The Use of Robotic Players in Online Games

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EXTENDED ABSTRACT

Motivation

Short in-class games have become an increasingly common way to teach a range of key concepts and theories in economics. These allow students to gain first-hand experience of incentives and the impact on decision making. This makes it easier for tutors to convey underlying economic theory and the implications of the resulting predictions. Furthermore, there is increasing evidence that these can have a positive impact on student learning (e.g., Emerson and Taylor, 2004; Dickie, 2006; and Emerson and English, 2016).

The move to an online teaching environment due to Covid-19 presents challenges for using this method of interactive teaching. Online versions of economics games have become increasingly common, and Carter and Emerson (2012) find no significant difference in students learning between paper and online experiments. However, these online games typically require human-human interaction. Consequently, the widespread adoption of asynchronous activities means that students cannot play such interactive games against one another.

An alternative is to run games in which students play against robotic players that make decisions according to some pre-programmed rules. This greatly increase the possibility of using online games asynchronously. However, as it stands very little is known about how this affects student learning. The aim of our study was to investigate how student perceptions and in-game behaviour change when robotic players are used.

Our study relates to a wider literature on framing and anonymity in games (e.g., Ross and Ward, 1996 and List et al., 2004). In addition, we also contribute to a wider literature on human-robot interactions (e.g., Wu et al., 2006).

Research design

We ran four online introductory microeconomics webinars for first-year undergraduates at Aston Business School in the UK. In these webinars students played a Prisoner's Dilemma game repeatedly against the same 'opponent'. Participants played the game for 8 rounds; however, this was unknown to them until after the final round. In this game, players are jointly better-off cooperating with one another but have an individual incentive to cheat.

In a series of different treatments, we varied whether students knowingly or unknowingly played other students or robotic players. 4 treatments:

i. *Know human (46 students)*
ii. *Know robot (42 students)*
iii. *'Believe' robot, actually human (49 students)*
iv. *'Believe' human, actually robot (67 students).*

Participants were also required to complete both a pre- and post- game questionnaire.

In the pre-game questionnaire, we obtained information on the students' characteristics. We asked their gender, age, and course of study, plus whether they were a home or overseas student and whether they had studied economics before coming to university. Finally, using a Likert scale, we asked the participants whether they agreed that greed is bad/immoral/incorrect.

In the post-game questionnaire, we asked the greed question again to see whether playing the game affected the students' attitudes. In addition, to assess perceptions of the game we also asked the participants whether they agreed that the game was i) fun, ii) helped

to understand economic theories and iii) represented real-world situations.

The results from the game plus our pre- and post-game questionnaires then allowed us to test two hypotheses:

> ***Hypothesis 1:*** *Students behave differently when playing against a robotic rather than a human player.*
> ***Hypothesis 2:*** *Students learn differently when playing against a robotic rather than a human player.*

Key findings

The results from our questionnaires demonstrate that:

1. *students typically found the game to be fun to play, helped them to understand economic theories and represented real-world situations. Furthermore, we find that perceptions of the game were similar across all four treatment groups.*
2. *a significant change in the students' perceptions of greed after playing the game **only** occurred for students that played against a robot **and** knew that they were doing so. These students became less averse to greed after the game.*

Finding 2) suggests that the in-game experience and perceptions of this may influence student learning outcomes from playing in-class games and therefore provides evidence in support of hypothesis 2.

To investigate further, we examined the in-game decision making for each of the treatments across each round of the game. To do this we estimated a Probit regression model where the dependant variable captured whether there was cooperation between the two players in a given round of the game. We controlled for a range of other factors, including the student characteristics obtained in our pre-game questionnaire. Crucially we then tested for differences in cooperation across our four treatments. We find that:

3. the likelihood of cooperation was unaffected if students played against a robot but didn't know that this was the case. However, cooperation was significantly less likely when students **knew** that they were playing against a robot (treatment iv).

Finally, we investigated what might be driving the lower cooperation when knowingly playing against a robot. To do so, we estimated a similar Probit model but now focussed on periods of the game that immediately followed a period of cooperation. Our dependent variable was whether in this subsequent period the human player(s) decided to cooperate. The results demonstrate that:

4. students in the 'know robot' treatment (iv) were more willing to deviate in the next round having established cooperation in the previous round.

Together findings (3) and (4) therefore provide support for hypothesis 1.

Overall, our findings indicate that knowingly playing in-class games against robotic players can influence in-game decision making and this in turn can influence learning outcomes. This suggests care needs to be taken when using robotic players in online games. Students are less likely to cooperate when knowingly playing against a robot player and this is in part due to having established cooperation they cheat in the subsequent period.

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