to best, lowest to highest, etc.

Examples

- Questionnaire Item:
  "Rate instructor on the following dimension item: The instructor's content was well organized."
  Strongly disagree
  Disagree
  Somewhat agree
  Agree
  Strongly Agree

  With this example we can sort these responses from least to most favorable, but we could not pinpoint the exact difference among categories because the scale is loosely defined and subject to interpretation by those who answer this item.

- SES, socio-economic status, originally measured by three indicators: educational level, income, and occupational prestige.
  High
  Middle
  Low

  If one is simply presented with these three categories, these can be ranked, but without more information, without more precision in measurement, we don't know the exact difference among each category.

Interval

Categories, that can be ranked, with equal interval based upon the scale or device used to measure that variable. For example, the scale used to measure distance in inches is well defined and the differences between 1 and 2 inches is the same as the difference between 6 and 7 inches, i.e., 1 inch remains the same throughout the same. Same is true for time measured in seconds, weight measured in pounds or kilos, etc. The difficulty with interval scaling is finding variables that lack a true zero point (the fourth requirement used to define Ratio variables, see below), few variables with equal interval scales have no zero point.

Ratio

Variables that possess categories, natural rank among categories, equal interval with scale/device used to measure those variables, and true zero point. Examples:

- time to complete a task
- counting objects in a box
- number of points scored during a game

This is the only type of variable for which one can compute ratios (e.g., if it takes me 10 seconds to complete at task, but takes you only 5 seconds, then it took me, 10/5 = 2, twice as long)

Equal interval characteristics – this is a function of the measuring scale or device used, not of the categories themselves. Examples of measurement scales that produce equal intervals:

- ruler in millimeters or inches,
- stop watch to record in seconds,
- counts of number of items scored correctly on tests,
- percentage of items scored correctly on tests, e.g., Test 1 scores:

  Bryan = 45%
  Miriam = 85%
  Melinda = 100%
  Ratio = 45/100 = .45*100 = 45%

7. Qualitative vs. Quantitative Variables

The distinction between these two classification of variables rests solely on the scale of measurement for each variable:

Nominal	= Qualitative/Categorical
Ordinal	= Quantitative (sometimes treated as qualitative if categories are few)
Interval	= Quantitative
Ratio	= Quantitative

If categories of a variable can be ranked, it is quantitative, if not ranked then qualitative.

Sometimes a variable has categories that can be ranked, but we treat that variable as qualitative (e.g. SES with three categories of low, middle and high; it is easier for data analysis via statistics to treat this variable as qualitative rather than quantitative).

Qualitative Variable (= Nominal Variable = Categorical Variable)

Nominal or categorical (i.e., no inherent rank to categories), or ordinal variable with limited number of categories (e.g., SES with three categories of low, middle, high).

Examples

- Sex
- Race
- Types of flowers

Quantitative Variable

Ranked categories (ordinal, interval, or ratio, assuming the ordinal measure contains many ranked categories).

Examples

- Number of test items answered correctly
- Weight in lbs.
- Number of pages read over the summer
- Age
- Score on Test 1

Sometimes students equate a quantitative variable with numbers and assume that if numbers are not present, then the variable cannot be quantitative. Below is a scale that could be used to measure one's current level of happiness with life and this scale has categories that can be ranked from happiest to saddest.

Source: http://www.backtosafety.com/posts/emotional-check-in-chart/

Things to notice:

- no numbers are used in the happiness scale above
- despite lack of numbers, this scale demonstrates a quantitative response
- categories can be sorted, or ranked, from most to least happy
- yet, due to lack of precision of measurement, this scale is at best ordinal

Exercise

Identify the variable or variables for each statement/hypothesis, indicate whether the variable is qualitative of quantitative, and identify the scale of measurement (Nominal, Ordinal, Interval, or Ratio).

1. Everyone buys a bag of apples, and we each count the number of whole apples in our bags.

Answer: Variable is number of apples in a bag and it is quantitative. The scale of measurement is ratio.

- Categories: Count of apples in a bag has distinct categories which are 0, 1, 2, 3, etc.
- Rank: The count can be ranked from less to more, i.e., 7 apples > 6 apples.
- Equal Intervals: Yes, since only the count is considered and not size, weight, or anything else. Thus, the difference between 2 apples and 1 apple is 1 apple. The difference between 15 apples and 14 apples is 1 apple. This count of 1 apple represent the same amount of difference no matter where on the scale (on the count of apples) we place this 1 apple.
- True Zero: There is a true zero point with count, 0 or no apples.

Since count of apples has all four criteria present it is a ratio variable.

Recall that one way to determine if a variable is ratio is to consider whether one can form a logical ratio between two quantities. For example, if I have 5 apples and someone else has 15 apples, then the other person has three times as many apples as I have: 15/5 = 3. Ratios can only be formed with ratio level data.

2. Time it takes individuals to complete a given task.

Answer: Quantitative and Ratio: Since the categories of time are rank-able (i.e., 4 seconds is longer than 3 seconds, and 3 seconds is longer than 2 seconds, etc.), the time it takes one to complete a task represents a quantitative variable. This is also a ratio variable since differences in seconds is precise and equal (e.g., the difference between 12 and 13 seconds is 1 second, and the difference between 115 seconds and 116 seconds is 1 second, and the 1 second difference across this range is equal), and there is true zero point.

3. The classification of people into student groups in high school (e.g., nerds, athletes, and losers, the names of group classifications used in my wife's high school in the 1970s).

Answer: These groups represent categories of a qualitative variable and therefore nominal (no natural rank to these labels; they are simply different groups).

4. Take the classification used above (nerds, athletes, losers) and provide a different label now with numbers, like this: group 1, group 2, and group 3.

Answer: This variable represents a simple label transformation (nerds = 1, athletes = 2, losers = 3). Despite using numbers 1, 2, and 3, this is not a quantitative variable. If there is no inherent rank to these categories, changing the labels will not change the scale of measurement. This example illustrates that use of numbers does not necessarily make a variable quantitative, so one should not focus on whether a number is used to decide whether a variable is qualitative vs. quantitative. Instead, one should determine whether the categories or the measuring device has a natural rank.

5. Computer chip makers – AMD, SIS, and Intel.

Answer: Since these represent names of different companies, with no natural rank to the names of the companies, this would be a qualitative variable, thus nominal.

8. Manifest and Latent Variables

Manifest Variables

Loosely described, **manifest** variables are those that can be directly observed or measured.

Examples

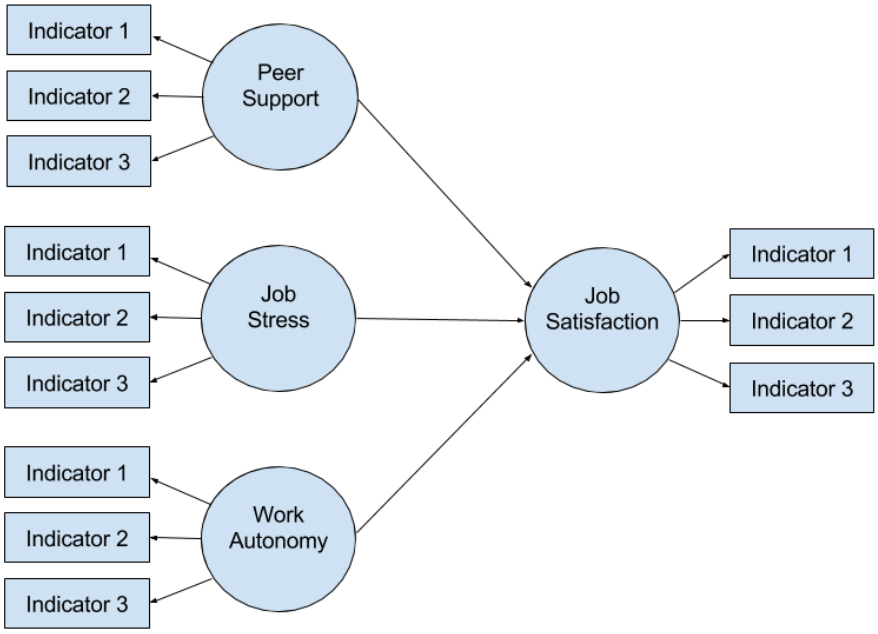
- Height measured in inches
- Weight measured in pounds
- Age in years
- Income in dollars

Latent Variables

Latent variables are not usually directly observed or measured, and must be inferred from indicator variables (e.g., variables used to represent, hence indicate, latent variables). Latent variables are constructed through composite variables as measured through scales and indexes.

Figure 1, displayed earlier and presented again below, shows four latent variables: Peer Support, Job Stress, Work Autonomy, and Job Satisfaction. Each latent variable in Figure 1 is measured by responses to three indicators each.

Figure 1: One possible model for Job Satisfaction.



Examples

- Latent Variable = Work Autonomy; measured through responses to items/indicators using a 5-point scale of 1 = "Strongly Disagree" to 5 = "Strongly Agree":
    - I often get to make the final decision on problems faced at work
    - My input is heard and valued at work
    - My work activities must be approved by managers
- Latent Variable = Test Anxiety; measured through responses to the following items/indicators using a 5-point scale ranging 1 = "Not at all like me" to 5 = "Very true of me":
    - Before important tests I start to feel anxious
    - My heart often beats fast before or during tests
    - During tests I often think that I will do poorly compared to others
    - I worry about how my poor test performance will affect my overall grades
- Latent Variable = Multiplication Understanding; measured through student responses to one or more mathematics tests that assess multiplication.
- Other examples measured in similar ways: reading comprehension, life satisfaction, academic self-efficacy.

In research latent variables are often constructed by computing mean or total scores, referred to as composite scores, from responses to scale indicators or items, hence latent variables are sometimes called **constructs**.

Example

This example briefly shows the process by which indicators are identified/developed and then used create a composite score.

1. Latent Variable = Test Anxiety
2. Test Anxiety is thought to be composed of two dimensions, shown below
    - Dimension 1: Physiological (somatic, emotionality) Reactions
        - sweating
        - headache
        - upset stomach
        - rapid heartbeat
        - feeling of dread
    - Dimension 2: Negative Cognition/Thoughts
        - expecting failure
        - negative thoughts
        - frustration
        - comparing oneself to others negatively
        - feelings of inadequacy
        - self-condemnation
3. To measure Test Anxiety, it is important to use scale items/indicators that measure both dimensions identified above.
4. Possible Indicators of Physiological Reactions
    - Before or during tests you feel your heart start to beat faster.
    - You get upset stomach while taking tests.
    - When taking a test, you get a feeling of dread.
5. Possible Indicators of Negative Cognition
    - While taking tests you think about how poorly you are doing.
    - You expect failure or poor grades when taking tests.
    - You become frustrated during testing.
6. Response options for the above 6 indicators may range from 1 to 7 with the following anchor wording:
    - 1 = Not at all like me
    - 7 = Very much like me
7. Suppose this scale of 6 items were administered to students. One possible student's responses to these 6 items appears below using the 1 (Not at all like me) to 7 scale (Very much like me)
    - Heart beats faster = 2
    - Upset stomach = 3
    - Feel dread = 2
    - Think of poor performance = 2
    - Expect failure = 1
    - Frustrated = 1
8. Composite Score for this student would be calculated as follows:
    - Sum = 2+3+2+2+1+1 = 11
    - Mean is 11 / 6 = 1.83
    - Composite Test Anxiety is 1.83 on a 1 to 7 scale, so this student seems to have low Test Anxiety

9. Independent and Dependent Variables, Predictor and Criterion Variables

I use independent variable and predictor synonymously and view dependent and criterion as synonyms too. For some an independent variable is one manipulated by a researcher in an experimental study and a dependent variable is that observed after manipulating the independent variable. Thus, use of terms independent and

dependent imply causation. If variables are not manipulated, or the outcome of manipulation, or if one is studying only relationships, predictions, or correlations, then variables should be called predictors and criterions (or is it criteria?).

The easiest way to identify independent (IV) and dependent (DV) variables is to consider the logical or observed time sequence for the variables.

- Independent/Predictor: variable that comes first in time sequence
- Dependent/Criterion: variable that follows IV in time sequence

Examples

For each, identify the IV and DV and determine whether each is qualitative or quantitative.

1. There will be a difference in math scores between males and females.

Answer:
IV = sex (female/male), Qualitative
DV = math scores, Quantitative
Reason = one's sex precedes math performance in time

2. Class size and student final test scores are not related.

Answer:
IV = class size, Quantitative
DV = student final test scores, Quantitative

3. Students whose parents are educators will earn higher scores on a test than students whose parents are not educators.

Answer:
IV = occupation of parents, Qualitative
DV = test scores, Quantitative
Sometimes folks think students is a variable; note that it does not vary since the focus of this hypothesis is upon parents of students, not parents of students vs non-students, so students is a constant.

4. For females in public schools, researchers found that one's mathematics attitude predicts well one's mathematics achievement. (Mathematics attitude is a latent variable and is formed as a composite score from responses to several indicators.)

Answer:
IV = mathematics attitude, Quantitative
DV = mathematics achievement, Quantitative

Constants: sex, because there is only one category, female; school setting, because only public schools included, nonpublic schools not included in hypothesis

10. Identifying Variables in Studies (with focus on Reading Tables or Graphs)

Example 1

Europe's Journal of Psychology, 8(1), pp. 159-181, doi:10.5964/ejop.v8i1.301
www.ejop.org

Exploring the Relationship among Loneliness, Self-esteem, Self-efficacy and Gender in United Arab Emirates College Students

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Table 1. Descriptive statistics and Cronbach's alpha values (n = 495).

	Males (n = 203)		Females (n = 292)		Total (n = 495)		
Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	α
Loneliness	40.96	11.08	45.06	9.93	43.38	10.60	.91
Self-esteem	29.43	5.50	26.97	4.44	28.60	5.14	.76
Self-efficacy	28.37	5.03	27.54	4.72	27.88	4.68	.87

Based upon this table, what are the IV and DV for this study?

Answers:
Variables are: sex (male and female), loneliness, self-esteem, and self-efficacy
IV = sex
DV = loneliness, self-esteem, and self-efficacy

Example 2

AN EMPIRICAL INVESTIGATION INTO THE RELATIONSHIP BETWEEN COMPUTER SELF-EFFICACY, ANXIETY, EXPERIENCE, SUPPORT AND USAGE

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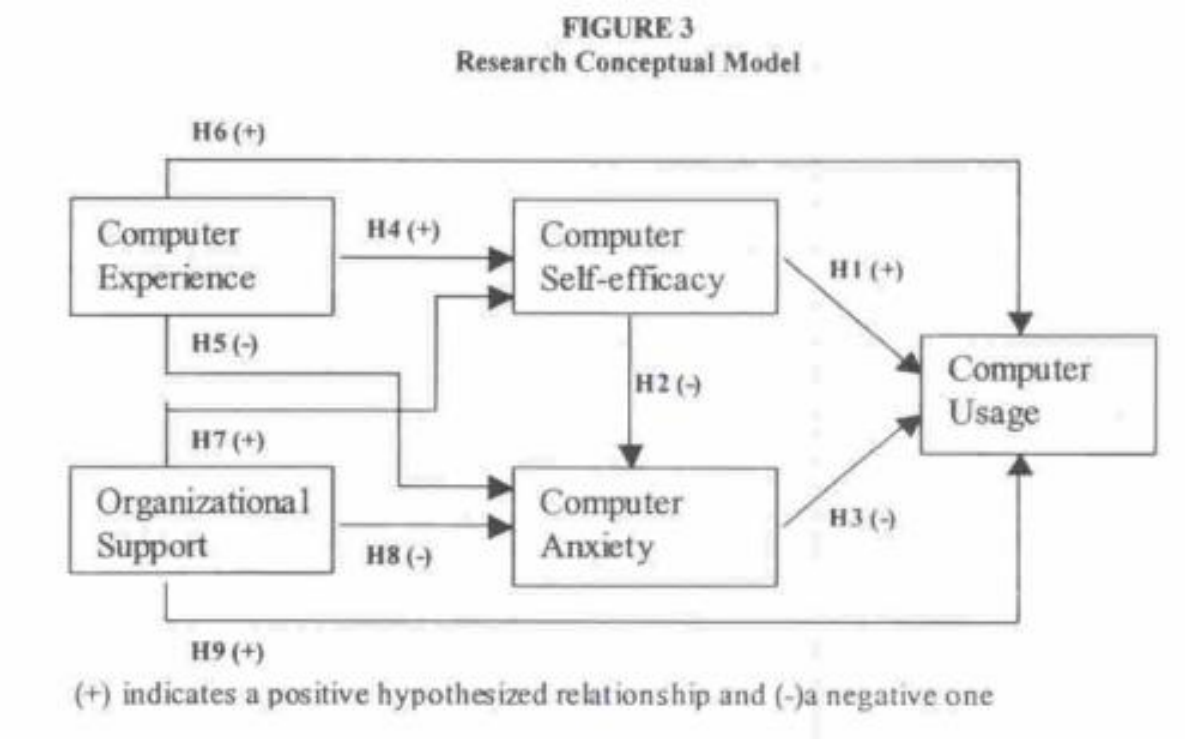

What do the arrows tell us in this theoretical model? Note that arrows show directions on hypothesized influence; IV point to DV. Which are IV and DV in this model?

Answers:
Overall DV = Computer usage
Two clear IV = computer experience, organizational support
Mixed IV and DV = Computer self-efficacy, computer anxiety

Example 3

Study Habits, Skills, and Attitudes

The Third Pillar Supporting Collegiate Academic Performance

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TABLE 2

Reliability Artifact Distributions for SHSA Constructs and GPA Criterion

Categories	$M\ r_{xx}$	$SD\ r_{xx}$	k_{rel}
Predictors			
Aggregate measures	0.82	0.10	15
Study habits	0.83	0.07	30
Study skills	0.71	0.07	23
Study attitudes	0.83	0.09	12
Study motivation	0.71	0.09	18
Study anxiety	0.75	0.05	11
Deep processing	0.68	0.09	24
Surface processing	0.64	0.09	16
Strategic processing	0.73	0.09	12
Metacognitive skills	0.79	0.06	7
Criterion			
First-semester freshman GPA	0.83	0.02	3
Freshman GPA	0.83	0.02	3
GPA	0.83	0.02	3

Note. SHSA = Survey of Study Habits and Attitudes; $M\ r_{xx}$ = mean of reliability distribution; $SD\ r_{xx}$ = standard deviation of reliability distribution; k_{rel} = number of independent reliability coefficients on which distributions are based.

Which are IV and DV?

Answers:

All predictor variables are IV (10 variables), an all criterion variables are DV (3 variables)

Example 4

Journal of Educational Psychology
1990, Vol. 82, No. 1, 33-40

0022-0663/90/$00.75

Motivational and Self-Regulated Learning Components of Classroom Academic Performance

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A correlational study examined relationships between motivational orientation, self-regulated learning, and classroom academic performance for 173 seventh graders from eight science and seven English classes. A self-report measure of student self-efficacy, intrinsic value, test anxiety, self-regulation, and use of learning strategies was administered, and performance data were obtained from work on classroom assignments. Self-efficacy and intrinsic value were positively related to cognitive engagement and performance. Regression analyses revealed that, depending on the outcome measure, self-regulation, self-efficacy, and test anxiety emerged as the best predictors of performance. Intrinsic value did not have a direct influence on performance but was strongly related to self-regulation and cognitive strategy use, regardless of prior achievement level. The implications of individual differences in motivational orientation for cognitive engagement and self-regulation in the classroom are discussed.

Purpose of study: determine whether motivation components and self-regulated learning predict academic performance for 7th grade students.

Table 2
Zero-Order Correlations Between Motivation and Self-Regulated Learning Variables and Performance

Variable	Grade 1	Seat-work	Exams/ Quizzes	Essays/ Reports	Grade 2
Motivation components					
Intrinsic value	.25**	.21**	.20**	.27**	.30***
Self-efficacy	.34***	.19*	.24**	.25**	.36***
Test anxiety	−.24**	−.14	−.21**	−.14	−.23**
Self-regulated learning components					
Strategy use	.18*	.07	.20**	.19*	.20**
Self-regulation	.32***	.22**	.28**	.36***	.36***

Note. $N = 173$.
* $p < .05$. ** $p < .01$. *** $p < .001$.

How many variables are identified in this table?

Answers:
10 variables
1. intrinsic value
2. self-efficacy
3. test anxiety
4. strategy use
5. self-regulation
6. grade 1 scores
7. seat work scores
8. exams/quizzes
9. essays/reports
10. grade 2 scores

Which do you think are predictors and criterions?

Answers:
Predictors: Intrinsic value, self-efficacy, test anxiety, strategy use, self-regulation
Criteria: self-work, exams, essays grade 1, grade 2

Example 5

Comparison of Hypermedia Learning and Traditional Instruction on Knowledge Acquisition and Retention

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Study purpose is to learn whether hypermedia enhanced instruction (experimental) produces better knowledge scores than traditional instruction not enhanced with hypermedia (control).

Table2.—Declarative, Conditional, and Procedural Knowledge Posttest Results

Group	Declarative knowledge ($k = 36$)	Conditional knowledge ($k = 23$)	Procedural knowledge ($k = 22$)
Control			
M	18.42	12.17	7.92
SD	5.99	3.81	2.937
Experimental			
M	19.60	14.33	8.80
SD	5.40	4.37	3.299
p	.594	.188	.475
t	0.54	1.35	0.73

Which are IV and DV in this table? Be precise in naming the IV and DVs. Name all presented in this table.

Answers:

IV = type of instruction (experimental group = hypermedia, control = tradition)

DV = three DVs: declarative knowledge scores, conditional knowledge scores, and procedural knowledge scores.