

**ANÁLISIS DEL CAMBIO DE OPINIÓN DE LOS ALUMNOS ANTE UNA  
PROPUESTA EDUCATIVA; APLICACIÓN DE PRINCIPIOS BÁSICOS  
DE ELECTROMAGNETISMO EN LA ESTRUCTURA DE RED**

**ANALYSIS OF OPINION SHIFT OF STUDENTS TO AN EDUCATIONAL  
PROGRAM; APPLICATIONS OF BASIC PRINCIPLES OF  
ELECTROMAGNETISM TO NET STRUCTURES**

**Jose A. Martínez  
Manuel Ruiz Marín**



**Universidad  
Politécnica  
de Cartagena**



June, 2016

## ANTECEDENTS

### INCREASING USE OF THE “NET CONCEPT” IN THE EDUCATIONAL ENVIRONMENT

- Moodle
- Social media applied to learning
- Cooperative learning
- European Space for Higher Education



**Interaction among students is pervasive**

## **ANTECEDENTS**

### **STUDENTS HAVE TO MAKE DECISIONS IN A COMPLEX CONTEXT OF INTERACTION WITH PEERS**

- Source of conflicts
- Acquire interpersonal competences
- Team work
- Group decisions

### **TWO KEY VARIABLES IN THAT PROCESS**

**Prior opinion**

**Peer attraction**

## AIMS OF THIS RESEARCH

### EXPLORING THE OPINION SHIFT AMONG STUDENTS CONSIDERING PEER ATTRACTION

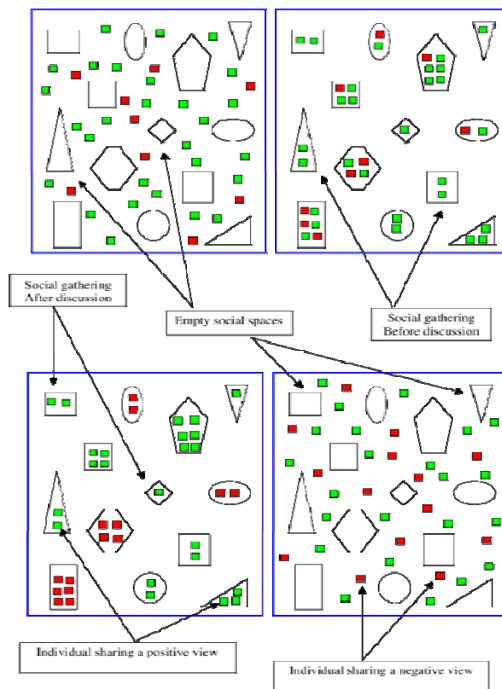
#### **Expected contributions:**

- Identify psychological and sociological variables influencing opinion shift
- Apply a novel approach based on some principles of physics (electromagnetism)

## THEORETICAL BACKGROUND

### SOME MODELS OF SHIFT OPINION DO NOT CONSIDER PEER ATTRACTION AND OTHER PSYCHOLOGICAL VARIABLES

Galam, S. (2003). Modelling rumors: the no plane Pentagon French hoax case. *Physica A: Statistical Mechanics and its Applications*, 320, 571-580

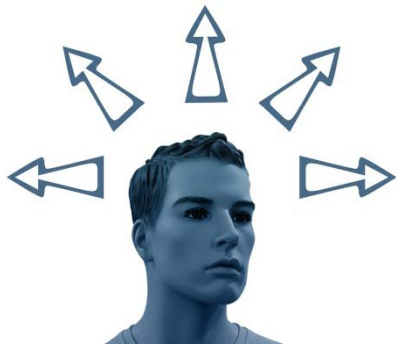


**The dynamics of opinions only depends of the opinion of others and the size and composition of the clusters**

## THEORETICAL BACKGROUND

**BUT WE KNOW THAT SOCIAL INFLUENCE IS DRIVEN BY SEVERAL VARIABLES (VERY STRONG THEORETICAL BACKGROUND):**

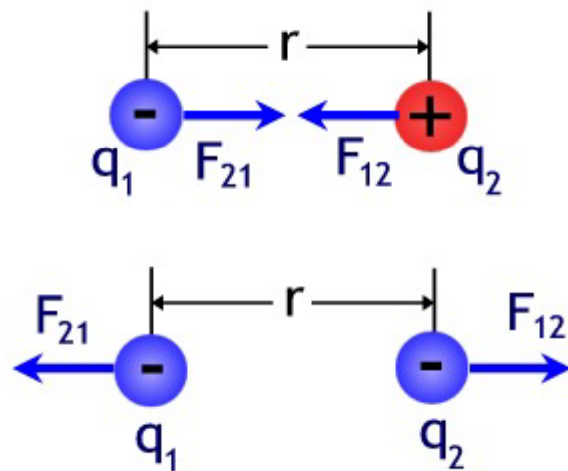
- Attraction
- Consistency
- Primary and secondary control
- Social proof



**We propose to consider such variables in the analysis of opinion shift in the net of interactions**

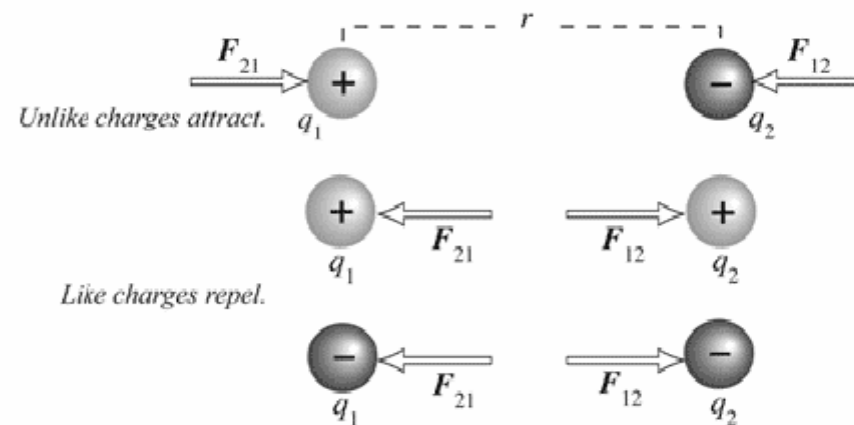
# ELECTROMAGNETISM ANALOY

## ELECTROSTATIC INTERACTION AMONG CHARGES → COULOMB'S LAW



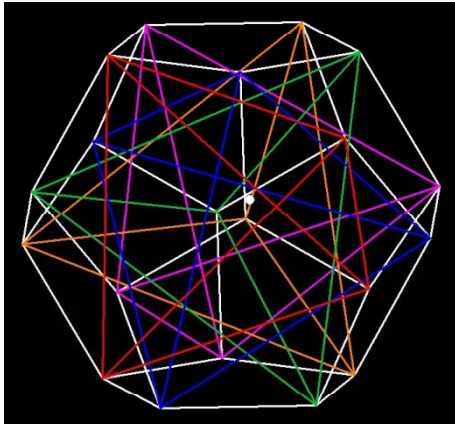
$$F = k \frac{q_1 q_2}{r^2}$$

$F$  = electrostatic force  
 $q$  = electric charge  
 $r$  = distance between charge centers  
 $k$  = Coulomb constant  
 $9.0 \times 10^9 \text{ N} \cdot \text{m}^2/\text{C}^2$

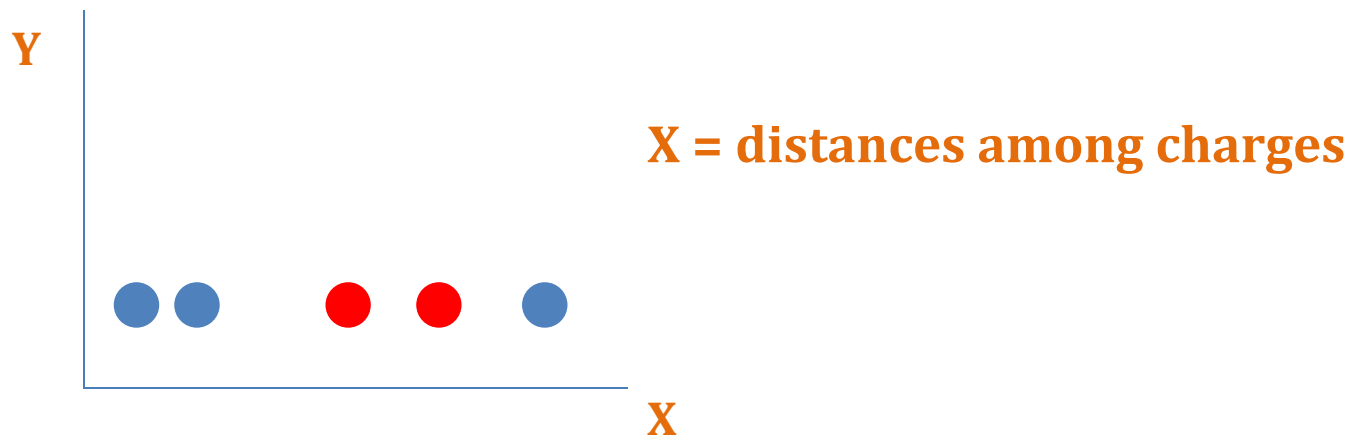


# ELECTROMAGNETISM ANALOY

## ELECTROSTATIC INTERACTION AMONG CHARGES → COULOMB'S LAW



Charges are in a 3-dimensional space but we simplify to a 2-dimensional space where all the charges are placed in the same Y-coordinate





# ELECTROMAGNETISM ANALOY

## COULOMB'S LAW BASIC EQUATIONS

-Physics

$$F_{1,2} = k \frac{q_1 q_2}{r_{1,2}^2}$$

$$F_{1,2} = F_{2,1}$$

$$F_{1,n} = \sum_{i=2}^n F_{1,i}$$

-Psychology

$$q_1 q_2 \neq q_2 q_1$$

$$k_{1,2} \neq k_{2,1}$$

$$F_{1,n} = \sum_{i=2}^n F_{1,i}$$

# ELECTROMAGNETISM ANALOY

## COULOMB'S LAW BASIC EQUATIONS

-Psychology

$$F_{1,2} = k \frac{q_1 q_2}{r_{1,2}^2}$$

$q_1 q_2$

We can't measure charges, but we can measure the product between charges as an indicator of the attraction between peers

$q_1 q_2$

This product can be positive or negative, and do not modify the interpretation of the Coulomb's Law

$r$

The distance between the charges is the difference between the opinion of students

$k$

The constant of the equation depends on the material where charges are interacting, so we can use the diference between the primary and secondary control between peers.

# EMPIRICAL STUDIES: STUDY 1

## PARTICIPANTS

- 62 students of Business Administration, grouped in 4 classrooms of 20, 19, 16 and 7 individuals.
- Participation was free → we provided a reward

## PROCEDURE

- We followed the innovative proposal of Bal et al. (2015) regarding testing a new educational intervention, which was part of a project designed by us.
- We explained the new proposal for a subject to be imparted the next year stressing advantages and drawbacks (we wanted to obtain polarized opinions)

## EMPIRICAL STUDIES: STUDY 1

### VARIABLES

- Peer attraction: We use the concept of “affinity”, measured in a scale from -5 to +5, avoiding zeros.
- Opinion to the new format of the subjects: 0-10 scale
- Leadership/gregarious: Primary and secondary control (Martínez & Soler, 2015)
  - Primary control: *I am an individualist, I like to take control. I am independent and autonomous, and I like to influence things and situations, rather than adapt to them;*
  - Secondary control: *I am a person who likes to adapt to situations, and limit my individualism and autonomy in order to adjust to the needs of others and the circumstances around me*

## **EMPIRICAL STUDIES: STUDY 1**

### **TIME FOR INTERACTION AND DISCUSSION**

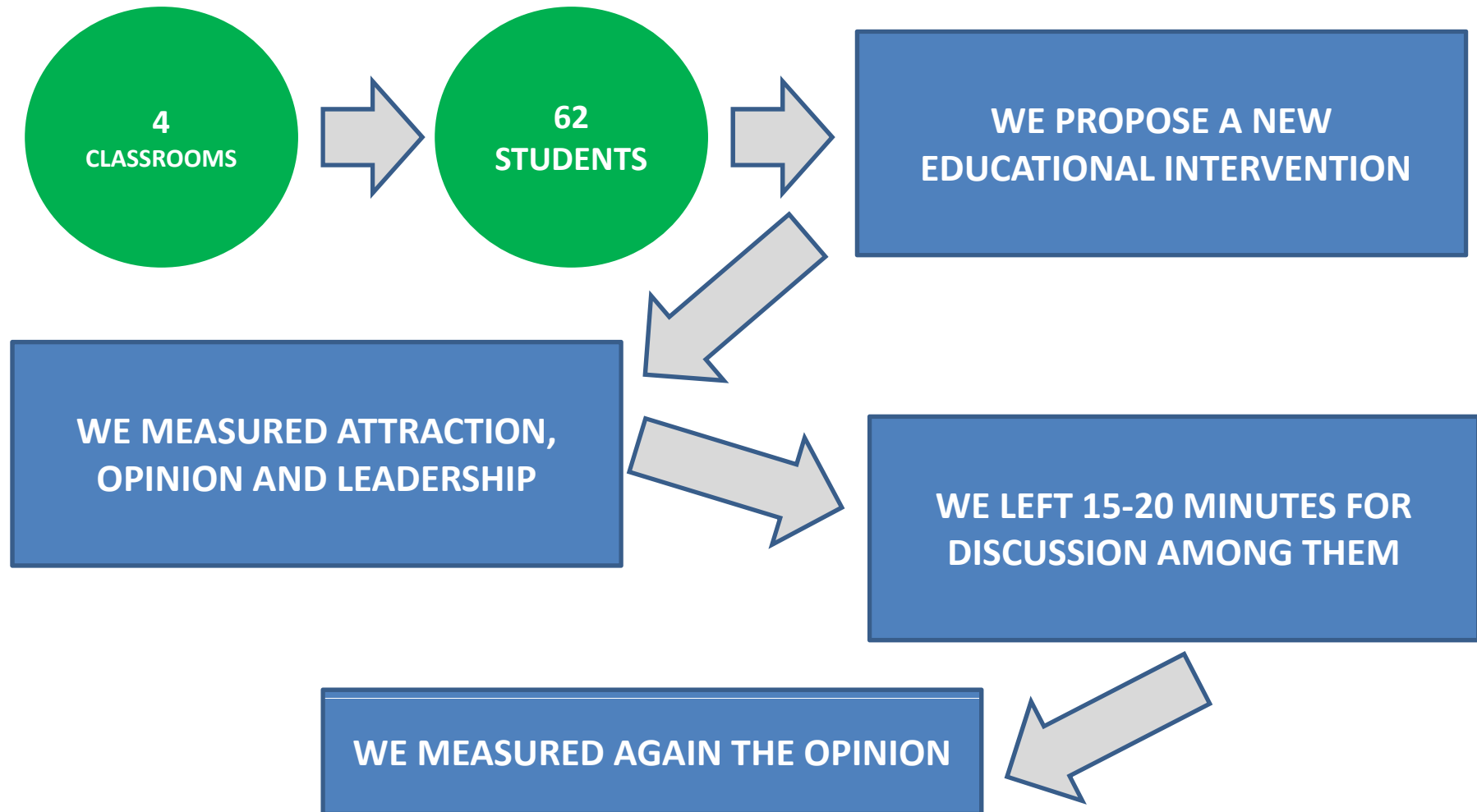
**We left 15-20 minutes for interaction and discussion. Students were encouraged to speak about the topic and to know the opinions of others. Professors abandoned the classrooms**

### **MEASURE AGAIN THE OPINION**

**We measured again the opinion of students regarding the new educational proposal**

# EMPIRICAL STUDIES: STUDY 1

## LET'S SUMMARIZE THE PROCEDURE



## EMPIRICAL STUDIES: STUDY 1

### EQUATIONS

(1) Affinity of individual  $i$  with respect to  $j$  (attraction):  $q_{ij}$

(2) Distance between opinions of individual  $i$  and individual  $j$ :  $r_{ij}$

(3) Dominance of the primary control between individual  $i$  and individual  $j$ :  $k_{ij}$

(4) Resultant force exerted by individuals of the net to individual  $i$

$$F_i = \sum_j F_{ij} = \sum_j k_{ij} \frac{q_{ij}}{r_{ij}^2}$$

(5) Opinion shift of individual  $i$ :  $C_i$

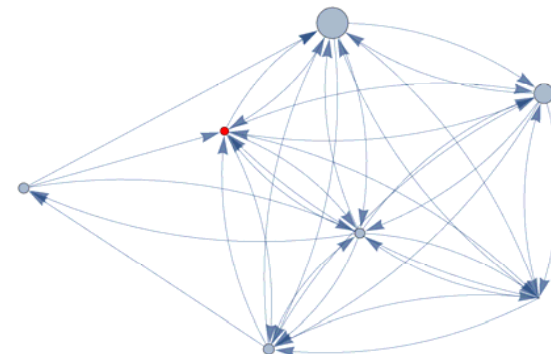
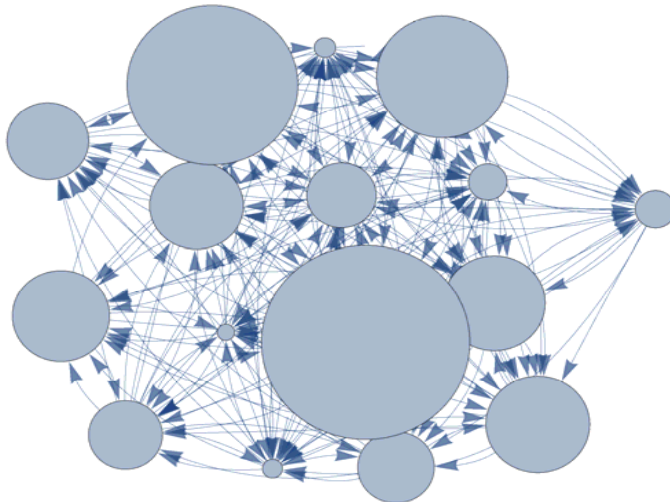
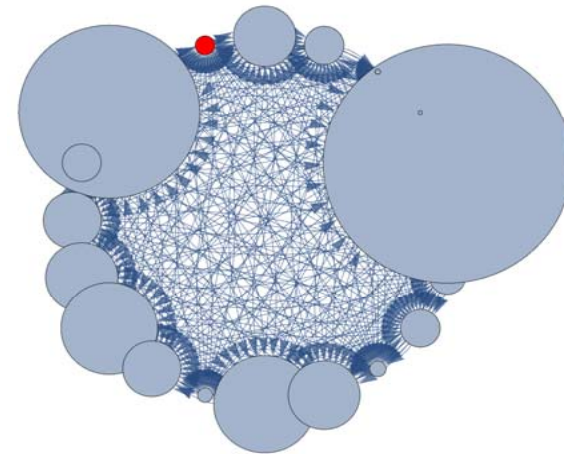
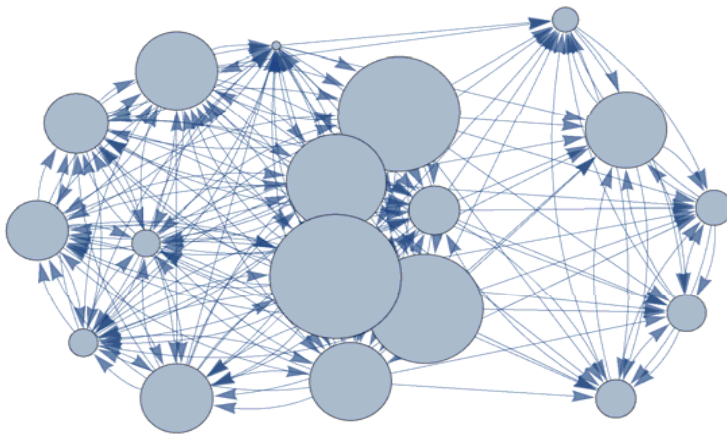
---

**Linear:**  $C_i = a + b F_i + e_i$

**Non-linear:**  $C_i = a + b/F_i + e_i$

# EMPIRICAL STUDIES: STUDY 1

## RESULTS → INTERACTION NETS





## EMPIRICAL STUDIES: STUDY 1

### RESULTS → REGRESSION EQUATIONS

---

	F	Sig.	Constant	b1
Linear	,262	,610	,083	,001
Non-linear	,189	,665	,111	3,287

---

---

**No effect**

**Nets are big and the interaction is difficult → We need a new study**

## EMPIRICAL STUDIES: STUDY 2

### **PARTICIPANTS**

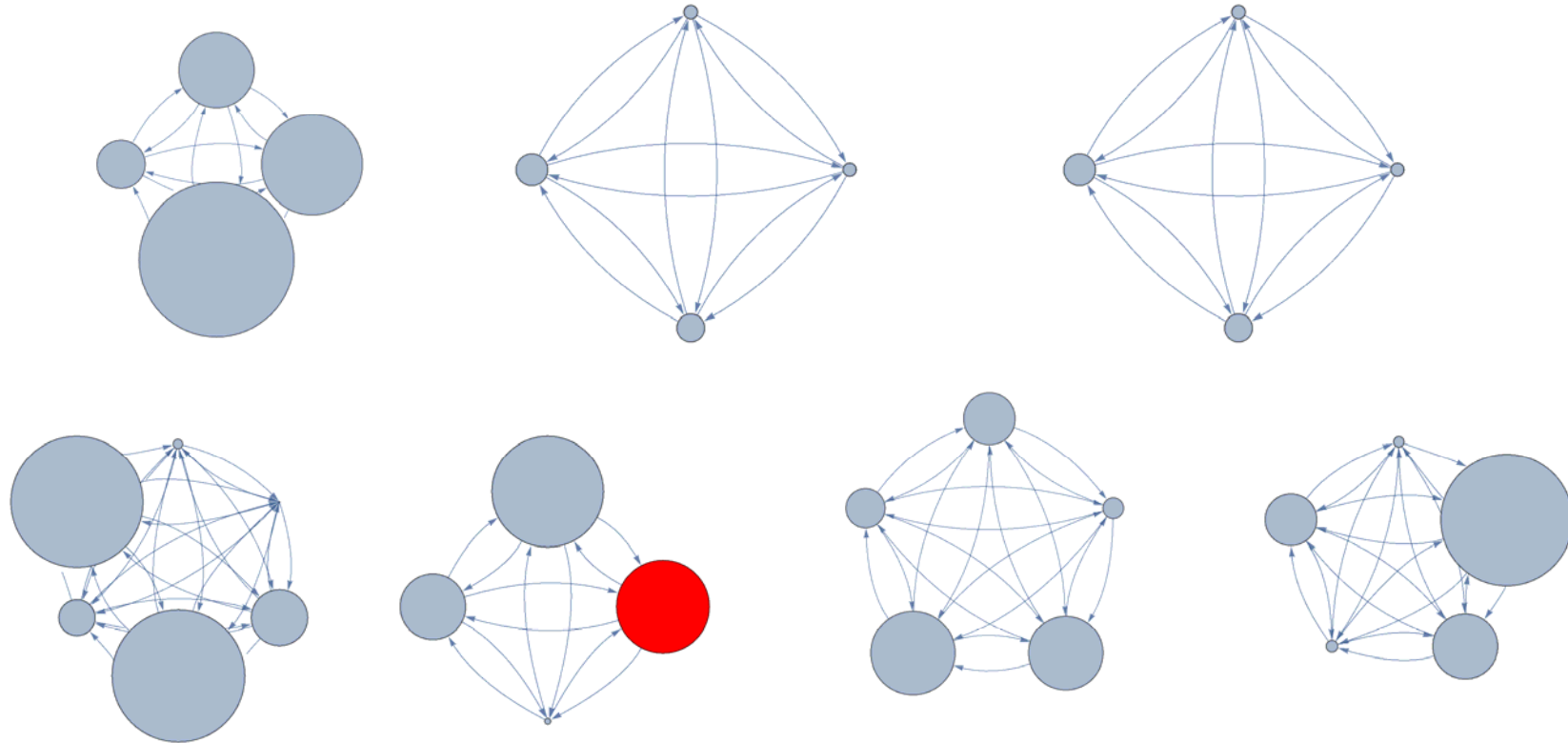
- 31 students of Business Administration, grouped in 7 sets of individuals between 3 and 6 each one
- Participation was free → we provided a reward

### **PROCEDURE, VARIABLES AND ANALYSIS**

- The same as Study 1

## EMPIRICAL STUDIES: STUDY 2

### RESULTS → INTERACTION NETS



## EMPIRICAL STUDIES: STUDY 1

### RESULTS → REGRESSION EQUATIONS

Normality of dependent variable; Regression equations with clustered robust standard errors

---

	Constant	Coef	F
Linear	.003	.171	.19
Non-linear	.627	<b>-2.53**</b>	<b>13.38**</b>

---

**\*\*p<0.05**

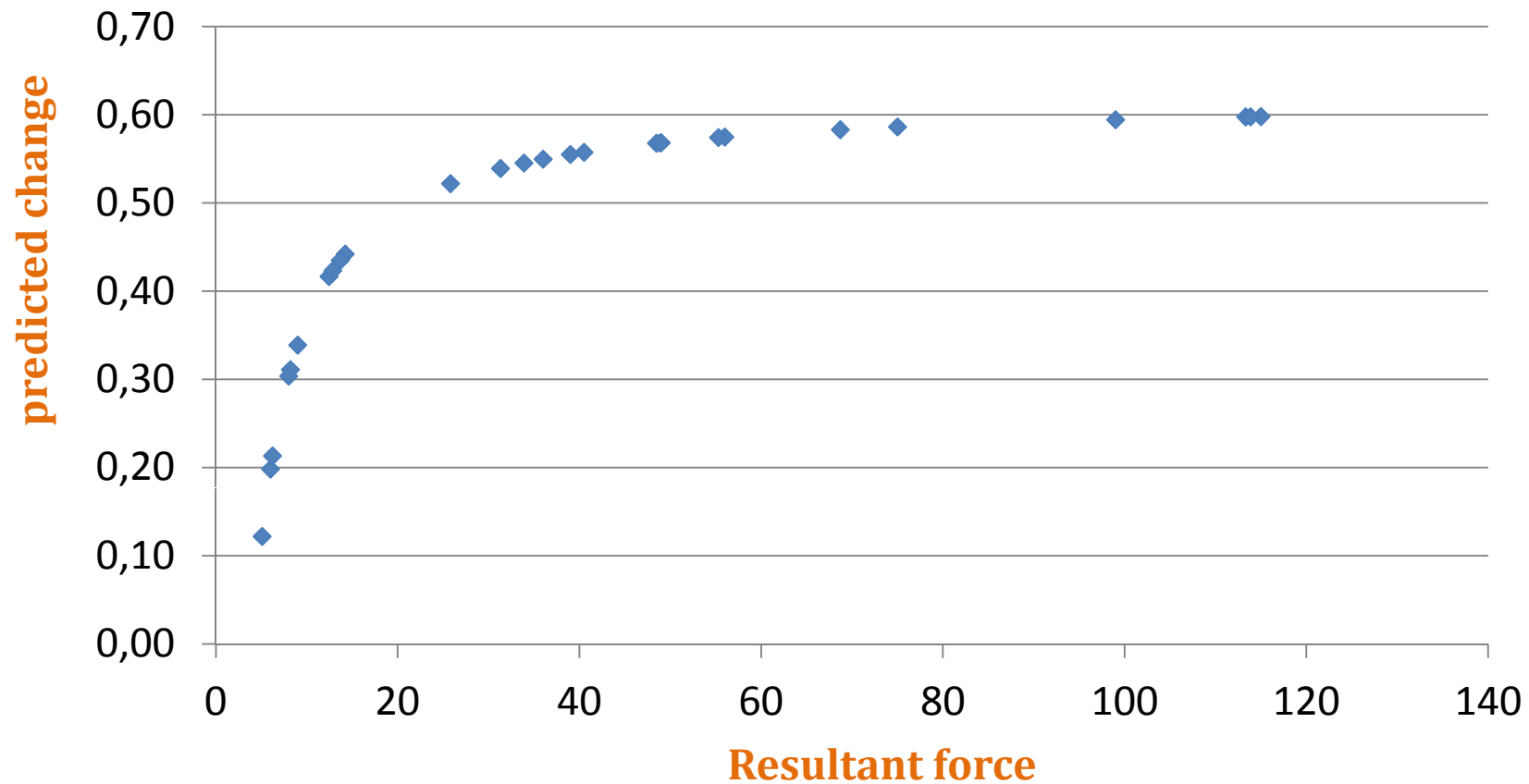
**Non-linear  
effect**

**Decreasing returns → saturation**

# EMPIRICAL STUDIES: STUDY 1

## RESULTS → REGRESSION EQUATIONS

Resultant force vs predicted change (after dropping 3 cases)



## IMPLICATIONS

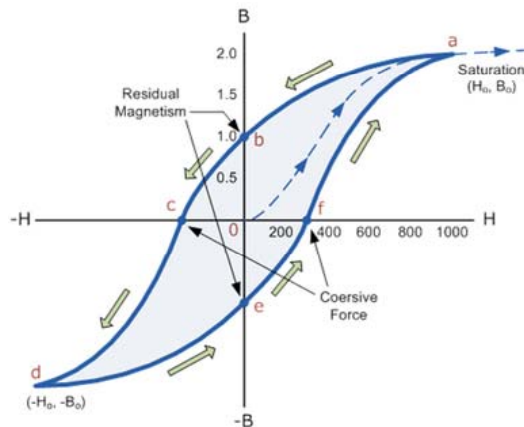
### EDUCATION

- Students opinions change over time, even in small periods of time because of interaction with peers
- Interaction in small groups is associated with opinion shift, but not in big groups
- Should we force students to work with other students with low affinity?

## IMPLICATIONS

### METHODOLOGY

- We need to include psychological variables in this type of models
- Physics equations could be an interesting way to explore social interaction
- Non-linear effect indicates decreasing returns



**Hysteresis and other electromagnetic phenomena are non-linear**

## LIMITATIONS

### METHODOLOGY

- Replication is needed
- Other methodological approaches are welcome
- Students were “in the lab”. The reality of their interactions is much more complex



**THANK YOU VERY MUCH**

**ANALYSIS OF OPINION SHIFT OF STUDENTS TO AN EDUCATIONAL PROGRAM; APPLICATIONS OF BASIC PRINCIPLES OF ELECTROMAGNETISM TO NET STRUCTURES**

**Jose A. Martínez  
Manuel Ruiz Marín**



**Universidad  
Politécnica  
de Cartagena**

**EMODS**  
Economic Modelling & Non Parametric Statistics  
Excellence Research Group

June, 2016