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Learning economics concepts through game-play: An experiment☆

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ABSTRACT

This paper introduces a video-game designed to support teaching introductory economics at undergraduate level. In order to test its effectiveness compared to traditional textbook learning we designed a laboratory experiment. Results show no evidence that playing the video-game leads to lower exam performance than reading a textbook, neither for multiple-choice nor for essay questions. We also find no gender bias and no effect of announcing the test prior to the learning task or thereafter. However, game behavior appears to be related to test performance, and differently so for different types of learning. Students perceive the two learning tools similarly in terms of understanding requirements or usefulness, but enjoyed the video-game considerably more. Interestingly, although women enjoyed the game less than men, they do not differ in their test performance.

1. Introduction

In the last decade, the spread of information technology in education has been rapid. The extensive use of teleconferencing, e-learning, and other advancements involving telecommunication technologies has considerably influenced the educational process in ways that complement and, sometimes, supersede traditional methods like face-to-face lectures (Bennett, Mims, & McKenzie, 2002; Donovan, Figlio, & Rush, 2006; Figlio, Rush, & Yu, 2010; Kearsley, 2000; Schreiber & Berge, 1998). More recently, complex "serious games" have emerged, significantly changing our perception of learning and approach to teaching.

Serious games are basically simulation games in which the players can experiment with different decisions and analyze their consequences in a virtual environment. While currently there is an accelerating tendency to use these games for teaching purposes, clean evidence on the effectiveness of this new learning environment is rare (see Sitzmann, 2011, for a meta-analytic study of the instructional effectiveness of computer-based simulation games). We aim to fill this gap by reporting results from a laboratory experiment in which students either read one chapter of a microeconomics textbook or played a level of an educational video-game. The latter, via game play and short-videos, conveyed the exact same information as the textbook. Thus, the only difference between these two groups lies in how the material was delivered: some students read the textbook chapter, while others played the video-game.

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After reading the chapter or playing the game, students took part in an exam, comprised of multiple-choice questions and free-text essay questions. The performance in the exam was monetarily incentivized. In addition, we administered a questionnaire that collected various demographics and measures of learning satisfaction. As a result, we are able to assess: (i) the students' cognitive learning outcomes, using the score they achieved by answering multiple-choice and essay questions, and (ii) the students' affective (or behavioral) learning outcomes, using the information on their satisfaction with this learning tool and their perception of its helpfulness. By analyzing these outcomes, we are able to determine how the interactive video-game delivery of the lecture compares with the passive textbook delivery across both learning dimensions. Additionally, in order to identify which students can be expected to benefit more from educational video-games, we consider two incentive conditions. In one condition ("high-powered incentives"), participants were informed about the exam-like test and its monetary incentivization right from the beginning of the session, so they could immediately adapt their behavior. In a second condition ("low-powered incentives"), participants were only informed that there would be a second part of the experiment, and to expect instructions on this part only after they finished the first part. While they might have had guesses about what was going to happen in the second part, their incentives to take the first (learning) part seriously should be lower than in the high-powered condition.

In addition to cognitive and affective outcomes, a special software allowed us to track every action undertaken by the players in the game, ranging from clicking on the screen to replaying a video, or hovering over a graph. This level of detail gives us the opportunity to study in-game behavior, and its connection to cognitive and affective outcomes.

We can report several interesting results. First, playing the video-game does not lead to lower exam performance than reading a textbook chapter. This holds true for multiple-choice questions as well as for essay questions. Second, the strength of incentives (announcing the exam or not) seems not to have an effect on final scores in either environment. Third, we do not find evidence that playing the video-game would have a different relative effect on exam performance for males compared to females. Fourth, contrary to previous findings on business simulations (Anderson & Lawton, 1992; Gosen & Washbush, 2004; Washbush & Gosen, 2001), we find that game behavior and exam performance are related, and differently so for different types of learning and assessment: scores in multiple-choice questions are only correlated with game play elements; essay question scores are correlated with both watching instructional videos and engaging in game play; and, particularly for questions requiring deep understanding, synthesis and evaluation, using interactive graphs is also related to exam performance. Finally, students perceived the two learning tools similarly in terms of understanding instructions or usefulness, but as expected, they enjoyed the video-game considerably more. Interestingly, although women enjoyed the game less than men, they performed at the same level in both the multiple-choice and the essay questions of the test.

It is worth noting that our results on the differential enjoyment in the game vis-a-vis the textbook may have further implications that could not be captured in our experimental environment where the allotted time was fixed and the treatment conditions were exogenously assigned (rather than endogenously self-selected by the students). A rational model of learning behavior would predict that students optimally allocate more time to studying when the available learning material is a more enjoyable game rather than a less enjoyable textbook. The results from our experiment then might imply that playing the game could lead to higher exam performance than reading a textbook, provided that the environment is one in which students can allocate their time freely across different activities.

Our contribution is related to a number of papers in the field of education inquiry. We discuss these papers in the theoretical background section and when formulating our hypotheses for the laboratory experiment. A few general notes, however, are in order here. Currently, there seems to be little empirical evidence on the impact of educational video-games on students' educational outcomes. An extensive base of publications exists on computer-based business simulations. However, even in this field, there is almost no evidence from cleanly designed experiments that compare learning outcomes under alternative pedagogies (two exceptions are Chou (2012), and Figlio et al. (2010), but they focus on online learning tools and not simulations). Wolfe (1990) and Burns, Gentry, and Wolfe (1990) identified this problem already 20 years ago, but there is still no convincing evidence on what simulations accomplish regarding cognitive learning. Gosen and Washbush (2004) conduct an analysis of 115 studies on this topic and find "that none [...] met all the criteria for sound research" (p. 283). Similarly, Wideman et al. (2007) conclude that support for the educational impact of simulations is subjective, at best.

A similar problem exists when analyzing the attitudes of the participants exposed to simulations (i.e., the affective domain). Most of the related studies, with few exceptions, find that students like simulation exercises and view them more positively than either lectures or case discussions (Burns et al., 1990; Faria, 2001; Gosen & Washbush, 2004). However, these are relative comparisons made by students experiencing different learning tools within a course. Anderson and Lawton (2009) note that providing valid substantiation for the power of a learning tool requires rigorous experimental design and exogenous treatment assignment. To the best of our knowledge, no study so far has employed an experimental design featuring control groups and allowing comparisons between student attitudes in a course that is solely textbook based versus those in a class that is solely game based. Our contribution attempts to fill this gap by combining experimental design with a rich data set of in-game behavior.

From a policy perspective, more evidence on the effectiveness of educational video-games is needed. If these games were reasonable, cost-effective substitutes for traditional classroom lectures, delivering high-quality content, then they could help address the problems of increased live-lecture class sizes (Bettinger & Long, 2007) and financial constraints in higher education (Figlio et al., 2010). Additionally, given their interactive and goal-oriented nature, it might be that these games can help overcome students' weak incentives to regularly keep up with classes, and prevent last-minute cramming in online courses (Donovan et al., 2006). Given their promise, a sound testing of their effectiveness in supporting learning is vital. This