Comparing different approaches in teaching System Dynamics in Italian Universities

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ABSTRACT

There has been two main objectives with which the idea to write this paper was started. First of all, to exchange, and hence put in common, the knowledge of different experiences in Italian academic context dealing with teaching of a consolidated but still innovative (at least in Italy) methodology. Secondly, to put in evidence possible pros and cons of each teaching approach in order to better face (at least be aware of)the next teaching years (learn one from the other!) .

SUMMARY

- ***Four teaching experiences in 4 different university contexts are presente.***

- ***Three experences are depicted from, so called, hard faculties (Sciences, Statistics and Engineering), and one from a softer faculty i.e. Communication Sciences.***

- ***Two are sufficiently consolidated courses (more than five academic years) and two are less experienced (both three academic years).***

- ***Three are placed in Master programme and only one (but this one is related to, maybe, the "hardest" faculty-Engineering) is collocated in Bachelor programme.***

- ***A final synthetic comparison table is sketched and an overall general common consideration is suggested.***

Information collected:

- **Course specific characteristics**
- **Students characteristics**
- **Course topics**
- **How the work practice is approached during the course**
- **How the students are evaluated**
- **Results acquired**
- **Notes and comments**

Teaching SD courses analysed

1. "**System theory for modelling and simulating enterprise processes**" - Communication Sciences Faculty at Communication and Sociology department – Rome University "La Sapienza" , conducted by **Habib Sedehi**
2. "**Dynamics of Complex Organisations**" – Faculty of Mathematical, Physical and Natural Sciences; Computer Sciences Department – Bologna University, conducted by **Edoardo Mollona**
3. "**Production System Modeling**" – Business & Economics Engineering Faculty at the Department of Business Engineering - Rome University "Tor Vergata", conducted by **Stefano Armenia**
4. "**System Dynamics**" - Second Level Master in Data Intelligence and Decision Strategies (DISD) at Statistics Department – Rome University "La Sapienza", conducted by **Roberto Berchi**

1. "System theory for modelling and simulating enterprise processes" - Communication Sciences Faculty at Communication and Sociology department – Rome University "La Sapienza"

I. Course specific characteristics

- Duration:
  - 5 weeks (6 hours x week) = 30 hrs theory in classroom
  - 5-10 weeks (2 hours x week) = 10-20 hrs practice in groups
- N. of students : 30-40

II. Students characteristics

- Age : 22-25 years old
- Background : not scientific knowledge
- Study orientation : enterprise communication/public relation sector

III. Course topics

- Course keywords: System, Model, Simulation
- System:
  - General System Theory- short introduction (L.V. Bertalanffy)
  - System thinking approach base lines
  - Learning organization introduction (P. Senge)
- Model:
  - Mental and Symbolic models
  - System Dynamics methodology
- Simulation:
  1. Why, When and Where use simulation
  2. SD simulation modeling
  3. Application areas

IV. How the work practice is approached during the course

- Work groups & Project Work
- Enterprise sector analysis (pick up a problem !)
- Causal Loop Diagram approach to analyse the problem

V. How the students are evaluated

- Project Work development
- Teacher vs. groups interaction
- Project work presentation

VI. Results acquired

- Students (attending) rate: growing 15-20 % per year
- Master dissertation thesis: 4-5 per year
- Colleagues knowledge in SD

VII. Notes and comments

- Limited time for practical work

2. Dynamics of Complex Organisations" – Faculty of Mathematical, Physical and Natural Sciences; Computer Sciences Department – Bologna University,

I. Course specific characteristics

- Duration:
  - 6 weeks (5 hours x week) = 30 hrs; Theory in classroom
  - 7 days intensive programme of 3-hours lectures = 20 hrs; theory of SD taught by a visiting professor (in the last three years Paal Davidsen)
- N. of students : 30-40

II. Students characteristics

- Age : 22-25 years old
- Background : scientific knowledge (the programme is held in a Faculty of Science)
- Study orientation : Computer Science & Management

III. Course topics

- Course keywords: Strategic management, Modelling, Simulation
- Strategic Management:
  - What is strategic management about.
  - The resource-based view in strategic management.
  - Proximities and mutual exchange between disciplines: The case of SD and the Resource-Based View of the firm.
- Modelling:
  - Modelling resource accumulation processes.
- Simulation:
  - Exploring dynamic properties of resource accumulation processes
  - Analysis of the firm as a resource accumulation system
  - Dynamic analysis of the emerging and evolution of competitive advantage.

IV. How the students are evaluated

- Written examination.

V. Results acquired

- Students (attending) rate: 80 % per year.
- Master dissertation thesis: 1-2 per year.

3. . "Production System Modeling" -Business & Economics Engineering Faculty at the Department of Business Engineering - Rome University "Tor Vergata"

I. Course specific characteristics

- Duration:
  - 5 weeks (3 hours x week) = 15 hrs theory in classroom
- N. of students : 120-150 undergraduates

II. Students characteristics

- Age : 20-23 years old
- Background : Bachelor Engineering Degree (B.Eng.). Most of them have mainly undergone the following courses: Control Theory, Microeconomics, various Calculus courses (mathematical analysis, Algebra, Geometry, Physics, etc…). No prior experience in SD
- Study orientation : Business and Management Engineering

III. Course topics

- Course keywords: System & Model, Behavior and Structure, Complexity & Feedback, Continuous Improvement, Simulation and what-if analysis:
  - Setting the context; describing modelling approaches and the basics of concepts related to the "Continuous Improvement" theory as well as the Business Process Re-engineering (BPR).
  - The basics of Systems Thinking and Systems Dynamics are explored, with peculiar reference to concepts like Complexity, Structure, Behaviour, Feedback, Causal Diagrams, Archetypes, Stocks&Flows dynamics and advanced SD topics.
  - Developing a model from scratch, validating and simulating.
  - Application examples, concepts of microworlds, decision support systems, policy evaluation and electronic business games.

IV. How the work practice is approached during the course

- Work groups & Project Work
- Enterprise sector analysis (pick up a problem !)
- Causal Loop Diagram approach to analyse the problem
- Produce final report on project work
- Bathtub Dynamics tests

V. How the students are evaluated

- Project Work development & presentation
- Final test: represent a given problem by a CLD and then transform it into a SFD

VI. Results acquired

- Although the module in the "Production Modelling Course" has not been regularly carried over, due to several reasons, it has been noticed an upsurge of interest for System Dynamics notwithstanding this aspect.
- The increasing students requesting their Master Degree dissertation in SD issues as well as by a higher attention (also curiosity) paid by other professors (belonging to the faculty council members) to the SD methodology.
- Master dissertation thesis: 5-10 per year

VII. Notes and comments

- Limited time for practical work

Overall comparison

Department → / Course characteristics ↓	Communication & Sociology	Computer Sciences	Business Engineering	Statistics
Course "age"	3 years	7 years	3 years	8 years
N. of students per year	50	40	120	25
Year of course (since initiating university courses)	5th	4th	3rd	After 5th
N. of course hours	30	48	15	24
Course topics key words	System Thinking, Modeling, Simulation	System Thinking, Strategic Mgmt, Organisation	System Thinking, Organisation Learning,	System Dynamics, Discrete event Simulation, Agent Based Simulation
Use of Case studies (when)	After theory	After theory	After theory	From beginning
Students evaluation	Project work	Written exam	Written exercise	Project work
Results acquired	Regular course with a 20% students increasing rate	Consolidated course, Involvement in national research projects	Interesting interactions with other faculties/departments under SD "umbrella"	Introduction of SD in Private & public organisation with practical problems resolution,
N. of SD dissertations per year	4	5	6	-