

Classroom Games in Economics: A Quantitative Assessment of the 'Beer Game'

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Motivation - an experiment on the use of experiments

- Growing use of departures from 'chalk-and-talk'
- use of classroom games and experiments is no exception.
 - <http://www.marietta.edu/~delemeeg/games/>, EN case studies, chapter in the EN Lecturer's Handbook and recent issue of *IREE*
- Benefits of games
 - immerse the students in the economic environments
 - games are seen to increase student motivation
 - promote an active learning environment / encourages deep learning
- But need to balance benefits with costs
 - Scientific approach to evaluating our own teaching

caveat utilitor
(let the user beware)

My specific exercise

- I assess the extent of, and quantify, the benefits of “The Beer Game”
 - Short- and medium-run benefits.
- Use a controlled experiment:
 - large class (about 200 students)
 - relatively homogenous undergraduates
 - some taught via game and others via traditional seminar
- Compare the two teaching methods along many dimensions
 - which method effectively achieves its learning outcomes?
 - which do participants prefer?

Findings

- Enjoyment seems to increase on average - but not uniformly
- Game effectively drives home the key idea of the game but may wrongly downplay related ideas
- Facts mastery or definitional aspects are better through slides
- Results are, if anything, strongest for the better students

Different delivery methods

- The seminar/lecture delivery is very standard:
 - 17 slides
 - discussed, using graphs generated in previous runs of the 'beer game', the concept of the 'bull-whip' effect
 - discussion of the changes in inventory management.
- The 'beer game' is a role-play simulation game:
 - "to experience first hand the typical coordination problems of (traditional) supply chains, in which information sharing and collaboration does not exist"
 - In the 'beer game', students each take one role in a four stage supply chain that consists of a Brewery, Distributor, Wholesaler and Retailer
 - Objective is to try to minimise costs at your stage of the plant by correctly managing inventory flows

Experiment

1. Students self-assign to one of 4 computer room sessions
2. 3 groups of student:
 - Normal Chalk-and-talk 'sign-up' student
 - Game 'Beer game' 'sign-up' student
 - None Did not sign up
3. Class:
 - On arrival - take a short test to assess existing knowledge
 - None group invited to take same test on their own
 - Class took place
 - Students retook the test (+ assessment questions)
4. Start of next term (about 6 weeks later):
 - All students took a mid-term test

Diff-in-Diff

- natural ability (λ_i) which is assumed constant across time
- average short-term effect of attending a class (γ^s)
- average medium-term effect of attending a class (γ^m)
- average short-term *marginal* effect of attending the game (β^s)
- average medium-term *marginal* effect of attending the game (β^m)
- average effect of exam study effort (e)
- individual- and time- specific deviations from these averages (ϵ_{it})

Person	Group	Before Class ($t = 0$)	After Class ($t = 1$)	Exam ($t = 2$)
h	None	$\lambda_h + \epsilon_{h0}$		$\lambda_h + e + \epsilon_{h2}$
i	Normal	$\lambda_i + \epsilon_{i0}$	$\lambda_i + \gamma^s + \epsilon_{j1}$	$\lambda_i + e + \gamma^m + \epsilon_{j2}$
j	Game	$\lambda_j + \epsilon_{j0}$	$\lambda_j + \gamma^s + \beta^s + \epsilon_{i1}$	$\lambda_j + e + \gamma^m + \beta^m + \epsilon_{i2}$

Regression

$$y_{it} = \alpha_i + \tau_1 T(\text{Post}) + \tau_2 T(\text{Exam}) + \eta_1 T(\text{Post}) \times D(\text{Game}) + \eta_2 T(\text{Exam}) \times D(\text{Class}) + \eta_3 T(\text{Exam}) \times D(\text{Game}) + \varepsilon_{it} \quad (1)$$

Table: Mapping between regression coefficients and underlying factors of interest

Description	Symbol	Coefficient	Variable
Natural ability within each group	λ_k	α_k	FE
Average short-term effect of attending class	γ^s	τ_1	T(Post)
Average medium-term effect of attending class	γ^m	η_2	T(Exam) \times D(Class)
Average short-term <i>marginal</i> effect of game	β^s	η_1	T(Post) \times D(Game)
Average medium-term <i>marginal</i> effect of game	β^m	η_3	T(Exam) \times D(Game)
Average effect of exam study effort	e	τ_2	T(Exam)

Summary Statistics and Timing

Time of Response	Group				Total
	Just Exam	Form	Normal	Game	
	No.	No.	No.	No.	No.
Before Class	0	10	62	58	130
After Class	0	0	62	58	120
Exam	68	10	62	58	198
Total	68	20	186	174	448

Group	Count	Mean	Median	Sd
	Total Students	Exam Mark, %	Exam Mark, %	Exam Mark, %
Just Exam	68	67	69	13
Form	10	67	69	13
Normal	62	65	69	14
Game	58	64	66	16
Total	198	65	69	14

Question 1 - Definitional

	(1)	(2)	(3)	(4)
	Q1s	Q1s	D(Q1p)	D(Q1p)
T(Post) - τ_1	0.89*** [0.00]	1.06*** [0.00]	1.45*** [0.00]	0.29*** [0.00]
T(Exam) - τ_2	1.20** [0.03]	1.35*** [0.00]	0.72 [0.24]	0.10 [0.52]
T(Post) x D(Game) - η_1	-0.51 [0.11]	-0.89*** [0.00]	-1.20*** [0.00]	-0.24*** [0.01]
T(Exam) x D(Class) - η_2	-0.30 [0.62]	-0.27 [0.59]	0.57 [0.36]	0.14 [0.40]
T(Exam) x D(Game) - η_3	0.27 [0.40]	-0.11 [0.68]	-0.31 [0.30]	-0.052 [0.56]
Constant	0.55*** [0.00]	0.55*** [0.00]	-1.84*** [0.00]	0.076** [0.01]
Observations	380	380	380	380
R-squared	0.178			0.123
Number of students	130	130	130	130
Estimation Method	Panel	Panel	Panel Probit	Panel
Student Effects	FE	RE	RE	FE

P-values reported in brackets

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Question 3 - Sources of Volatility

	(1) $q3^{info}$	(2) $q3^{consumer}$	(3) $q3^{nocollab}$	(4) $q3^{delays}$	(5) $q3^{supplychain}$	(6) $D(q3^{all})$	(7) $D(q3^{cons\ unrelatd})$
T(Post) - τ_1	0.56*** [0.00]	-0.34* [0.05]	0.68*** [0.00]	0.23 [0.14]	0.065 [0.70]	0.67*** [0.00]	0.38 [0.30]
T(Exam) - τ_2	-0.30 [0.47]	-0.10 [0.82]	-0.40 [0.32]	0.20 [0.60]	0.20 [0.64]	-0.46 [0.31]	0.70 [0.30]
T(Post) x D(Game) - η_1	0.61** [0.01]	-0.35 [0.17]	0.79*** [0.00]	0.33 [0.14]	0.38 [0.12]	0.33 [0.26]	0.33 [0.41]
T(Exam) x D(Class) - η_2	0.30 [0.50]	-0.13 [0.79]	0.87** [0.04]	-0.41 [0.32]	-0.52 [0.25]	0.61 [0.20]	-1.04 [0.19]
T(Exam) x D(Game) - η_3	0.43* [0.07]	-0.50** [0.05]	0.84*** [0.00]	0.30 [0.18]	0.22 [0.37]	-0.13 [0.61]	1.34** [0.02]
Constant	2.82*** [0.00]	3.42*** [0.00]	2.02*** [0.00]	3.09*** [0.00]	2.90*** [0.00]	0.13 [0.29]	-2.16*** [0.00]
Observations	380	380	380	380	380	380	380
R-squared	0.207	0.090	0.318	0.084	0.066		
Number of students	130	130	130	130	130	130	130
Estimation Method	Panel	Panel	Panel	Panel	Panel	Panel Probit	Panel Probit
Student Effects	FE	FE	FE	FE	FE	RE	RE

P-values reported in brackets

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Question 4 - Volatility Gap Along Supply Chain

	(1)
	Q4s
T(Post) - τ_1	1.45*** [0.00]
T(Exam) - τ_2	1 [0.23]
T(Post) x D(Game) - η_1	0.28 [0.57]
T(Exam) x D(Class) - η_2	-1.19 [0.19]
T(Exam) x D(Game) - η_3	1.36*** [0.01]
Constant	-0.48*** [0.00]
Observations	373
Number of students	130
R-squared	0.184
Estimation Method	Panel
Student Effects	FE

P-values reported in brackets

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Student Views on the Teaching Method

Please rate this session compared to our ordinary EC108 sessions.
Rate each one separately:

	Much Better	Slightly Better	No Different	Slightly Worse	Much Worse
Overall session (S1)	5	4	3	2	1
Delivery and engagement (S2)	5	4	3	2	1
Content (S3)	5	4	3	2	1
Your interest in the material (S4)	5	4	3	2	1

$$S_{ji} = \alpha + \beta_1 D(\text{Game}) + \beta_2 \text{Controls} + \epsilon_i \forall j \in (1, 2, 3, 4) \quad (2)$$

Session Question Analysis I

VARIABLES	(1) S1	(2) S1	(3) S2	(4) S2	(5) S3	(6) S3	(7) S4	(8) S4
D(Game)	0.30 [0.11]	0.37 [0.13]	0.37** [0.02]	0.55** [0.02]	0.25 [0.15]	0.31 [0.21]	0.53*** [0.00]	0.48** [0.05]
D(Session 3)		-0.59** [0.03]		-0.44* [0.06]		-0.41 [0.12]		-0.14 [0.56]
D(Session 4)		-0.44* [0.06]		-0.086 [0.69]		-0.28 [0.18]		-0.24 [0.33]
Exam Mark, %		-0.0093* [0.08]		-0.010** [0.04]		-0.011** [0.05]		-0.00015 [0.98]
Constant	3.80*** [0.00]	4.65*** [0.00]	3.82*** [0.00]	4.53*** [0.00]	3.49*** [0.00]	4.33*** [0.00]	3.66*** [0.00]	3.80*** [0.00]
Observations	119	119	119	119	119	119	119	119
R-squared	0.022	0.101	0.043	0.100	0.018	0.078	0.075	0.085
Estimation Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Student Effects	None	None	None	None	None	None	None	None

P-values reported in brackets

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Session Question Analysis II

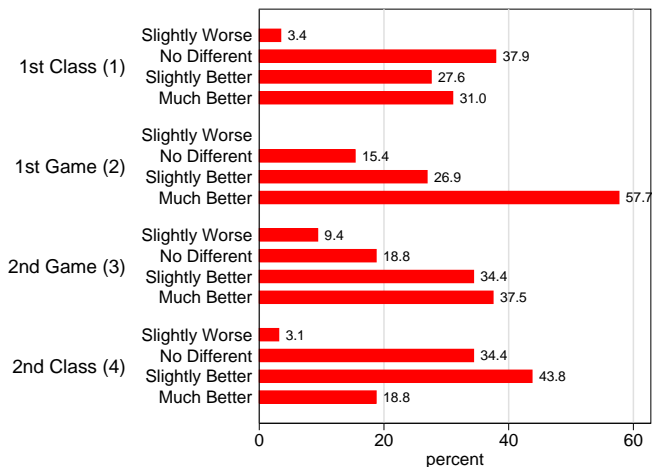


Figure: Delivery and engagement (S2) scores across session

Findings

- Enjoyment seems to increase on average - but not uniformly
- Game effectively drives home the key idea of the game but may wrongly downplay related ideas
- Facts mastery or definitional aspects are better through slides
- Results are, if anything, strongest for the better students