A close-up photograph of a person's hands using a metal tool, possibly a wrench or a similar fastener, to work on a piece of metal. The background is slightly blurred, focusing attention on the hands and the tool. The overall tone is industrial and focused.

**Every  
relationship  
goes through  
a struggle,  
but only strong  
relationships  
get through it.**

ILIKETOQUOTE.COM

ILIKETOQUOTE.COM

How do you test for a relationship or the strength of a relationship between two variables?

What is categorical data?

What differentiates categorical from quantitative data?

Formulate some simple questions that can be answered either "yes" or "no".

Do you think there might be a relationship between any of these things?

How strong is the relationship?

To find the existence and strength of a relationship between categorical data we use two-way tables.

## Two-Way Tables

	Question A			
		Yes	No	Total
Question B	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	a + b + c + d

		Question A		
		Yes	No	Total
Question B	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	a + b + c + d

$$a+b+c+d = n$$

What do these probabilities tell you?

Joint  $a/n$

$c/n$

		Question A		
		Yes	No	Total
Question B	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	a + b + c + d

$$a+b+c+d = n$$

What do these probabilities tell you?

Marginal  $(a+c)/n$

$(a+b)/n$

		Question A		
		Yes	No	Total
Question B	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	a + b + c + d

$$a+b+c+d = n$$

What do the following tell you?

Conditional  $a/(a+c)$

$b/(b+d)$

## An example

	Have a Job			Total
		Yes	No	
Own a vehicle	Yes	8		10
	No			30
	Total	26	14	40

What is the probability that a person selected at random:

has a job and owns a vehicle?

who has a job also owns a vehicle?

who owns a vehicle also does not have a job?

	Drink Coffee			
Drink Soda		Never	Sometimes	Often
	Never			
	Sometimes			
	Often			

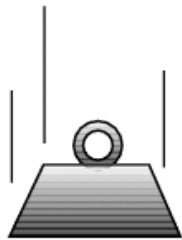
Another?


Your turn. In pairs:

- Think of two categorical questions on topics that might be related.
- Ask your question to everyone in the class.
- Investigate using a two-way table whether there is a relationship between the two variables.
- Present your finding to the class.

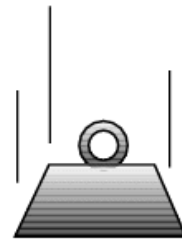
Precision and Significance in the Real World

A 1500 kg mass  
is approaching  
your head at  
45.3 m/s



Precision

LOOK  
OUT!!



Significance

Doing a study with categorical data.



## Categorical Study with Sig. Test

1. Your Question(s)/Hypotheses
2. Observed Results
3. Significance Test - all steps
4. Conclusion(s)- describe the relationship(s)

The students in a grade school were asked what goal was more important to them.

	Grade			Total
	4	5	6	
Grades	49	50	69	168
Goals				
Being popular	24	36	38	98
Sports	19	22	28	69
Total	92	108	135	335

The students in a grade school were asked what goal was more important to them.

Goals

	Grade			
	4	5	6	Total
Grades	49	50	69	168
Being popular	24	36	38	98
Sports	19	22	28	69
Total	92	108	135	335

Do you think there a relationship between these variables?

## The Chi-Square Test of Significance

Step 1: State the hypotheses

Step 2: Calculate and write down:

the Chi-Square Test Statistic

the "degrees of freedom" (df)

the p-value

Step 3: Make the decision

Step 4: State the conclusion

We are going to describe this process using an example.

Remember, your study will have different numbers and conclusions!

## Step 2: Calculate

### Observed

	Grade			
	4	5	6	Total
Grades	49	50	69	168
Popular	24	36	38	98
Sports	19	22	28	69
Total	92	108	135	335

Step 3 Make the decision

Method 1: if the confidence level from the  $X^2$  table is high enough, reject the null hypothesis, otherwise do not reject the null hypothesis.

Method 2: if the  $TV > CV$ , reject the null hypothesis, otherwise do not reject the null hypothesis.

Method 3: if p-value is low enough, reject the null hypothesis, otherwise do not reject the null hypothesis.

If using method 1:

Step 3: Make the decision

The probability of the null hypothesis being true lies between 0.75 and 0.90, therefore there is not enough evidence to reject the null hypothesis.

Step 4: State the conclusion

There is little evidence for a relationship between students' grade level and what they consider important.

If using method 2:

Step 3: Make the decision

The  $X^2$  test value (1.51)  $\lt$  the critical value (9.488) therefore the null hypothesis is not rejected.

Step 4: State the conclusion

There is no evidence for a relationship between students' grade level and what they consider important.

If using method 3:

Step 3: Make the decision

The  $p(X^2 \geq 1.51) = 0.82$ , therefore the null hypothesis is not rejected.

Step 4: State the conclusion

There is no evidence for a relationship between students' grade level and what they consider important.

Your turn: Is there a significant association by school area? Just do the significance test.

	School Area			
	Rural	Suburban	Urban	
Grades	57	87	24	
Popular	50	42	6	
Sports	42	22	5	

## Categorical Study with Sig. Test

1. Your Question(s)/Hypotheses
2. Observed Results
3. Significance Test - all steps
4. Conclusion(s)- describe the relationship(s)

Note: this conclusion is NOT the same one you do for the significance test!

Is there any relationship between eye color and hair color?

Do a complete categorical study.

Turn in. One each.