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Learning–testing process in classroom: An empirical simulation model

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A B S T R A C T

This paper presents an empirical micro-simulation model of the teaching and the testing process in the classroom (Programs and sample data are available – the actual names of pupils have been hidden). It is a non-econometric micro-simulation model describing informational behaviors of the pupils, based on the observation of the pupils' communication behavior during lessons and tests. The representation of the knowledge process is very simplified. However, we tried to study the involvements of individual motivation, capability and relationship with other pupils of each pupil, to compare them to the new-classical (and keynesian) and Austrian information and knowledge theoretical results. It is a first step and future development should concern expectation behaviors and dynamics. This paper aims too to give, we hope so, some criteria of pupils' rationality in the classroom.

0. Introduction

Since the famous experiences of Chamberlin (1948) and then Smith (1962), the classroom has become a favorite field of applied micro or macro-economics laws of the experimental economics (Delemeester & Brauer, 2000). In the usual experiment design, pupils play some economic roles, and the teacher leads experiment. The modelling of the classroom is mainly educational or psychological,[1] however pupils and teacher rarely play their own role (Fernandez & Gali, 1999; Gary-Bobo & Trannoy, 2004).

Our purpose was to model the relationship between pupils and teacher in the classroom, during the lesson and during tests and exams. Our model is empirical – but not econometric – and based on observation.[2] The model calculates some micro-simulations[3] but it tries to explain and not to forecast any socioeconomic events. The classroom is considered as an information and knowledge complex market.[4] Indeed, in such a market, the teacher would appear as the main "supplier" of information and the pupils as "demanders", but information process in the classroom is actually rather more complex.[5] We have analyzed all the informational – listening, chatting and cheating one – behavior of pupils and the teacher during lessons and tests, and then translated them into a few simple equations.

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[1] See Brophy and Good (1986) or Carroll (1963). Some mathematical models has been developed (Goldman & Kearns, 1991; Jackson & Tomkins, 1992; Mathias, 1997) according to an artificial intelligence point of view.

[2] It is based on the experience of the author, who teaches economics, law and management in high school and economics at university.

[3] According to the micro-simulation principles described by Orcutt (1957), even if this author initially promoted micro-econometric models. "*Microsimulation (a.k.a. microanalytic simulation) is a modelling technique that operates at the level of individual units such as persons, households, vehicles or firms. Within the model each unit is represented by a record containing a unique identifier and a set of associated attributes e.g. a list of persons with known age, sex, marital and employment status; or a list of vehicles with known origins, destinations and operational characteristics. A set of rules (transition probabilities) are then applied to these units leading to simulated changes in state and behaviour. These rules may be deterministic (probability = 1)*, such as changes in tax liability resulting from changes in tax regulations, or stochastic (probability ⩽ 1), such as chance of dying, marrying, giving birth or moving within a given time period. In either case the result is an estimate of the outcomes of applying these rules, possibly over many time steps, including both total overall aggregate change and, crucially, the distributional nature of any change." ***International Microsimulation Association***. The microsimulation belongs to a more general individual modelling approach called Agent-based Computational Economics (a.k.a. ACE) – see Gilbert (2008, pp. 17–18) about then links between Microsimulation and the ACE and Tesfatsion and Judd (Eds.) (2006) for a wdier overview.

[4] See Anderson and Holt (1996) about an experimental analysis of information, but where pupils and the teacher did not play their own role.

[5] Especially, relationship between pupils and teachers could be view as a game. See our paper (1996).

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Nomenclature

i	Rank of the pupil
j	Rank of the lesson's chapter
c	Rank of the tests (from 1 to $c_{\max}$)
C^i	Courage and effort of i
A^i	Understanding capability of i
M_c^i	Mark of i during test c
$\overline{M^i}$	Quarterly average of pupil i
$\overline{M^{\mathrm{TOT}}}$	Whole quarterly average
$\overline{M_A^{\mathrm{TOT}}}$	Actual whole quarterly average
$\overline{M_S^{\mathrm{TOT}}}$	Simulated whole quarterly average
$\overline{\Delta M^{\mathrm{TOT}}}$	Difference between simulated and actual whole quarterly average
θ_M^{TOT}	Ratio ΔM^{TOT} over M_A^{TOT}
E^i	Encoding capability of i during lesson
L_j	Chapter j of the current lesson
B_j^i	Chatting's level of pupil i during the lapse of time of the jth chapter's lesson
B_j^{TOT}	Whole chatting's level during the lapse of time of the jth chapter's lesson
B^{TOT}	Whole chatting's level at the end of the lesson
w_L^i	Weight of the lesson according to pupil i
w_T^i	Weight of the chatting according to pupil i
w_M^i	Weight of the marks according to pupil i
c_F	Fraud cost
K_j^i	Knowledge's level of pupil i about the chapter j
G_j^i	Gap of pupil i concerning the chapter j
K_t^{TOT}	Knowledge accumulated during t by all pupils
l	Encoding deterioration coefficient
P_j^i	Test answer to question j by i
π_j^i	Point of the mark of question j by i
f	Free-riding's catching dummy variable

Consequently, our major topic is clearly the *modelling of educational learning*,[6] but we believe we could obtain some results which could improve the understanding of the Economics of information too (R.Buda, 2000). According to this, we'll consider the New-classical Economic School (Becker, 1964) through its design of learning process, the New-keynesian Economic School (Grossman & Stiglitz, 1980) through its model of asymmetric information, and the Austrian Economic School (Hayek, 1937, 1945) through its process of knowledge discover.

In the first section, we'll present and describe the equations of the Model,[7] then we'll explain the calibration of the model based on an actual data-sample. Then some anti-fraud policies will be presented and simulation displayed. Finally, we'll comment the empirical results and we'll bring them closer to the more relevant theoretical results, especially to compare them to the New-classical (and keynesian) imperfect market model and the Austrians economics knowledge process theoretical results.

1. The equations of the model

The class is composed of N pupils and one teacher. The teacher teaches a lesson which is divided into j periods. The pupils have to learn the lesson before the test (exam, or competitive exam). This test is divided into 20 parts.[8] The quarterly average of each pupil is calculated with their marks in each test.

Properties and behaviors: Each pupil i works with courage (C^i) and is able to understand the lesson according to his capabilities (A^i)[9]

$$0 \leqslant C^i \leqslant 200 \tag{1}$$

$$0 \leqslant A^i \leqslant 200 \tag{2}$$

The teacher gives information to the pupils, puts the test and the marks according to the answers of each pupil. During the lesson, he can give *boni b* to the pupils who give good answers and help the teacher in making the understanding of the class increase. On the other hand, the teacher can give *mali m* to the pupils who are chatting during the lesson. Each *bonus* and *malus* (resp.) increases or decreases (resp.) one percent of the quarterly average.

Behaviors during lesson: When the teacher teaches the lesson, pupil i believes he has understood – translated by the encoding variable E_j^i –, but he did'nt because of his own chatting or the chatting around.[10] Then he consequently won't have to cheat during the test because he things he has the right answers.

6 The author would like to reassure the reader – especially if the reader is one of his pupils or students. For the author, the behaviors are often translatable into some equations, never the individuals.

7 It was implemented in Turbo-Pascal 7.0.

8 This assumption is obviously restrictive, however we chosen it because of the "French" assessment system based on 20 points.

9 We have used the Random function.

10 We consider here the chatting as a direct conversation between two pupils (or students). However, the role of the mobile in the pupil's conversation is increasing and we'll have to consider it – see Rau, Gaoa, and Wu (2008).