

### CS-411 : Digital Education & Learning Analytics

## Chapter 8:

## Measuring learning effects

## **Research Question**

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Is it more effective to watch MOOCs individually or in teams ?



Solo / Team

Test Score

Experimental Plan: Between Subjects, 1 dimension





### Experimental Plan: Between Subjects, 2 dimensions

		Factor 1			
		Modality 1.1	Modality 1.2		
Factor 2	Modality 2.1	Group A	Group E		
	Modality 2.2	Group B	Group D		
	Modality 2.3	Group C	Group F		

## Interaction des variables animation et collaboration sur l'inférence



### Interaction Effects

The effect of one independent variable on the dependent variable depends upon the other independent variable

### Interaction Effect ?



# **Experiment Biases**

# Were the groups really equivalent at the beginning ?

- same age (in average) → Questionnaire
- same gender ratio → Questionnaire
- same socio-cultural level → Questionnaire
- same school level → Recruitment
- same background knowledge → Pre-test
- same level for mutual knowledge (friends?) → Recruitment
- same level of intelligence → Pre-test
- same spatial reasoning → Pre-test

#### Paper Folding Test

The two figures on the left represent a square piece of paper being folded. In the second figure a small circle shows where a hole has been punched through all of the thicknesses of paper. Choose the drawing on the right that shows where the holes are after the paper has been unfolded.



Moyennes d'inférence selon les capacités de rotation mentale



Groupe selon score au PF

Were the groups really equivalent at the beginning ?

### SOLUTIONS

Control before forming groups

Distribute Equally among conditions: controlled variables

Control after forming groups

→ Verify that the groups do not differ significantly: randomized variables
Control after forming groups

➔ If the groups do not differ significantly, use covariate analysis Use "repeated measures" also called "within subjects" The same subjects pass in both conditions

Experimental Plan: Within Subjects, 1 dimension

	Factor				
	Modality 1	Modality 2			
Subjects 1, 3, 5	First	Second			
Subjects 2, 4, 6	Second	First			

COUNTER-BALANCING

(avoiding the order effect)

Pro: fewer subjects, samples are equivalent

Cons: complex order effects

# Research Sub Questions Is it more eff are they better? 2. Why are they on MOOCs 2. Why are small teams?



Processes



*Process Variables*  3. Why are they better?



### Example : The effect of persistency of information







## **Research Sub Questions**

Is it more effective to watch MOOCs individually or in small teams ?

3. Could this difference be explained by chance ?



Is this difference in group means due to **sampling** or is it the effects of condition changes?

If group 2 had been in condition 1 and group 1 in condition 2, would group 2 still get a higher performance ?

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$$m = 37.2$$

m = 38.1

m = 2.8





The sample size reduces the probability to get by chance a sample mean that is far from the population means The differences of mean are the same, but which one is more significant?



## "Significant" does not mean "large" !

Age Gender Row in classroom Teacher: A or B ? Learning style IQ Test Mental Rotation test Motivation test Level (low, medium, high) Opinions Pre-test score Post-test score Learning gain Response time Balance of participation Number of help requests Total fixarion time on X Gaze paths Sequences of actions

- ≠ types of variables
- → ≠ distributions
- → ≠ analyses

- 1. Nominal, discrete
- 2. Ordinal, ordered
- 3. Metric, continuous, <u>normal</u> (?)
- 4. Times series

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Categories	Ordinal	Metric
(Discrete)	(Scale)	(Continous)

Single	Ind: LearnStyle= Surface	Ind: Motivation= Low	Ind: IQ= 142
Value	Dep: Style = Leader	Dep: CodeQuality= Low	Dep: Score= 23

Time	Ind: {play pause back}	Ind: Attention {3 3 5}	Ind: HeartRate {60 90}
Series	Dep: gaze {O <sub>1</sub> O <sub>3</sub> O <sub>1</sub> O <sub>2</sub> }	Dep: {low low med}	Dep: RespTime {33 22 10}

Gaze {( $X_1 Y_2, \alpha_1, T_1$ }, .... }



Independent Variable

Is learning in teams more effective than learning alone ? Do students who watch the MOOC at the same time succeed better?









### Does MOOC activity increase EPFL grades?



**Table 3:** Comparison of normalized grades (z-scores) for students who participated to the MOOC (yes) and students who did not participate (no).

Course	t	df	р	MOOC(N)		Course (z-score)			d
				yes	no	yes		no	
	2.0	16	.07	226	15	0.04	=	-0.54	0.58
	2.0	15	.06	292	15	0.04	=	-0.70	0.73
	2.9	63	.00	468	49	0.04	> *	-0.34	0.38
	3.0	32	.01	322	31	0.07	> *	-0.73	0.80
	3.6	402	.00	435	230	0.11	> *	-0.20	0.31
	4.3	36	.00	434	32	0.05	> *	-0.73	0.79



## Summary

- Research Question To be answered by the experiment
- Hypothesis Expected results (A > B); an affirmation
- Independent variables What one varies between the conditions (or Factor)
- Modality
   Value of a factor
- Condition Set of (factor, modality) per group of subjects
- Control group
   The reference against which one will compare
- Dimension Number of factors
- Dependent variables How does one measure the effects ?
- Controlled variables Things you try to keep constant or to randomize
- Intermediate variables Explain the link from Independent to Dependent Variables
- "Significant" difference Probably (<5%) not due to sampling error
- Interaction effect The effect of one IV on the DV depends upon another IV
- Between/Within subject Do subjects pass in one or several conditions ?
- Counterbalancing Inverting the order of conditions for within-subject plans