Learning-Testing Process in Classroom: An Empirical Simulation Model

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Summary

This paper presents an empirical micro-simulation model of the teaching and the testing process in the classroom▼. 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.

Key-Words : Teaching, Learning, Cheating, Information, Communication, Knowledge, Micro-simulation, Classroom

JEL Classification : A2, D83, G14

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▼ Programs and sample data are available - the actual names of pupils have been hidden.

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”*Time is mali*” one of my students.

Since the famous experiences of E.H.Chamberlin (1948) and then V.L.Smith (1962), the classroom has become a favorite field of applied micro or macro-economics laws of the experimental economics (G.Delemeester & J.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 (R.Fernandez & J.Gali, 1999 ; R.Gary-Bobo & A.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.

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 (G.S.Becker, 1964) through it’s design of learning process, the New-keynesian Economic School (S.J.Grossman & J.E.Stiglitz, 1980) through its model of asymmetric information, and the Austrian Economic School (F.A.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.

I - 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 tests (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]

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

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

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. They are interested in some topics different from the lesson (L_j). Lessons and topics are divided into 20 parts, thus pupils choose at each moment between chatting or listening to the lesson. Pupil will pay attention during the lesson, if its weight (w_L) is greater than the weight of his chatting (w_T).

$$w_{L,j}^i = w_M^i * M_{c-1}^i \tag{3}$$

where $c-1$ is the rank of the previous test and w_M the weight of the mark. The weight of the course depends on the test too. During the lesson, the pupil i accumulates knowledge[11] (K_j^i). Sometimes pupil i has well understood ($K_j^i = L_j$), but sometimes the pupil i has misunderstood ($K_j^i \neq L_j$) or has not listened to the lesson ($K_j^i = 0$)[12]. If a pupil i is chatting with a pupil k - exclusively during the j lapse of time -, both haven't recorded the information given ($K_j^i = 0$ and $K_j^k = 0$). The event of chatting depends on the expectation of the test - especially the cost of fraud (c_F) during the test.

$$w_T^i > w_L^i + c_F \tag{4}$$

At the end of each lesson, the aggregation of chatting's behavior is given by

$$B^{TOT} = \sum_{i=1}^{N} \sum_{j=1}^{20} B_j^i \tag{5}$$

There is a gap, when the pupil doesn't pay attention during lessons

$$\text{if} \quad K_j^i = 0 \text{ then} \quad G_j^i = 1 \tag{6}$$

$$\text{hence} \quad G^i = \sum_{j=1}^{20} G_j^i \tag{7}$$

The chatting of some pupils can disturb the understanding of the weakest pupils, especially according to a few thresholds :

$$C^i \leq \overline{C} \tag{8}$$

$$A^i \leq \overline{A} \tag{9}$$

$$\sum_{i=1}^{N} G_j^i \geq \overline{G} \tag{10}$$

At the end of the lesson, pupil i accumulated the following level of knowledge[13]

$$K^i = \sum_{j=1}^{20} K_j^i \tag{11}$$

and the whole class

$$K^{TOT} = \sum_{i=1}^{N} \sum_{j=1}^{20} K_j^i \tag{12}$$

For each pupil if $K_t^i \leq \overline{K_0^i}$ with $0 \leq l \leq 1$ then the encoding capability is given by

$$E_t^i = E_{t-1}^i * l \tag{13}$$

that means pupil i will be able to understand the future lessons with a minimal level of knowledge $\overline{K_0^i}$.

Behaviors during a test : Pupil i answers to the test in writing papers P_j. His answers depends on his knowledge ($P_j^i = K_j^i$). If the answer is correct ($K_j^i = L_j$) then pupil i gets a point in his mark[14] ($\pi_j^i = 1$). Hence his total mark is

$$M_c^i = \sum_{j=1}^{20} \pi_j^i - c_F * f \tag{14}$$

where fraud $f = 1$ if pupil is caught in free-riding behavior[15] - a microeconomic word which denotes the behavior of someone who uses a good without to pay it -, and c_F the points which are lost by the free-rider pupil.

Nomenclature

i	Rank of the pupil
j	Rank of the lesson's chapter
c	Rank of the tests (from 1 to *cmax*)
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
$\overline{M^{TOT}}$	Whole quarterly average
$\overline{M_A^{TOT}}$	Actual whole quarterly average
$\overline{M_S^{TOT}}$	Simulated whole quarterly average
ΔM^{TOT}	Difference between simulated and actual whole quarterly average
$\overline{\theta_M^{TOT}}$	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
S	Number of pupils who success the exam (or tests)

II - Calibration of the Model

The sample of actual data (marks and other assessments) come from personal actual marks of pupils given by the author, as teacher. The pupils were pupils in a French high school of the western suburb of Paris - Lycée Guy de Maupassant (Colombes). Two classes studied *Economics and law* at the degree of ”Classe de Premire - in French educational system” and one at the degree of ”Classe de Terminale - in French educational system” - they prepared baccalaureate examination. The last class studied *Administrative Management* at the degree of ”Classe de Terminale”. All of them have been evaluated during a baccalaureate training test. Neither the author (the teacher) nor the pupils knew that the actual marks will be used into a simulation model, when the test happened.

The calibration of the model consisted to determine the value of some parameters of the equations of our model. So, we have iterated some simulations with different values of parameters, on an actual sample of four classes until to obtain simulated averages the most near from the actual one.

So, we have built an average lag indicator and an error indicator given by the formulae of ΔM^T and θ_M^T

$$\Delta M^{TOT} = \overline{M_S^{TOT}} - \overline{M_A^{TOT}} \quad (15)$$

$$\theta_M^{TOT} = \frac{\Delta M^{TOT}}{M_A^{TOT}} \quad (16)$$

where $\overline{M_S^{TOT}}$ is the simulated total average and $\overline{M_A^{TOT}}$ is the actual total average.

The results of our calibration simulation are displayed on tables 3 and 4 describing the simulation of class #1, #2, #3 and #4. The result of the first (-0.28) and the third (0.37) class seem to be relatively good (error less than 4%). Unfortunately, the simulation of second (2.16) and the fourth (-2.40) class are relatively less good (error less than 30%). We could explain this greater error because the assumption of homogeneity of tests was probably too strong in fact. Furthermore, one of the pupils, # 022, did not respect the rules of the classroom (class #4).

As soon as our model was specified, we could use it to simulate some collective or scenarios to study the involvement of communication’s behavior of the pupils to their performances. According to this purpose, the role of the teacher is obviously not neutral.

Table 1: Simulation results for classes #1 and #2

		Tests #1	#2	#3	Gains	Losses	Balance	b/m	$\overline{M_S^i}$	K^i	$\overline{M_A^i}$	ΔM^{TOT}
Class #1	Pupil #001	9	10	15	0	-26	-26	0	11.33	32	9.71	1.62
	Pupil #002	15	14	15	0	0	0	0	14.67	43	11.64	3.03
	Pupil #003	15	1	0	0	-188	-188	0	5.33	26	7.07	-1.74
	Pupil #004	12	1	0	0	-35	-35	0	4.33	29	10.46	-6.13
	Pupil #005	9	2	0	0	-8	-8	0	3.67	20	2.71	0.96
	Pupil #006	6	1	2	0	-9	-9	-1	2.97	14	5.43	-2.46
	Pupil #007	12	2	0	0	-187	-187	0	4.67	22	8.09	-3.42
	Pupil #008	14	14	17	0	0	0	0	15.00	44	9.66	5.34
	Pupil #009	11	10	7	0	0	0	0	9.33	27	6.60	2.73
	Pupil #010	10	1	1	0	-60	-60	0	4.00	19	7.07	-3.07
	Pupil #011	10	0	0	0	-144	-144	0	3.33	21	4.09	-0.76
	Pupil #012	13	17	14	0	0	0	0	14.67	44	8.01	6.66
	Pupil #013	12	11	16	0	0	0	0	13.00	36	4.76	8.24
	Pupil #014	17	12	10	0	0	0	0	13.00	37	8.52	4.48
	Pupil #015	14	16	12	0	0	0	0	14.00	42	12.00	2.00
	Pupil #016	11	0	2	0	-99	-99	0	4.33	21	7.53	-3.20
	Pupil #017	17	5	0	1	-119	-118	0	7.33	42	12.29	-4.96
	Pupil #018	13	1	0	0	-151	-151	0	4.67	21	8.07	-3.40
	Pupil #019	7	1	1	0	-5	-5	0	3.00	18	6.01	-3.01
	Pupil #020	8	0	0	0	0	0	0	2.67	19	5.80	-3.13
	Pupil #021	15	11	12	0	0	0	0	12.67	37	11.67	1.00
	Pupil #022	14	16	17	0	0	0	0	15.67	46	12.00	3.67
	Pupil #023	8	2	3	0	-7	-7	0	4.33	10	8.80	-4.47
	Pupil #024	10	1	1	0	-100	-100	0	4.00	24	10.74	-6.74
	M_c^{TOT}	12	6	6	-	-	-	-1	8.00	K^{TOT}=694	8.42	-0.28
	c_F	-8	-20	-20	1	-1138	-1137	B^{TOT}=366				
Class #2	Pupil #001	9	4	5	0	0	0	0	6.00	17	7.00	-1.00
	Pupil #002	12	12	15	1	0	1	0	13.00	38	7.00	6.00
	Pupil #003	8	3	1	0	-25	-25	0	4.00	13	5.07	-1.07
	Pupil #004	8	3	2	0	0	0	0	4.33	12	7.00	-2.67
	Pupil #005	10	10	10	0	0	0	0	10.00	30	8.74	1.26
	Pupil #006	9	2	1	0	-15	-15	0	4.00	17	6.22	-2.22
	Pupil #007	13	10	12	0	0	0	0	11.67	34	7.92	3.75
	Pupil #008	14	11	9	0	0	0	0	11.33	33	7.61	3.72
	Pupil #009	12	10	12	0	-12	-12	0	11.33	33	8.11	3.22
	Pupil #010	20	14	14	0	0	0	0	16.00	48	9.94	6.06
	Pupil #011	13	12	16	0	-20	-20	0	13.67	40	7.11	6.56
	Pupil #012	13	11	13	0	0	0	0	12.33	34	6.13	6.20
	Pupil #013	10	9	9	0	0	0	0	9.33	27	5.00	4.33
	Pupil #014	5	0	2	0	-10	-10	0	2.33	9	7.06	-4.73
	Pupil #015	6	4	11	0	0	0	0	7.00	15	6.22	0.78
	Pupil #016	14	11	13	0	0	0	0	12.67	38	7.33	5.34
	Pupil #017	14	9	13	0	0	0	0	12.00	36	4.86	7.14
	Pupil #018	10	6	9	0	0	0	0	8.33	24	11.18	-2.85
	Pupil #019	8	7	9	0	0	0	0	8.00	21	6.76	1.24
	Pupil #020	6	0	0	0	0	0	0	2.00	6	7.54	-5.54
	Pupil #021	14	17	12	0	0	0	0	14.33	43	6.45	7.88
	Pupil #022	17	14	12	0	0	0	0	14.33	42	8.59	5.74
	Pupil #023	10	9	4	1	-283	-282	0	7.67	23	7.96	-0.29
	Pupil #024	12	12	10	0	0	0	0	11.33	32	8.46	2.87
	M_c^{TOT}	11	8	9	-	-	-	0	9.46	K^{TOT}=665	7.40	2.16
	c_F	-6	-20	-20	2	-365	-363	B^{TOT}=214				

III - Anti-fraud Policies Simulations

After each lesson, we assume that the teacher gets a test to the pupils, and marks them. We have considered the oral activities of pupils during lesson. It is integrated into the evaluation of each pupil. Moreover, as we know, some pupils try to cheat during the tests to obtain some answers they ignore and the behavior of the teacher is not neutral to control it. We have selected four typical anti-fraud policies. Then we made run some collective and individual simulations.

Quarterly average's calculation - All the marks are collected into a quarterly average according to the following procedure. If we consider the *bonus* $b = 1$ and the *malus* $m = -1$, the oral score of pupil O is given by

$$O^i = 1 + \frac{\sum m + \sum b}{100} \tag{17}$$

and the average of the *cmax* marks of each pupil i, $\overline{M^i}$, is calculated according to formula

$$\overline{M^i} = O^i * \left(\frac{1}{cmax} \sum_{q=1}^{cmax} M_q^i\right) \tag{18}$$

Repression against fraud policies - Each teacher has got a reputation to his pupils. The pupils usually expect the reaction of their teacher in front of their cheating's behavior.

We designed four policies :

#1 - the *non-rigorous* one : The teacher leaves its pupils communicating during tests. Consequently, the "free-rider" pupil never losses any point,

#2 - the *simple auctions policy* one : During test, the first free-rider losses n points, then the following one losses $n+1$ points, and so on.

> *When pupils cheat, we assumed they search information, but they have to minimize the lapse of time during they are communicating each others. We considered that during this lapse of time, they are not able to gain more than p points - during our actual tests $p = 5$. If someone free-rides, it means that the "price" of the information obtained is to much low, so free-rider losses 5 points and then the "price" increases one point more : $p = 5 + 1$ and so on.*

Table 2: Simulation results for classes #3 and #4

		Tests #1	#2	#3	Gains	Losses	Balance	*b* or *m*	$\overline{M_S^i}$	K^i	$\overline{M_A^i}$	ΔM^{TOT}
Class #3	Pupil #001	6	4		0	-19	-19	0	5.00	9	12.34	-7.34
	Pupil #002	7	7		0	0	0	0	7.00	14	12.06	-5.06
	Pupil #003	19	15		0	0	0	0	17.00	34	13.33	3.67
	Pupil #004	12	12		0	0	0	0	12.00	23	7.99	4.01
	Pupil #005	10	7		0	0	0	0	8.50	17	10.60	-2.10
	Pupil #006	6	2		0	0	0	0	4.00	8	12.06	-8.06
	Pupil #007	19	14		0	0	0	0	16.50	33	16.48	0.02
	Pupil #008	18	14		0	0	0	0	16.00	31	11.11	4.89
	Pupil #009	10	4		0	0	0	0	7.00	14	8.50	-1.50
	Pupil #010	8	6		0	-8	-8	0	7.00	13	8.00	-1.00
	Pupil #011	9	11		0	0	0	0	10.00	20	7.80	2.20
	Pupil #012	11	7		2	-56	-54	0	9.00	21	8.16	0.84
	Pupil #013	12	14		0	0	0	0	13.00	25	10.71	2.29
	Pupil #014	17	15		0	0	0	0	16.00	32	7.10	8.90
	Pupil #015	8	7		0	0	0	0	7.50	14	8.08	-0.58
	Pupil #016	15	3		1	-33	-32	0	9.00	29	8.00	1.00
	Pupil #017	12	16		0	0	0	0	14.00	28	7.21	6.79
	Pupil #018	10	4		0	-10	-10	0	7.00	14	1.50	5.50
	Pupil #019	9	5		0	0	0	0	7.00	13	10.26	-3.26
	Pupil #020	9	7		0	0	0	0	8.00	16	11.77	-3.77
	M_c^{TOT}	11	9		-	-	-	0	10.02	K^{TOT}=408	9.76	0.37
	c_F	-5	-17		3	-126	-123	B^{TOT}=178				
Class #4	Pupil #001	14	14	14	0	0	0	0	14.00	40	15.33	-1.33
	Pupil #002	12	12	15	0	0	0	0	13.00	39	12.06	0.94
	Pupil #003	14	16	12	0	0	0	12	15.68	41	11.28	4.40
	Pupil #004	13	10	8	0	0	0	0	10.33	30	11.33	-1.00
	Pupil #005	8	9	7	0	-40	-40	0	8.00	23	11.24	-3.24
	Pupil #006	13	8	8	0	0	0	0	9.67	28	12.21	-2.54
	Pupil #007	3	1	0	0	-78	-78	0	1.33	16	11.17	-9.84
	Pupil #008	12	9	5	0	0	0	0	8.67	25	8.33	0.34
	Pupil #009	1	0	1	0	-43	-43	-1	0.66	14	7.71	-7.05
	Pupil #010	2	0	0	0	-70	-70	0	0.67	6	3.00	-2.33
	Pupil #011	3	0	0	0	-20	-20	0	1.00	11	8.00	-7.00
	Pupil #012	10	8	8	0	0	0	0	8.67	24	9.43	-0.76
	Pupil #013	1	0	8	0	-229	-229	0	3.00	1	4.72	-1.72
	Pupil #014	9	12	10	0	0	0	0	10.33	30	6.50	3.83
	Pupil #015	12	10	13	0	-20	-20	0	11.67	33	11.80	-0.13
	Pupil #016	5	0	1	0	-68	-68	0	2.00	18	7.94	-5.94
	Pupil #017	10	10	13	0	0	0	0	11.00	29	13.64	-2.64
	Pupil #018	3	0	0	0	-117	-117	0	1.00	16	6.57	-5.57
	Pupil #019	8	7	7	0	0	0	0	7.33	22	8.40	-1.07
	Pupil #020	7	9	13	0	0	0	0	9.67	28	14.36	-4.69
	Pupil #021	11	13	11	0	0	0	0	11.67	34	10.45	1.22
	Pupil #022	3	0	0	2	-35	-33	0	1.00	0	7.58	-6.58
	M_c^{TOT}	8	7	7	-	-	-	11	7.29	K^{TOT}=508	9.78	-2.40
	c_F	-20	-20	-20	2	-720	-718	B^{TOT}=304				

#3 - the *no-return auctions policy* one : The rule is the same as simple auctions policy but the cost of fraud never decreases between two tests, and

#4 - the *maximal repression* one : The free-rider who is caught, losses all the points of the test - 20 in the French assessment system.

Description and results of the simulations - We firstly made run four typical simulations to investigate the performances of the pupils according to the anti-fraud policy of the teacher - see Table 5 and 6. The first simulations gave us a collective answer, but we need to investigate according to an individual point of view.

So we have tried to analyze the individual rationality - see Table 7 - in making run some other simulations. We have chosen three typical (but not actual) pupils : pupil #5 (C^5=92 and A^5=45), pupil #20 (C^{20}=23 and A^{20}=121) and pupil #35 (C^{35}=43 and A^{35}=190).

Table 3: Anti-fraud policies' simulation

Policy		Tests #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Gains	Losses	Balance	b/m	$\overline{M^i}$	K^i
Non rigorous policy	Pupil #001	13	15	15	12	12	16	16	10	10	8	2	0	2	0	12.70	122
	Pupil #002	16	20	16	12	11	13	12	9	7	9	4	0	4	0	12.50	121
	Pupil #003	15	15	15	16	12	12	12	12	13	10	1	0	1	0	13.20	130
	Pupil #004	19	15	10	10	10	12	13	13	12	11	0	0	0	0	12.50	120
	Pupil #005	17	8	9	6	8	3	7	7	7	5	57	0	57	0	7.70	81
	Pupil #006	16	7	8	2	4	6	6	5	8	3	44	0	44	0	6.50	69
	Pupil #007	19	15	16	12	10	10	11	4	3	3	0	0	0	0	10.30	101
	Pupil #008	17	3	10	10	7	6	9	6	7	5	60	0	60	0	8.00	82
	Pupil #009	11	9	8	9	6	8	11	9	7	5	70	0	70	0	8.30	77
	Pupil #010	9	9	7	3	2	1	1	1	1	2	0	0	0	0	3.60	30
	Pupil #011	6	2	3	1	2	0	2	3	0	2	0	0	0	-1	2.08	12
	Pupil #012	10	12	9	11	7	9	11	9	8	7	10	0	10	0	9.30	81
	Pupil #013	8	5	2	2	1	2	1	0	1	2	0	0	0	0	2.40	20
	Pupil #014	12	8	6	6	6	6	9	6	7	9	13	0	13	0	7.50	58
	Pupil #015	11	8	5	4	4	2	2	0	2	0	0	0	0	-1	3.76	32
	Pupil #016	13	10	7	4	2	2	1	1	1	0	0	0	0	0	4.10	40
	Pupil #017	9	12	10	10	10	7	14	4	11	6	83	0	83	0	9.30	64
	Pupil #018	9	12	9	8	5	6	3	5	7	7	6	0	6	0	7.10	60
	Pupil #019	9	8	8	10	8	6	7	7	7	6	66	0	66	0	7.60	56
	Pupil #020	12	9	3	2	2	2	1	1	1	2	1	0	1	0	3.50	31
	Pupil #021	8	5	5	1	0	2	1	0	2	1	0	0	0	0	2.50	19
	Pupil #022	10	6	2	0	1	1	2	2	1	1	0	0	0	0	2.60	22
	Pupil #023	12	8	7	7	6	5	5	7	4	3	11	0	11	-1	6.34	46
	Pupil #024	11	8	10	6	7	4	10	6	9	4	61	0	61	0	7.50	53
	Pupil #025	11	4	2	3	4	5	6	4	3	3	0	0	0	0	4.50	39
	Pupil #026	8	9	9	4	3	5	5	3	4	3	0	0	0	0	5.30	43
	Pupil #027	7	10	10	6	4	9	10	9	7	3	64	0	64	0	7.50	54
	Pupil #028	9	5	3	2	4	4	4	6	6	5	12	0	12	0	4.80	32
	Pupil #029	7	9	12	11	7	8	10	7	9	9	79	0	79	0	8.90	68
	Pupil #030	9	8	4	5	4	4	1	1	1	1	0	0	0	0	3.80	30
	Pupil #031	13	10	8	6	5	3	1	0	1	2	0	0	0	-1	4.85	44
	Pupil #032	7	9	4	3	4	4	7	3	2	0	0	0	0	0	4.30	37
	Pupil #033	6	7	2	2	2	0	0	0	2	2	0	0	0	-2	2.25	13
	Pupil #034	4	2	2	3	1	1	1	1	0	0	0	0	0	0	1.50	10
	Pupil #035	7	3	2	2	0	1	1	0	2	1	0	0	0	0	1.90	11
	Pupil #036	5	10	6	10	8	5	10	4	4	5	61	0	61	-1	6.63	26
	Pupil #037	9	4	1	2	4	3	1	0	1	3	0	0	0	0	2.80	19
	Pupil #038	5	2	1	0	3	5	2	2	3	2	0	0	0	0	2.50	13
	Pupil #039	10	12	14	7	9	9	10	6	7	10	82	0	82	0	9.40	33
	Pupil #040	6	0	1	1	2	3	1	0	0	0	0	0	0	0	1.40	10
	M_c^{TOT}	10	8	7	6	5	5	6	4	5	4	-	-	-	-7	6.08	
	c_F	0	0	0	0	0	0	0	0	0	0	787	0	787	B^{TOT}=1102		K^{TOT}=2009
Auction repression policy	Pupil #001	13	11	16	16	12	13	17	14	16	14	0	0	0	0	14.20	140
	Pupil #002	16	12	14	13	18	17	16	18	14	16	0	0	0	0	15.40	151
	Pupil #003	15	12	16	15	12	14	16	14	12	14	0	0	0	0	14.00	139
	Pupil #004	19	14	15	13	13	17	17	10	12	18	0	0	0	0	14.80	147
	Pupil #005	17	3	0	1	0	2	2	0	1	1	1	-60	-59	0	2.70	74
	Pupil #006	16	6	0	0	1	2	2	1	1	0	1	-80	-79	0	2.90	80
	Pupil #007	19	16	18	14	14	16	14	14	15	17	0	0	0	0	15.70	152
	Pupil #008	17	9	12	8	0	1	0	3	0	0	5	-591	-586	0	5.00	84
	Pupil #009	11	12	15	11	11	13	7	1	2	3	13	-1290	-1277	0	8.60	82
	Pupil #010	9	4	4	9	13	10	11	9	10	10	1	-40	-39	0	8.90	84
	Pupil #011	6	6	9	6	6	6	7	9	8	5	0	0	0	0	6.80	63
	Pupil #012	10	6	9	6	12	15	13	13	9	7	0	-60	-60	0	10.00	97
	Pupil #013	8	9	10	15	13	11	9	9	8	8	1	-40	-39	0	10.00	95
	Pupil #014	12	8	9	13	10	11	11	10	9	7	0	-60	-60	0	10.00	95
	Pupil #015	11	11	9	9	7	7	8	5	4	10	0	0	0	-1	8.02	77
	Pupil #016	13	12	11	8	6	7	7	5	5	5	0	0	0	0	7.90	77
	Pupil #017	9	9	9	8	1	1	1	2	1	1	3	-544	-541	0	4.20	51
	Pupil #018	9	8	5	9	10	9	10	10	9	8	0	-40	-40	0	8.70	81
	Pupil #019	9	1	0	2	0	0	1	3	2	0	0	-5	-5	0	1.80	47
	Pupil #020	12	10	11	10	12	12	10	12	12	9	0	-80	-80	0	11.00	104
	Pupil #021	8	5	5	5	9	8	8	10	9	8	0	0	0	-1	7.43	72
	Pupil #022	10	8	5	4	8	12	9	10	12	6	0	0	0	0	8.40	81
	Pupil #023	12	14	9	7	4	7	9	5	4	1	1	-33	-32	0	7.20	67
	Pupil #024	11	10	10	10	8	12	13	6	2	0	15	-1466	-1451	0	8.20	88
	Pupil #025	11	11	11	8	6	11	13	12	12	11	0	0	0	0	10.60	105
	Pupil #026	8	7	6	5	8	9	11	9	9	11	0	-20	-20	0	8.30	81
	Pupil #027	7	1	1	0	0	0	2	2	1	1	0	0	0	0	1.50	27
	Pupil #028	9	5	4	6	9	10	11	8	6	6	0	-46	-46	0	7.40	69
	Pupil #029	7	1	0	1	1	2	2	0	2	1	0	-7	-7	-1	1.68	39
	Pupil #030	9	6	7	5	8	8	6	7	4	9	0	0	0	0	6.90	63
	Pupil #031	13	13	8	11	10	15	10	10	10	9	0	-20	-20	0	10.90	103
	Pupil #032	7	8	10	12	13	12	11	10	9	8	0	-60	-60	0	10.00	93
	Pupil #033	6	4	2	0	3	1	1	2	7	3	0	0	0	0	2.90	23
	Pupil #034	4	4	4	7	3	3	4	4	2	3	0	0	0	0	3.80	31
	Pupil #035	7	4	6	3	3	3	3	3	3	3	0	0	0	0	3.80	33
	Pupil #036	4	2	0	0	0	1	0	0	1	0	1	0	1	0	0.80	19
	Pupil #037	9	5	3	5	6	3	4	3	2	3	0	0	0	0	4.30	37
	Pupil #038	5	1	1	1	2	3	4	4	3	5	0	0	0	0	2.90	26
	Pupil #039	10	15	11	10	8	12	12	6	1	2	10	-1629	-1619	0	8.70	52
	Pupil #040	6	2	1	2	2	2	1	3	3	6	0	0	0	0	2.80	23
	M_c^{TOT}	10	8	7	7	7	8	8	7	6	6	-	-	-	-3	7.48	
	c_F	-7	-20	-20	-20	-20	-20	-20	-20	-20	-20	52	-6171	-6119	B^{TOT}=532		K^{TOT}=3052

Table 4: Anti-fraud policies' simulation (Continued)

Policy		Tests #1	#2	#3	#4	#5	#6	#7	#8	#9	#10	Gains	Losses	Balance	b/m	$\overline{M^i}$	K^i
No-return auction policy	Pupil #001	13	11	16	16	14	17	15	14	15	15	0	0	0	0	14.60	146
	Pupil #002	16	12	14	15	19	16	15	13	14	13	0	0	0	0	14.70	145
	Pupil #003	15	12	16	16	15	9	16	16	15	15	0	0	0	0	14.50	145
	Pupil #004	19	14	13	16	14	14	13	15	17	15	0	0	0	0	15.00	146
	Pupil #005	17	6	0	1	1	2	3	1	1	0	0	-178	-178	0	3.20	91
	Pupil #006	16	8	0	1	1	0	2	1	3	0	2	-96	-94	0	3.20	82
	Pupil #007	19	16	15	18	17	19	19	13	13	16	0	0	0	0	16.50	165
	Pupil #008	17	6	0	2	0	1	1	1	1	1	1	-140	-139	0	3.00	64
	Pupil #009	11	12	10	11	14	10	13	10	13	11	17	-2064	-2047	0	11.50	87
	Pupil #010	9	4	5	4	2	3	4	4	7	5	0	0	0	0	4.70	43
	Pupil #011	6	6	7	7	3	4	5	2	7	8	0	0	0	0	5.50	52
	Pupil #012	10	6	10	12	12	9	6	8	8	5	0	-60	-60	-2	8.43	82
	Pupil #013	8	9	9	8	10	11	10	12	12	7	1	-60	-59	0	9.60	88
	Pupil #014	12	9	14	9	8	9	8	10	11	8	2	-100	-98	0	9.80	84
	Pupil #015	11	11	9	8	10	10	10	11	14	8	0	0	0	0	10.20	97
	Pupil #016	13	12	12	7	9	9	10	11	11	11	0	0	0	0	10.50	103
	Pupil #017	9	9	13	8	12	11	11	8	1	0	16	-1430	-1414	0	8.20	76
	Pupil #018	9	8	11	11	7	10	11	9	9	9	0	-40	-40	0	9.40	81
	Pupil #019	9	1	0	2	0	0	1	3	2	0	0	-5	-5	0	1.80	43
	Pupil #020	12	10	12	7	10	13	14	13	9	8	0	-100	-100	0	10.80	99
	Pupil #021	8	5	4	2	3	3	7	8	10	11	0	0	0	0	6.10	60
	Pupil #022	10	8	9	8	8	11	13	14	11	12	1	0	1	0	10.40	102
	Pupil #023	12	13	13	13	13	11	12	7	8	7	0	-20	-20	0	10.90	106
	Pupil #024	11	7	0	2	0	2	2	1	0	0	0	-166	-166	0	2.50	42
	Pupil #025	11	11	6	7	8	10	10	4	4	7	0	0	0	0	7.80	75
	Pupil #026	8	7	8	8	6	7	8	12	11	13	0	0	0	0	8.80	83
	Pupil #027	7	1	1	0	0	0	2	2	1	1	0	0	0	0	1.50	35
	Pupil #028	9	5	4	8	9	11	11	7	6	6	0	-6	-6	0	7.60	74
	Pupil #029	7	1	0	1	1	2	2	0	2	1	0	-8	-8	0	1.70	43
	Pupil #030	9	6	6	7	4	2	3	8	5	7	0	0	0	0	5.70	54
	Pupil #031	13	13	14	12	10	14	14	13	6	9	0	0	0	0	11.80	114
	Pupil #032	7	8	9	12	9	9	7	11	11	8	0	-20	-20	0	9.10	87
	Pupil #033	6	4	5	4	2	5	5	3	3	2	0	0	0	0	3.90	30
	Pupil #034	4	4	3	3	3	5	3	4	6	8	0	0	0	0	4.30	37
	Pupil #035	7	4	5	3	1	3	4	1	1	2	0	0	0	0	3.10	24
	Pupil #036	4	2	0	0	1	1	0	0	1	0	0	-9	-9	0	0.90	25
	Pupil #037	9	5	3	1	3	2	0	1	3	4	0	0	0	0	3.10	26
	Pupil #038	5	1	0	2	3	2	2	1	2	0	0	0	0	-1	1.78	13
	Pupil #039	10	13	9	0	0	2	2	1	2	0	6	-418	-412	0	3.90	27
	Pupil #040	6	2	5	2	4	5	4	5	6	6	0	0	0	0	4.50	37
	M_c^{TOT}	10	8	7	7	7	7	7	7	7	6	-	-	-	-3	7.36	
	c_F	-7	-20	-20	-20	-20	-20	-20	-20	-20	-20	46	-4920	-4874	B^{TOT}=478		K^{TOT}=3013
Total repression policy	Pupil #001	13	15	19	13	17	17	13	15	13	12	0	0	0	0	14.70	146
	Pupil #002	16	18	13	18	15	14	14	13	16	13	0	0	0	0	15.00	149
	Pupil #003	15	15	13	15	14	15	16	14	15	15	0	0	0	0	14.70	147
	Pupil #004	19	12	12	15	16	14	14	13	16	15	0	0	0	0	14.60	144
	Pupil #005	17	9	5	1	2	1	1	0	0	0	4	-200	-196	-1	3.56	84
	Pupil #006	16	7	0	1	2	1	1	0	3	0	1	-100	-99	0	3.10	89
	Pupil #007	19	15	16	17	16	18	14	15	13	14	0	0	0	0	15.70	155
	Pupil #008	17	10	9	7	1	1	0	0	0	0	2	-640	-638	-1	4.46	91
	Pupil #009	11	13	2	2	4	0	0	1	0	0	2	-320	-318	0	3.30	51
	Pupil #010	9	6	7	11	9	10	10	5	3	7	1	-20	-19	0	7.70	68
	Pupil #011	6	7	5	5	4	2	2	3	5	7	0	0	0	0	4.60	42
	Pupil #012	10	8	8	9	9	9	12	11	14	8	1	-80	-79	0	9.80	94
	Pupil #013	8	11	6	6	6	14	13	13	10	10	0	-140	-140	0	9.70	87
	Pupil #014	12	9	10	12	8	14	7	11	9	11	0	-60	-60	0	10.30	98
	Pupil #015	11	15	12	11	13	9	4	7	7	7	0	0	0	-1	9.50	93
	Pupil #016	13	8	4	10	11	11	10	8	7	9	0	0	0	0	9.10	87
	Pupil #017	9	8	11	10	9	12	9	11	10	11	16	-2000	-1984	0	10.00	97
	Pupil #018	9	6	7	8	9	5	8	6	9	10	0	-20	-20	0	7.70	72
	Pupil #019	9	2	0	2	1	0	1	3	2	0	0	-20	-20	0	2.00	47
	Pupil #020	12	14	11	12	9	11	13	10	5	6	2	-20	-18	0	10.30	97
	Pupil #021	8	8	9	6	5	7	9	8	14	8	0	0	0	0	8.20	77
	Pupil #022	10	8	9	3	4	7	4	11	11	13	0	-20	-20	0	8.00	78
	Pupil #023	12	11	9	10	10	13	9	9	6	11	0	-20	-20	0	10.00	94
	Pupil #024	11	8	7	2	0	1	1	0	2	0	2	-400	-398	0	3.20	58
	Pupil #025	11	11	9	8	8	9	10	6	4	5	0	0	0	0	8.10	72
	Pupil #026	8	7	4	5	4	4	4	4	8	9	0	0	0	0	5.70	54
	Pupil #027	7	1	1	0	0	0	2	2	1	1	0	0	0	0	1.50	40
	Pupil #028	9	7	13	9	8	11	13	9	11	5	0	-40	-40	0	9.50	92
	Pupil #029	7	13	3	1	3	0	1	0	0	1	4	-280	-276	0	2.90	46
	Pupil #030	9	8	8	4	7	8	8	11	13	9	0	0	0	0	8.50	79
	Pupil #031	13	9	10	11	12	10	11	12	8	6	0	0	0	0	10.20	97
	Pupil #032	7	10	8	9	7	5	5	7	9	9	0	-20	-20	0	7.60	73
	Pupil #033	6	6	6	5	3	6	5	2	3	4	0	-40	-40	-1	4.55	34
	Pupil #034	4	5	5	5	3	4	3	2	3	1	0	0	0	0	3.50	32
	Pupil #035	7	3	6	5	4	1	2	1	5	1	0	0	0	0	3.50	30
	Pupil #036	4	3	0	0	1	1	0	0	1	0	0	0	0	0	1.00	24
	Pupil #037	9	4	5	6	2	2	3	1	1	1	0	0	0	0	3.40	26
	Pupil #038	5	3	3	2	1	2	7	3	5	2	0	0	0	0	3.30	24
	Pupil #039	10	13	10	10	9	0	0	1	0	1	11	-900	-889	0	5.40	42
	Pupil #040	6	3	5	6	3	4	1	1	1	1	0	0	0	0	3.10	25
	M_c^{TOT}	10	9	8	7	7	7	7	6	7	6	-	-	-	-4	7.27	
	c_F	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	46	-5340	-5294	B^{TOT}=540		K^{TOT}=3035

Table 5: Individual comparison between the anti-fraud policies

	Pupil # 005 (92, 45)			Pupil # 020 (23,121)			Pupil # 035 (43,190)		
	Honest	Free-rider	Non given	Honest	Free-rider	Non given	Honest	Free-rider	Non given
Non rigorous	K_5= 385	K_5= 0	K_5= 234	K_{20}= 285	K_{20}= 0	K_{20}= 179	K_{35}= 201	K_{35}= 0	K_{35}= 83
	K_T= 8337	K_T= 7222	K_T= 8165	K_T= 8006	K_T= 7222	K_T= 8165	K_T= 8561	K_T= 7712	K_T= 8165
	$\overline{M}_5$= 2.2	$\overline{M}_5$= 19.1	$\overline{M}_5$= 8.7	$\overline{M}_{20}$= 14.5	$\overline{M}_{20}$= 0.0	$\overline{M}_{20}$= 9.6	$\overline{M}_{35}$= 10.7	$\overline{M}_{35}$= 0.0	$\overline{M}_{35}$= 4.5
	$\overline{M}_T$= 10.5	$\overline{M}_T$= 9.9	$\overline{M}_T$= 10.7	$\overline{M}_T$= 10.5	$\overline{M}_T$= 10.2	$\overline{M}_T$= 10.7	$\overline{M}_T$= 11.2	$\overline{M}_T$= 10.1	$\overline{M}_T$= 10.7
	S= 26	S= 16	S= 24	S= 23	S= 23	S= 24	S= 30	S= 23	S= 24
Maximal repressive	K_5= 385	K_5= 0	K_5= 383	K_{20}= 385	K_{20}= 0	K_{20}= 283	K_{35}= 201	K_{35}= 0	K_{35}= 169
	K_T= 11001	K_T= 10640	K_T= 11000	K_T= 11046	K_T= 10640	K_T= 11000	K_T= 8561	K_T= 10906	K_T= 11000
	$\overline{M}_5$= 19.3	$\overline{M}_5$= 18.4	$\overline{M}_5$= 19.1	$\overline{M}_{20}$= 14.2	$\overline{M}_{20}$= 0.0	$\overline{M}_{20}$= 9.4	$\overline{M}_{35}$= 10.7	$\overline{M}_{35}$= 0.0	$\overline{M}_{35}$= 9.4
	$\overline{M}_T$= 14.1	$\overline{M}_T$= 14.0	$\overline{M}_T$= 14.1	$\overline{M}_T$= 14.3	$\overline{M}_T$= 13.8	$\overline{M}_T$= 14.1	$\overline{M}_T$= 11.2	$\overline{M}_T$= 14.1	$\overline{M}_T$= 14.1
	S= 36	S= 33	S= 34	S= 35	S= 33	S= 34	S= 30	S= 35	S= 34
Simple auction	K_5= 382	K_5= 0	K_5= 382	K_{20}= 270	K_{20}= 0	K_{20}= 270	K_{35}= 204	K_{35}= 0	K_{35}= 185
	K_T= 10972	K_T= 10640	K_T= 10959	K_T= 10959	K_T= 10767	K_T= 10959	K_T= 10977	K_T= 10824	K_T= 10959
	$\overline{M}_5$= 18.8	$\overline{M}_5$= 18.4	$\overline{M}_5$= 19.0	$\overline{M}_{20}$= 14.2	$\overline{M}_{20}$= 0.0	$\overline{M}_{20}$= 13.8	$\overline{M}_{35}$= 10.5	$\overline{M}_{35}$= 0.0	$\overline{M}_{35}$= 9.6
	$\overline{M}_T$= 14.1	$\overline{M}_T$= 14.0	$\overline{M}_T$= 14.1	$\overline{M}_T$= 14.1	$\overline{M}_T$= 13.9	$\overline{M}_T$= 14.1	$\overline{M}_T$= 14.1	$\overline{M}_T$= 13.9	$\overline{M}_T$= 14.1
	S= 34	S= 33	S= 34	S= 26	S= 16	S= 34	S= 35	S= 35	S= 34

IV - Discussion and Concluding Remarks

Micro-simulation is an interesting technics, but we have to pay attention to our first results. Firstly, the behaviors we have modelled are unfortunately unobservable : chatting is rather observable, not free-riding[16]. So an experimental and questionnaire approach could help us to correct this drawback, especially to estimate the behavioral coefficients. Let's now examine the empirical results that we'll compare to the theoretical results, and present the future development.

An empirical analysis : Most of our results - Table 5 and 6 - are not amazing, because they came from a mechanical process. The knowledge level decreases if the teacher does not supervise his exams and tests. Nevertheless tables 5 and 6 tell us the rate level of knowledge doesn't decrease so widely as we might have expected. No significant difference seems to exist between all the anti-fraud policies - we mean #2, #3 and #4. The non-rigorous policy (#1) doesn't incite pupils to pay attention during lessons (and to learn)[17]. The global level of knowledge decreases and so that, even if pupils can free ride during the test and exam, free riding becomes inefficient and useless - see Table 8.

To investigate the individual point of view, we have made three simulations - Table 7 : the basic simulation (non given), ”honest” one (the pupil never free-rides), and ”free-rider” one (the pupil free-rides). We found that in the ”honest” one, the level of knowledge is good, but in the ”free-rider” one, the free-rider pupil makes the other (especially the weakest one) fail. Free-riding is no use to the pupils who have the strongest intellectual capabilities. However, some other simulations seem necessary to confirm our first results, and to give a better interpretation of our indicators.

A recall of the theoretical context : The educational learning process is an important topic of the New-classical Economic Thought that was illustrated by G.S.Becker (1964). The learning is considered as an human investment process according to the competition model. However, this pattern is difficult to model in an individual level and on a short run[18] - pupils rarely expect the returns from the tests and *a fortiori* from the lessons.

Paradoxically, neither New-classical(and keynesian) in their *Economics of information* nor Austrian in their *Knowledge discover process*, use the educational field which should be an evident field of analysis. The Information (and Knowledge) concept didn't appear at the beginning of the History of the Political Economy[19]. In the competitive model of production of the new-classical thought of

Table 6: General comparison of the anti-fraud policies

Criteria	Nonrigourous policy	Simple auctions policy	No-return auctions policy	Maximal repression policy
Winnings/Losses of fraud	0	-6119	-4874	-5294
Chatting	787	532	478	540
Max. level of knowledge	122	152	165	155
Min. level of knowledge	10	19	13	24
Total of knowledge	2009	3052	3013	3035
Min. average	1.40	0.80	0.90	1.00
Max. average	13.20	15.70	16.50	15.70
General average	6.08	7.48	7.36	7.27

the end of the ninetieth century, the admitted assumption was that the economic agent has got freely all relevant information he needs to make his own decision[20]. The Austrian economists denied this assumption, in explicating that the market mechanism is explained because of the lack of information of individual agents (F.A.Hayek, 1945) but the both economic thoughts agreed about the self-regulatory of the market economy. After 1929 crises, the Keynesian economists questioned this self-regulatory - F.A.Hayek (1937) linked it to the information's process discovery. Information is dispersed among the individuals and available through the commodities price. Since the seventies, the information is became an important theoretical economic topic. It consisted to leave one of the assumptions of the pure and perfect competition model and to explain the persistent disequilibrium of the market. Especially S.J.Grossman and J.E.Stiglitz proposed the paradoxical result that if a market is efficient in terms of information, all relevant information is already reflected in market prices, then no individual would be incited to acquire the information on which prices are grounded[21].

An essay of theoretical interpretations of the model : One of the results of our model was that a classroom where the teacher leaves pupils free to communicate has worse test results than one where teacher control the communication between pupils. We can translate this results so : *when pupils expect free-riding without cost, they don't learn lesson and then they have to ask neighbors during test. But neither individual pupil nor his neighbors are incited to learn, so no pupil is able to answer and so to succeed the test. If one of the pupils had learnt lesson, he would have produced public information, because he should have to give it to other pupils of the classroom. Except if he agrees to give information to other pupils, he has no interest to make so according to an effort/marks analysis*[22]. We obtain a variant of *Grossman-Stiglitz effect*" (S.J.Grossman and J.E.Stiglitz, 1980) linked to the public information : no individual could make profit in producing public information.

Fundamentally, pupils have a search information's behavior to produce answer that teacher is waiting for. Such a behavior should obviously take place during lesson but not during test or exam. During our actual tests, we usually tell to our pupils that c_F (fraud cost) doesn't represent a punishment but **the price they have to pay to buy the cheating information**. Consequently, pupils have to choose between two behaviors : producing answer (by learning) or "buying" cheating information with a high probability to buy a wrong answer - they usually don't know if they "buy" the right answer.

In fact, the free-rider try to achieve a wrong goal in optimizing a score (the average mark) instead of acquiring knowledge (by listening and understanding the lesson)[23], in other words, in producing their own information[24].

The next development of the model : They should concern the expectation's behavior[25], the long run dynamics. Moreover, some functions should be revised, especially the encoding function[26] E^i_j, the learning function K^i_j, the lesson function L_j which could be build as a network, and the mark parameter π^i_j which could be no more boolean. The design of knowledge provided by F.Machlup (1984) could help us to perform the specification[27]. Moreover, we'll keep our *non a priori* theoretical point of view - our empirical model doesn't belong to one economic thought or to one other - and we'll try to understand the pupil's behavior in front of knowledge, and finally, we hope so, get some criteria of the pupil's rationality[28] in the classroom.

Notes

[1]- See J.E.Brophy and T.L.Good, 1986, Teacher behavior and student achievement. *Handbook of Research on Teaching*. M.C.Wittrock, New York: MacMillan, 328-357 or J.B.Carroll. 1963. A model of school learning. *Teachers College Record* 64: 723-733. Some mathematical models has been developed (S.A.Goldman and M.J.Kearns, "On the Complexity of Teaching", *Proceedings of the Fourth Annual Workshop on Computational Learning Theory*, ACM Press, 1991 ; J.Jackson and A.Tomkins, "A Computational Model of Teaching", *Proceedings of the Fifth Annual Workshop of Computational Learning Theory*, ACM Press, 319-26, 1992 ; H.D.Mathias, "A Model of Interactive Teaching", *Journal of Computer and System Sciences*. 54(3): 487-501, 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 G.H.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 behavior. 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 N.Gilbert (2008, pp.17-18) about then links between Microsimulation and the ACE and L.Tesfatsion and K.L.Judd (Eds) (2006) for a wider overview.

[4]- See L.R.Anderson and C.A.Holt (1996) about an experimental analysis of information, but where pupils and the teacher didn't play their own role.

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

[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 P.L.P. Rau et al. (2008).

[11]- Term used according to an educational point of view and not according to an Austrian point of view : ”[...] *information is the stock of the existing known, while knowledge is the flow of new and ever expanding areas of the known.*” P.Boettke (2002, p.266).

[12]- In a future release, we could specify this learning function so $K_j^i = \alpha^i * L_j$ where $0 \leq \alpha \leq 1$.

[13]- In a future release, we could consider it exists a hierarchy among the lesson's items. One couldn't get the L_n item of the lesson if he has not previously the L_m one with $m < n$. The L vector could be translated into a network.

[14]- In a future release, we could introduce a β parameter so $\pi_j^i = \beta$ with $0 \leq \beta \leq 1$ according the quality of the answer.

[15]- We have only consider data transmission between one ”sender” and one ”receiver”, but cheating behavior is more complex (J.Kerkvliet and C.L.Sigmund, 1999). See P.W.Grimes & J.P.Rezek (2005) about the psychological determinants of the cheating behavior. Moreover, we should distinguish between girls and boys inside the classroom. About the gender differences of participation in class, see A.Caspi et al. (2008).

[16]- About cheating test, see W.H.Angoff, ”The Development of Statistical Indices for Detecting Cheaters”, *Journal of the American Statistical Association*, 69 (345): 44-49, 1974 ; R.B.Frary, T.N.Tideman and T.M.Watts, ”Indices of Cheating on Multiple-Choice Tests”, *Journal of Educational Statistics*, 2 (4): 235-56, 1977 ; and more recently G.J.Cizek, *Cheating on Tests: How to Do It, Detect It and Prevent It*, Lawrence Erlbaum Associates, 1999 ; B.A.Jacob and S.D.Levitt, ”Rotten Apples: an Investigation of the Prevalence and Predictors of Teacher Cheating”, *Working Paper NBER*, 9413, 2003.

[17]- C.R.Tittle and A.R.Rowe (1974) had shown that the instructor who had a reputation of being ”lovable and understanding” had the greater amount of cheating in his class. Those who where most in need of points were willing to take greater risks. Furthermore, moral appeal did not work for decreasing this amount. J.R.Magnus *et al.* (2002) have shown a sociocultural difference between the cheaters, but J.Kerkvliet (1994) don't find a typical profile of cheater.

[18]- E.A.Hanushek (1971) and more recently Rivkin S.G., E.A.Hanushek and J.F.Kain (2005), C.Jaag (2006) provide a real neoclassical approach of the classroom, however, the teachers and the students remain some abstract optimizing agents.

[19]- Even later in the ACE - see T.Brenner (2006). The rare works come from Economics of Education towards Economics of Information - let's quote N.R.Netusil and M.Haupert (1995) about the New-classical school and Z.X.Zygmont (2006) about the Austrian Economics' school.

[20]- See by e.g. I.Macho-Stadler and J.D.Perez-Castrillo (2001).

[21]- See P.J.Boettke (2001) and P.J.Boettke & P.Leeson (2003) about the recent critique of this result.

[22]- However, we have supposed that the pupils were same psychological and we know it is not always actual see R.Buda (1996, *op.cit.*).

[23]- The ”classical” assessment system often seems to lead pupils toward this wrong goal - see B.Holmstrom and P.Milgrom, ”Multitask Principal-Agent Analyses: Incentive Contracts, Asset

Ownership and Job Design", *Journal of Law, Economics and Organization*, 7 (Spring): 24-51, 1991.

[24]- Let's add the Austrians generally consider that actors "are not only confronted with their lack of knowledge of the other person but also with their lack of self-knowledge" (T.Aimar, 2008). Our microsimulation approach could perhaps help to investigate about it.

[25]- Sometimes pupils have bad cost of fraud's (c_F) expectations so that, free-riding does not normally increase. They did'nt know the teacher's policy or they mistake on it.

[26]- We should consider more sociopsychological determinants ; see M.A.Burke and T.R.Sass (2008) about the peer-effect and the performance of the individuals in the classroom.

[27]- F.Machlup provided a classification of the individual knowledge. The *practical knowledge* linked to the professional activities, *intellectual knowledge* answering to our curiosity, *entertaining knowledge* linked to leisures and our emotional stimulation, *spiritual knowledge* linked to our religious beliefs, and *randomized knowledge* obtained without any search.

[28]- During quarterly, some pupils keep an actual "*boni-mali accounts*".

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