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Procedia - Social and Behavioral Sciences 182 (2015) 203 – 212

Procedia Social and Behavioral Sciences

4th WORLD CONFERENCE ON EDUCATIONAL TECHNOLOGY RESEARCHES, WCETR-2014

Tracking the behavior of players in a cost accounting simulation and identifying work patterns

Lucinio Gonzalez-Sabate [a] *, Antoni Olive[a], Josep Oriol[a], Jordi Cuadros[a], Joaquin Menacho[a]

[a]*IQS-Universitat Ramon Llull (URL), Via Augusta, 390, 08017 Barcelona, Spain*

Abstract

This paper summarizes the results of using two Excel-based simulations run on a cost accounting course to instruct about the contribution margin. Students' learning has been assessed using achievement tests and analyzing traces. Conclusions of the research are: students stayed active, focused their work on the key actions, and worked where the instructor wanted them to work; there was knowledge acquisition since the tests provide evidence of learning; and the activity was well-accepted by the students.

Peer-review under responsibility of Academic World Research and Education Center.

Keywords: Simulations; contribution margin; Excel; achievement tests; traces; R statistical environment; feedback survey

1. Introduction

Some concepts, phenomena, and dynamics are complex and difficult to understand using traditional methods, such as lecturing. Today's professors have to face with a lack of motivation and engagement by the students, and have to think of activities to make students stay active. In contrast, current state of technology allows the existence of a wide range of interactive tools to bring to class. Simulations are used to emphasize the concepts taught in class

* Lucinio Gonzalez-Sabate. Tel.: +34-932-672-000.
E-mail address: lucinio.gonzalez@iqs.edu

Peer-review under responsibility of Academic World Research and Education Center.
doi:10.1016/j.sbspro.2015.04.757

using traditional methods. This paper summarizes the results of using two Excel-based simulations run on a cost accounting course.

The research consists of using three methods to verify: whether the activity incentivizes the students' work (active learning); whether there is a generalized work pattern among students (focused learning); whether the activity increases students' comprehension of the key concepts previously specified (increased knowledge); and whether students' attitude is receptive to these innovative teaching methods (students' attitude). Increased knowledge is measured by comparing the results of the post-tests with the results of the pre-tests and by verifying whether students score higher in the post-tests than in the pre-tests. Student learning perception is measured by a feedback survey. Everything is done with the aim of improving the learning of future cohorts of students.

We should distinguish between game, simulation, and simulation game (Ellington, 1981). Games consist of any activity in which the user competes with others to achieve a goal. Simulations are virtual representations of reality. The player can experiment but is not able to alter reality. The results of the simulation are always the same, and the player can only visualize some fictitious situations. Simulation games refer to a combination of both. They consist of activities that are live representations of reality in which players compete. The activity referred to in this paper falls within the category of simulations, because it is a virtual representation of reality and does not involve interaction among the players.

Listing the benefits of simulations, Ezz, Loureiro-Koechlin, and Stergioulas (2012) remind that there is a need for non-conventional tools in education. They are more effective than lecturing with regards to theoretical concepts, which are difficult to assimilate and retain after some time. Visual examples are easier to understand and assimilate. Simulations allow students to practice *in vivo* the theoretical concepts taught in lectures. Simulations capture the attention of users, make them stay active, and accelerate learning. Learning is based on trial-and-error. Students are able to observe the consequences of their decisions. Simulations promote decision making and allow evaluation of human reaction to given situations. They allow failing without cost and can be stopped at any moment to analyze the effects of any previous decision. They also allow users to face situations rarely encountered in reality and for which they should be prepared. Finally, the authors state that simulations are an appropriate methodology, because today's students are "digital" and therefore completely familiar with these tools.

Randel, Morris, Wetzel, and Whitehill (1992), Terrell and Rendulic (1996), Prensky (2003), and Tao, Cheng, and Sun (2009) remark that simulation games cause an increase in user's motivation to learn.

Salas, Wildman, and Piccolo (2009) argue that the value of a simulation depends on the acceptance of the tool by the students, on quantified results (to what extent they have learnt in line with the expectations of the teacher), and on the students' behavior *a posteriori* (to what extent their knowledge increases). In sum, it depends on whether the user is ready to experience the simulated situation.

2. Activity description

The activity was conducted in the 2013-2014 academic year of the IQS School of Management Degree in Business Administration and Management as part of "Management Control", a third-year course. There were three groups, with 51, 63, and 39 students respectively. 97 students participated in the entire activity (pre-tests, simulations, post-tests), representing 63% of the total number of students.

The activity intends to present the concept of the contribution margin. A first simulation instructs the students that a firm with a negative unit contribution margin must stop selling since the more it sells, the more it loses. In a second simulation, students are required to split a finite manufacturing capacity between two variants of a product on the basis of their total contribution margin, and have to realize that in the short run, when the fixed costs cannot be altered, maximizing the profit consists of maximizing the contribution margin.

The two knowledge components to be taught are: 1) "firms with a negative unit contribution margin must stop selling; any increase in sales reduces profits or increases losses and any reduction in sales increases profits or reduces losses" and 2) "in the short run fixed costs do not vary and should not be taken into consideration when making decisions; hence, maximizing the result involves maximizing the contribution margin."

In simulation 1, Click & Enjoy is an e-commerce firm which faces a challenging situation: the more they sell in units, the more they lose. Students have to classify costs as either variable or fixed, and have to create an income statement for the first year of operations. Screen 1 of the simulation is shown in Figure 1. When the number of

transactions (number of units) is 50,000, the EBT (earnings before taxes) are -638,500 €. When the number of transactions is 100,000, the EBT are 656,000 €. Students must identify the reason. They must realize that the selling price does not cover the unit variable cost and, hence, the unit contribution margin is negative. They must conclude that if the firm stops selling, it will lose the fixed costs; but if the firm keeps selling, it will lose the fixed cost plus the negative contribution margin. Therefore, it must stop selling immediately.

	A	B	C	D	E	F	G
1	**CLICK & ENJOY**						
2							
3	Selling price	10,00				UNIT GROSS MARGIN	2,00
4	Purchase price	8,00					
5	Initial n° of transactions	50.000				EBT	-638.500
6	Increasing n° of transactions	100.000				New EBT	-656.000
7						Number of changes	1
8							
9	COST STRUCTURE						
10							
11	Cost concept	Variable (€/unit)	Fixed (€)				
12							
13	Warehousing	0	100.000				
14	Shipping	1	0				
15	Marketing	0	50.000				
16	Customer acquisition	0	6.000				
17	Sales	0,3	80.000				
18	Purchases	0,4	30.000				
19	Administration	0,15	40.000				
20	General management	0	115.000				
21	Website development	0	150.000				
22	Website maintenance	0,5	0				
23	Hardware depreciation	0	20.000				
24	Financial	0	30.000				
25							

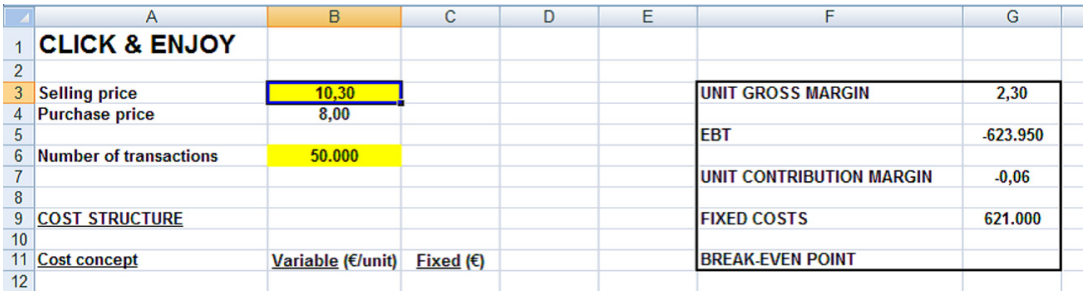
Figure 1. Click & Enjoy screen 1. Decimal and thousand characters are according to the Spanish convention.

Screen 2 of the simulation is shown in Figure 2, in which the unit contribution margin is also presented. Students are invited to increase the selling price until the unit contribution margin is positive in order to reverse the situation.

	A	B	C	D	E	F	G
1	**CLICK & ENJOY**						
2							
3	Selling price	10,00				UNIT GROSS MARGIN	2,00
4	Purchase price	8,00					
5						EBT	-638.500
6	Number of transactions	50.000					
7						UNIT CONTRIBUTION MARGIN	-0,35
8							

Figure 2. Click & Enjoy screen 2 (portion).

Screen 3 of the simulation may be seen in Figure 3, in which the fixed costs and the break-even point in number of transactions are shown. Students cannot set a selling price higher than 10.50 € "because the market does not accept selling prices higher than 10.50 €." Students are requested to calculate the selling price that makes the unit contribution margin to be 0, the selling price interval for which the unit contribution margin is positive, and the number of transactions that makes the EBT to be 0 when the selling price is 10.50 €.



	A	B	C	D	E	F	G
1	**CLICK & ENJOY**						
2							
3	Selling price	10,30				UNIT GROSS MARGIN	2,30
4	Purchase price	8,00					
5						EBT	-623.950
6	Number of transactions	50.000					
7						UNIT CONTRIBUTION MARGIN	-0,06
8							
9	COST STRUCTURE					FIXED COSTS	621.000
10							
11	Cost concept	Variable (€/unit)	Fixed (€)			BREAK-EVEN POINT	
12							

Figure 3. Click & Enjoy screen 3 (portion).

In simulation 2, Pumping Industrial Company is a firm which manufactures an industrial product and plans to launch to the market an improved version of the product. Both versions (standard and improved) would be manufactured in the same plant. The firm utilized 100% of the manufacturing capacity of the plant and could not increase its size. Therefore, in order to manufacture units of the improved version the firm has to reduce the production of units of the standard version. Unit costs for both versions of the product are detailed. Students must split the finite manufacturing capacity of the plant between the two versions, maximizing the profits. Students must realize that in the short run the fixed manufacturing costs will not vary and should therefore not be taken into consideration. Afterwards, decisions should be made on the basis of the total contribution margin. Given this, they must split the manufacturing capacity, maximizing the total contribution margin and taking into account the variations in the selling prices of both products, depending on the number of units sold. Furthermore, they must recognize that their unit contribution margins also vary, and that there is an exchange rate between the number of units manufactured of both versions of the product (1 unit of the standard version is equivalent to 2 units of the improved version). In splitting the manufacturing capacity between the two versions of the product, students must utilize the plant's manufacturing capacity in full. Figure 4 shows a portion of the second screen of the simulation. Students must enter a set of number of units for both versions. Excel checks whether the manufacturing capacity is utilized in full and, if so, the total contribution margin is shown. Students must try all the possible combinations and identify the combination with the largest total contribution margin.

	A	B	C	D
1	**PUMPING INDUSTRIAL COMPANY**			
2				
3	**STANDARD TYPE**			
4	Number of units assembled and sold			
5	Selling price	0	€	
6	Unit variable cost	5.150	€	
7	Unit contribution margin	0	€	
8				
9	**IMPROVED TYPE**			
10	Number of units assembled and sold			
11	Selling price	0	€	
12	Unit variable cost	3.420	€	
13	Unit contribution margin	0	€	
14				
15	**TOTAL CONTRIBUTION MARGIN**		€	
16				
17				
18	Calculate Total Contribution Margin			
19				
20				
21		**Possible combinations**		
22	**n° of combinations**	**STANDARD**	**IMPROVED**	**TCM (€)**
23				
24				
25				
26				

Figure 4. Pumping Industrial Company screen 2 (portion).

The entire activity consists of 10 steps: 1) lecture; 2) pre-test (for both simulations); 3) simulation 1 pre-test; 4) simulation 1; 5) simulation 1 post-test; 6) simulation 2 pre-test; 7) simulation 2; 8) simulation 2 post-test; 9) post-test (for both simulations); 10) feedback survey. The theoretical concepts to be used in the simulation are presented by the professor during the lecture. Initial pre-test and final post-test have many questions and are common to both simulations, and pre-test and post-test for each of the simulations consists of a single question specific to the simulation. Pre-tests and post-tests consist of the same questions. Answers are corrected in a binary way (right/wrong).

3. Methodology

In order to comply with methodological triangulation, three sources of evidence have been used in this research. The three methods used to assess the students' learning are: achievement tests (pre-test and post-test), the collection and analysis of the students' trace files, and a feedback survey. Traces are analyzed using the R statistical environment to identify work patterns.

The purpose of achievement tests is to measure the influence of student participation on learning outcomes. By measuring knowledge and attitudes before and after the activity, the effectiveness of the activity can be measured.

Analysis of traces allows us to track all the students' actions when filling in the Excel cells. Among the students' actions tracked are CELL_CHANGED (a value or a formula is entered in a cell or a range of cells) and SHEET_CALCULATE (a cell with a referenced formula is re-calculated). The most informative type of action is CELL_CHANGED, which allows us to check whether the value entered by the student is correct.

The feedback survey consists of a set of questions to be answered according to a scale ranging from total disagreement to total agreement. The survey consists of twenty-two questions. Three of the questions are open. Some questions refer to the students' perception of the usefulness of the simulation ("The activity accelerates learning"). Other questions measure the degree of satisfaction ("If I was offered to do it again, even if it were not compulsory, I would do it again").

4. Results

The two knowledge components to be taught are: 1) "firms with a negative unit contribution margin must stop selling; any increase in sales reduces profits or increases losses and any reduction in sales increases profits or reduces losses" and 2) "in the short run fixed costs do not vary and should not be taken into consideration when making decisions; hence, maximizing the result involves maximizing the contribution margin." The pre-tests and post-tests consisted of a set of questions related to these two knowledge components. Pre-tests and post-tests consisted of the same questions. Answers were corrected in a binary way (right/wrong).

The initial pre-test and the final post-test consisted of 22 questions. The results have been analyzed per student and per question. Figure 5 shows a histogram with the differences in results between the initial pre-test and the final post-test, per student. 24 out of 97 students scored lower in the post-test than in the pre-test. 73 out of 97 students scored higher in the post-test than in the pre-test. The average grade increased by 5.2 percent points, from 51.9% to 57.1%.

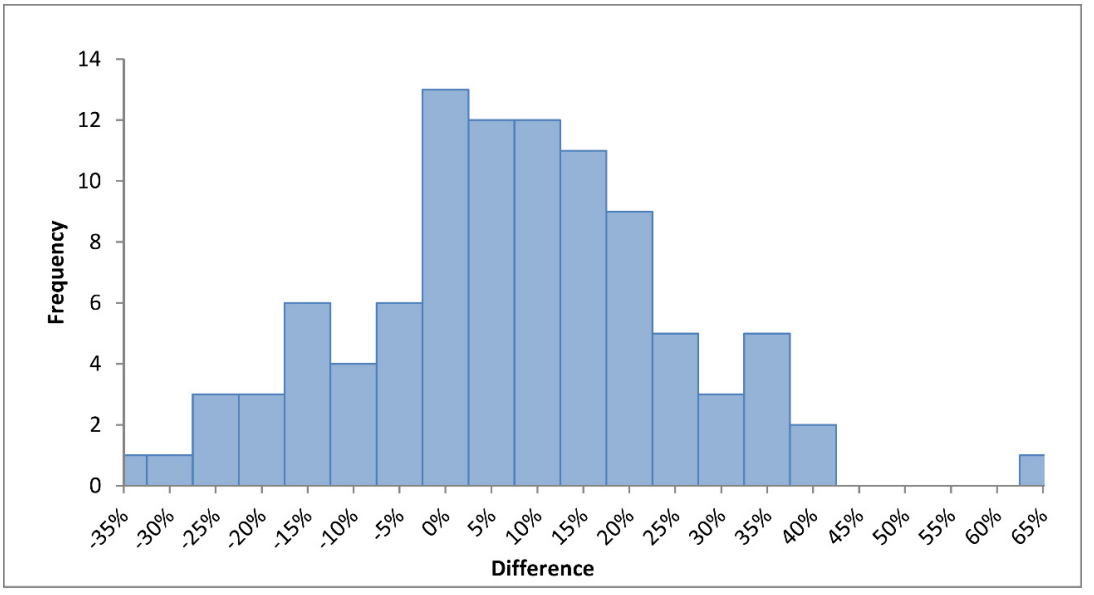


Figure 5. Histogram with the differences in results, per student.

Figure 6 shows a histogram with the differences in results between the initial pre-test and the final post-test, per question. In 3 out of 22 questions students scored lower in the post-test than in the pre-test. In 19 out of 22 questions students scored higher in the post-test than in the pre-test.

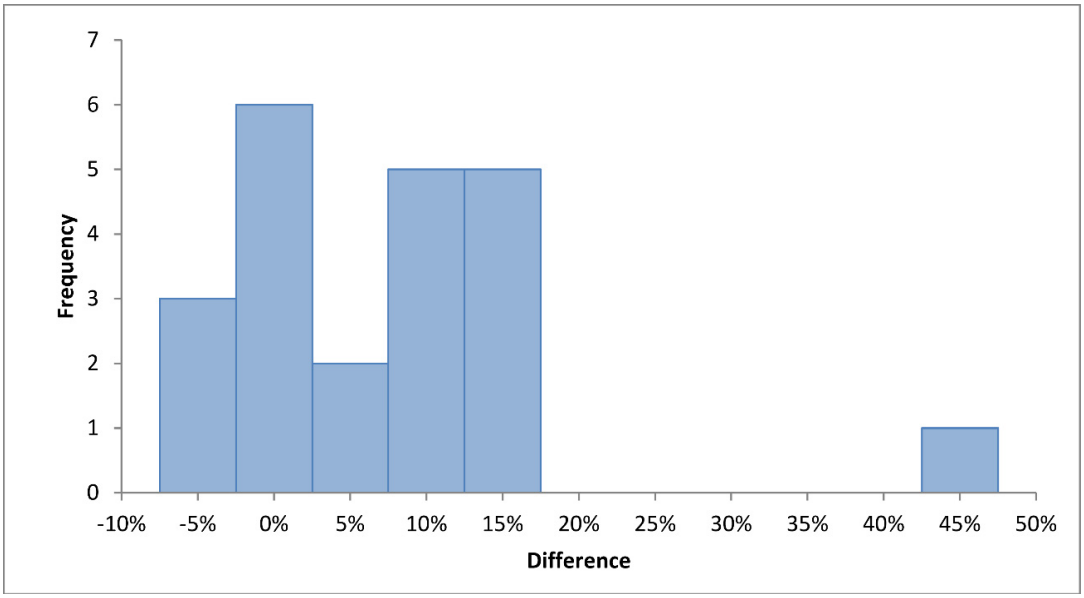


Figure 6. Histogram with the differences in results, per question.

In order to confirm that the difference in results between the initial pre-test and the final post-test is significant, a t test for paired samples was conducted. The hypothesis that the results are equal is rejected by 95%. Therefore, the results of the post-test are significantly better than the results of the pre-test.

The single question for both the pre-test and post-test for Click & Enjoy (simulation 1) was: "Sometimes, 'the more we sell, the more we lose.' Why?" Answers were also corrected in a binary way (right/wrong). Figure 7 shows a histogram with the difference in results between Click & Enjoy pre-test and post-test, per student. 15 out of 97 students answered the question correctly in the pre-test and 57 out of 97 students answered the question correctly in the post-test.

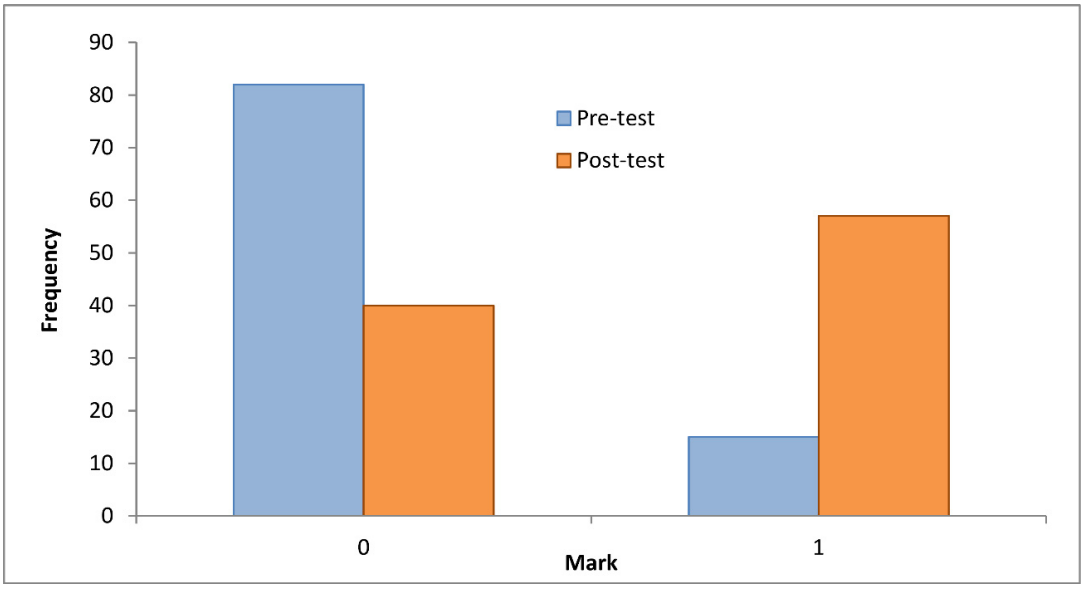


Figure 7. Histogram with the differences in results, per student.

As far as the Click & Enjoy simulation is concerned, students performed 28,343 actions in total. CELL_CHANGED actions were 8,789 (31%) and SHEET_CALCULATE actions were 18,363 (65%). Figure 8 shows the students' actions and the minute of the action. Each point in the graph is an action. Each column is the set of actions of a given student. The X-axis represents the 103 students and the Y-axis represents the minute each action is carried out. Two results are obtained from the analysis of the graph: students carried out the last action after 45-50 minutes; and students concentrated their activity in the first 20 minutes when they worked in the cells of screen 1 of the simulation. In view of this, we may conclude that students stayed active and the simulation did not induce inactivity.

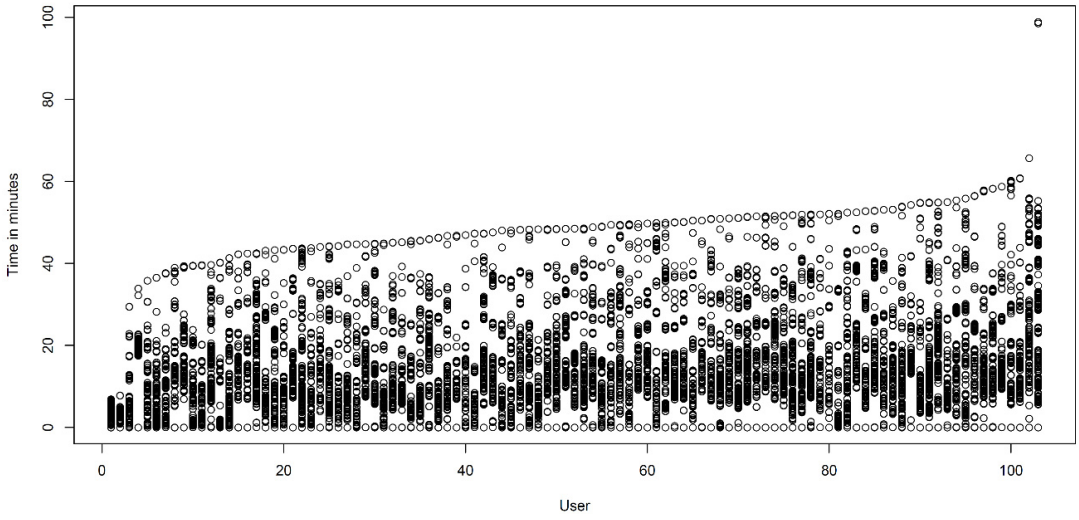


Figure 8. Students' actions and minute of the action.

For the Click & Enjoy simulation, Figure 9 shows the students' CELL_CHANGED actions and the minute of the action on each screen (actions of screen 1 in red, actions of screen 2 in blue, and actions of screen 3 in green). Screen 1 has 26 editable cells and there are a lot of actions concentrated in the first 20 minutes. Screen 2 has only one editable cell. Screen 3 has two editable cells and there are a lot of actions (less than in screen 1) but scattered in time. On average, students spent 23.09 minutes on screen 1, 4.88 minutes on screen 2, and 20.26 minutes on screen 3.

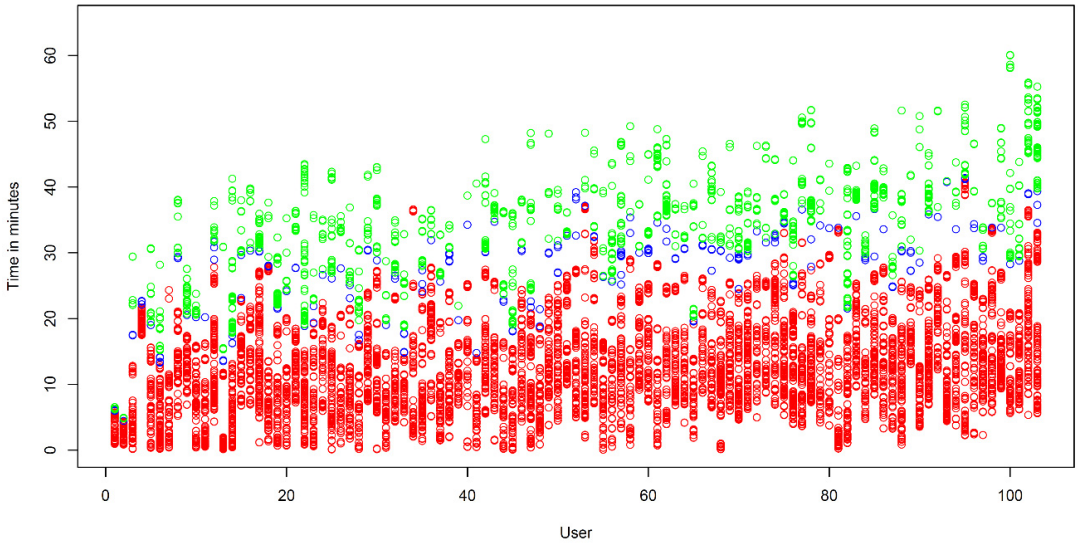


Figure 9. Students' CELL_CHANGED actions and minute of the action by screen.

In order to assess the extent to which students completed the task correctly, some cells of the Click & Enjoy simulation were specially monitored. Cell B3 in screen 3 was modified 1,009 times. This cell was used to answer two questions asked to the students: what is the selling price that makes the unit contribution margin to be 0 (correct answer: 10.36 €), and what is the selling price interval for which the unit contribution margin is positive (correct answer: 10.36 € to 10.50 €). Previously, students had to realize that selling prices higher than 10.50 € would not be accepted by the market. The values entered most were 10.36 € (160 times out of 1,009, 16%) and 10.50 € (226 times out of 1,009, 22%). In cell B6 in screen 1 students had to enter a number of transactions higher than 50,000 to realize that "the more we sell, the more we lose." They had to enter numbers of transactions higher than 50,000 up to 5 times to access to screen 2. All values higher than 50,000 are correct. The number of correct values entered is 510 which corresponds to the number of students who had access to screen 2 (102 students × 5 times = 510 correct values). In the same cell, some values are lower than 50,000 or even negative. Thus, some students correctly realized that "the less we sell, the less we lose."

The feedback survey shows that for most of the questions, "agreement" in regards to the usefulness of the simulation (including all degrees of agreement) is higher than 75%. As far as the open questions are concerned, students do value the ability to practice and consolidate concepts taught in lectures.

5. Discussion

The results of pre-tests and post-tests allow us to conclude that students learnt, since they scored higher in their responses to the post-tests than in their responses to the pre-tests.

Analysis of Click & Enjoy's traces demonstrates that students stayed active and the simulation did not induce inactivity. Students were more focused on their activity in the first 20 minutes when they worked in the cells of screen 1 of the simulation and worked for 45-50 minutes in total.

Students worked on the Click & Enjoy's cells that they were asked to work on. 102 out of 103 students accessed screen 2 and correctly understood that "any increase in sales reduces profits or increases losses." Some of them entered numbers of transactions lower than 50,000 o even negative figures and appeared to correctly understand that "any reduction in sales increases profits or reduces losses."

The results presented in this study support the Ezz, Loureiro-Koechlin, and Stergioulas (2012) assertion that simulations are effective, capture the attention of users, make them stay active, and are a widely accepted methodology. We cannot say if they are more effective than lecturing as a means of teaching theoretical concepts because the activity was not designed with an experimental group (which runs the simulation) and a control group (which is exposed to additional lecturing instead of running the simulation).

On the other hand, the simulation is valuable and effective because it was well accepted by the students and they learnt what the professor expected them to learn, thus supporting the argument made by Salas, Wildman, and Piccolo (2009).

6. Conclusion

The main conclusions of the research are: students stayed active and the simulation did not induce inactivity; students focused their work on the key actions and worked where the instructor wanted them to work; there was knowledge acquisition since the tests provide evidence of learning; and the activity was well-accepted by the students.

Acknowledgments

The research leading to these results has been carried out using funds from the agreement between the Universitat Ramon Llull (URL) and the Departament d'Economia i Coneixement of the Generalitat de Catalunya. The authors wish to express their gratitude to X. Jolonch and N. Avery for their revision of a previous version of this manuscript.

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