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Using an Online Bidding Game to Teach Costing in Management Accounting

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Abstract

This paper describes an online multi-player game (Bidding Game), which was developed to reinforce the understanding of cost behavior and cost concepts taught in an introductory management accounting undergraduate course. The Bidding Game was motivated by the aim to facilitate active learning as students apply the theories that they have learnt in a fun and interactive manner. A survey was independently administered by the Centre for Teaching Excellence from the authors' university. A total of 196 students voluntarily participated in the survey. The survey results suggest that the game significantly improves students' perceived knowledge of the costing topic. Students also agreed that the game enhanced their learning and that they had a positive experience playing the game.

Keywords: game-based learning, introductory management accounting, costing

1. Introduction

Game-based learning has been gaining widespread adoption due to its success in enhancing students' learning experiences and outcomes. Educators have turned to game-based learning, ranging from digital games to traditional board games (Alwi et al., 2017; Bowen et al., 2021, Carenys and Moya, 2016; Carvalho and Oliveira Neto, 2022; Connolly et al., 2012; Lee et al., 2019; Lopez-Hernandez et al., 2022; Mouse, 2019; Seow and Wong, 2016; Silva et al., 2019; Tan et al., 2021; Voshaar et al., 2022).

Silva et al. (2019) encouraged educators to introduce games into their curriculum as games can be an effective way for students to learn. In traditional teacher-centric learning environments, the teacher controls the learning. On the other hand, game-based learning presents a learner-centered approach to learning whereby the student controls their learning experience through interactivity. Lippicott and Pergola (2009) call game-based learning "edutainment" as games capitalize on the entertainment value of the activity to motivate students in their learning. It is important to have a framework to guide educator in using game-based learning to develop students' hybrid skills (Carvalho and Oliveira Neto, 2022).

Board games and simulation games are popular types of game-based learning. Mousa (2019) applied the Monopoly game in accounting classes and reported that students pick up soft skills such as problem solving, collaboration, communication, and critical thinking while playing the game. Tan et al. (2021) modified the Monopoly game and demonstrated that the modified game produces higher-order thinking skills for students. Lopez-Hernandez et al. (2022) presented an empirically validated serious game, Accounting Marathon, and demonstrated that the game significantly improved students' actual academic performance. Soflano et al. (2015) developed a game to teach structured query language. Their results showed that the game produced better learning outcomes than those who learned from a textbook.

Jeopardy!-related games are also popular. Lee et al. (2019) used a Jeopardy!-style game to improve students' understanding of Excel. Bee and Hayes (2005) employed the Jeopardy! Game to help students review for an undergraduate accounting information systems (AIS) exam. Their results reflected a significant increase in the students' understanding of AIS exam material that was covered after playing the game. Students also requested that they be able to review for other exams in a similar manner. Fratto (2011) developed a PowerPoint Jeopardy!-style game in an introductory managerial accounting course to provide students with immediate feedback and promote active learning.

With new technologies, gamification of the learning process becomes more important (Silva et al, 2021). Increasingly, educators are using mobile-gaming apps. Seow and Wong (2016) found that their mobile-gaming app. Accounting Challenge, helped to generate interest and motivation for digital-native students to learn accounting. Voshaar et al. (2022) developed a gamified mobile learning application for first-year accounting students. Their results indicate that serious app users achieve a significantly higher score in the final exam than non-serious users. Zhao (2019) reported that Quizizz, an educational app that enables students to participate in fun multiplayer class activities brings positive impact on students' learning

experiences. Class section in which Quizizz is applied more frequently reports higher scores on the satisfaction of using this app and higher scores on the instructor's teaching evaluation. Beatson et al. (2020) examined the effect of gamification, in the form of a mobile app, Quitch, on the behavioral engagement and academic performance of business students in two first-year courses in accounting and management. Their results indicated that increased use of the app is significantly positively associated with the final exam results. Pechenkina et al. (2017) developed a gamified mobile learning app which delivered multiple-choice quizzes directly to students' personal mobile devices post-lecture and pre-tutorial. Their results show that the app helped to increase student retention rates and there was a positive correlation between students' scoring highly on the app and achieving higher academic grades.

Connolly et al. (2012) found that playing computer games was linked to positive knowledge acquisition, perceptual and cognitive skills, behavioral change, affective and motivational outcomes, and physiological outcomes. Sanchez and Olivares (2011) demonstrated that learners are attracted to keep engaging with the game, resulting in better learning outcomes. Chambers and Shufflebottom (2010a and 2010b) and Facer et al. (2004) highlighted that due to the interactivity of mobile-gaming, learners actively participate in the learning experience, resulting in higher motivation and improved learning outcomes. Bowen et al. (2021) used an auction-setting game as a novel first-day in class activity to introduce the role of accounting and motivate students in the learning of accounting.

In this study, we examine whether the online bidding game can improve students' learning of the costing topic for an introductory management accounting undergraduate course. The Bidding Game is an online multi-player game to reinforce the understanding of cost behavior and cost concepts taught in an undergraduate introductory management accounting course. The goal is to improve students' learning experience and outcome, and to supplement in-class learning, books and other written materials with an interactive game. Students often perceive management accounting as a dry and boring course and have difficulties understanding how concepts could be integrated and applied to solve business problems.

We organize the remainder of the paper as follows. In section 2, we describe the Bidding Game. In section 3, we present the feedback provided by the students, followed by the concluding section 4.

2. The Bidding Game and Implementation

The online multi-player Bidding Game was developed to reinforce the understanding of cost behavior and cost concepts taught in an introductory management accounting undergraduate course. Playing the game facilitates active learning as the students apply the theories that they have learnt in a fun and exciting way. It may be played during in-person classes or remotely as the game is web-based. The game can be made available to any faculty and external institution who wish to use it as a teaching tool. It has been used as an in-class activity in more than two semesters by at least ten course sections comprising more than 400 students. It has also been used to introduce accounting in a fun way to visiting high school students.

2.1 Scope and Learning Objectives

The Bidding Game (see appendix for selected screenshots) simulates a competitive marketplace that comprises a customer, played by the instructor, and businesses, played by the students. The Game is played over several rounds. In each round, the customer will announce the tender quantity. Each business is required to decide on the bid quantity and bid price. The winner is the business that makes the highest total profits for all the rounds.

The Bidding Game is organized as follows:

• Create a new game

• The instructor can change the default the cost variables and their values. The instructor may also define inflation and cost fluctuation rates to inject uncertainty. This enables students to learn that prediction based on historical data can never be perfect, as in the real world.

• Before each round

• Students analyze the actual data for the last 20 rounds. In round 1, they use cost estimation methods to derive the cost function of the business. In subsequent rounds, they may evaluate the accuracy of their cost prediction be comparing the estimated costs with the actual costs.

• During the round

• Students decide on the bid quantity and bid price by applying their understanding of cost behavior and other relevant information such as the industry structure and the financial position of the competitors. The instructor may vary the tender quantity for each round (see Table 1) to test the students' ability to apply the right concepts.

Table 1. Varying Tender Quantity for Each Round of the Game

	Strong Competition	Weak Competition
Market is not competitive • High tender quantity, demand more than supply	Apply concept of absorption costing Bid quantity = Maximum production capacity Bid price = Customer price cap	
Market is competitive • Tender quantity just below total supply quantity	Apply concepts of absorption costing and stepped cost behavior Bid quantity = Up to relevant range of fixed costs Bid price = Competitive pricing	Bid quantity = Up to relevant range of fixed costs Bid price = Aggressive pricing
Market is very competitive • Tender quantity is below production capacity of each business	Apply concepts of variable costing and differential analysis Bid quantity = Tender quantity Bid price = Variable cost	Bid quantity = Tender quantity Bid price = Aggressive if competitors are very weak and the business is certain of winning

The learning objectives from playing the Bidding Game include students (i) analyzing the cost data and applying the suitable cost estimation method; (ii) understanding cost behavior for decision making; and (iii) evaluating and synthesizing all the information to make decisions in an uncertain environment.

2.2 Intended Audience and Time Requirement

We played the Bidding Game during class as one of the learning activities in the undergraduate Management Accounting course. Students are not given extra credit for playing the Game. These full-time university students range in ages between 19 and 21 years. Students typically take the Management Accounting course during their first or second year at the university. Each class comprises around 40 students. Students form their own teams of four to five students and typically, there would be eight to nine competing teams. It takes approximately an hour to play the game. Time is provided after each round for the students to analyze the data and discuss their strategy for the next round. The instructor may also define the time allowed for the students to make their decisions and submit their bids.

2.3 Implementation Guidance

Instructors can use the Bidding Game as a supplementary learning resource after covering the concepts of cost estimation, cost behavior and differential analysis in the Management Accounting course. Students can play the game to consolidate their levels of knowledge of these theories and apply them to make decisions. Instructors may ask the students to play in teams to encourage teamwork and collaborative learning. To make the game more exciting, instructors may hasten the pace by limiting the time to 5 minutes or less to make the decision. Instructors could make the last round a catch-up round so that losing teams will be encouraged to play throughout the game. As students usually will be very excited when playing the game, it is important for instructors to do a debrief at the end of the game to discuss the ‘good’ and ‘bad’ decisions made during the game and review the main learning points.

3. Findings and Discussion

A questionnaire was independently administered by the Centre for Teaching Excellence (CTE) from the authors’ university. The survey was administered to all students who were enrolled in the introductory Management Accounting course of one of the authors in Term 1 of Academic Year 2019/2020 (August to December 2019). A total of 196 students voluntarily participated in the survey.

3.1 Perceived Knowledge of Costing

Students rated their knowledge of the costing topic *before* and *after* playing the Bidding Game. We conducted a paired-samples t-test to compare the perceived knowledge of costing before and after playing the game. The results (see Table 2) indicate that students’ mean perceived knowledge of cost differs between the two periods, specifically, before playing the bidding game (M=3.74, SD=1.094) and after playing the bidding game (M=4.63, SD=1.09).

The mean increase (after – before) is 0.89 and highly significant (t=12.642, df=195, p<0.001). The results are consistent with the notion that the bidding game is effective in improving perceived knowledge.

Table 2. Results of t-test and Descriptive Statistics for Growth in Perceived Knowledge of Costing due to the Game

	Before bidding game		After bidding game			95% CI for Mean			
Outcome	M	SD	M	SD	n	Difference	t	df	p-value
Perceived Knowledge of costing [a]	3.74	1.094	4.63	1.090	196	-1.020, -0.745	12.642	195	0.000

a. Survey scale: 1 = Very Low; 2 = Fairly Low; 3 = Somewhat Low; 4 = Average; 5 = Somewhat High; 6 = Fairly High; and 7 = Very High

3.2 Student Feedback

Table 3. Descriptive Statistics for Effectiveness of the Game

	Questions [a]	Mean (n=196)	Standard Deviation
1.	The game enhances my learning.	5.80	0.97
2.	The game is aligned to lesson/course learning objectives.	5.85	0.90
3.	The game allows me to build on my knowledge in this course.	5.75	0.96
4.	The game enhances my ability to make connections to real-life issues.	5.84	0.98
5.	The game allows me to make meaningful connections to concepts taught in class.	5.79	0.97
6.	The game makes sense to me.	5.66	1.08
7.	The game allows me to learn at my own pace.	4.87	1.39
8.	The game provides me with timely feedback for my learning.	5.45	1.15

a. Survey scale: 1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neutral; 5=slightly agree; 6 = agree; and 7 = strongly agree

We asked students to rate the effectiveness of the Bidding Game in enhancing their learning on a seven-point Likert scale ranging from strongly disagree (=1) to strongly agree (=7). The mean effectiveness rating of 5.8 (SD=0.97) indicates that the game was effective in helping students to learn the costing topic (see Table 3). Students also indicated that the Bidding Game was aligned to the lesson/course learning objectives (M=5.85, SD=0.9) and allows building of knowledge in the course (M=5.75, SD=0.96). Students also appreciated that the

game helped them to make connections to real-life issues (M=5.84, SD=0.98) and concepts taught in class (M=5.79, SD=0.97). All questions achieve a rating of above 5 (=agree) except for one question relating to learning pace (M=4.87, SD=1.39).

Table 4. Frequency Distributions and Statistics for Effectiveness of the Game

	Frequency Distribution (%) (n=196)			
	Disagree (Response 1, 2 & 3)	Neutral (Response 4)	Agree (Response 5, 6 & 7)	Chi-square p-value
Please rate the effectiveness of the bidding game in terms of the following [a]:				
1. The game enhances my learning.				
n=	4	21	171	170.914
%	2%	10.7%	87.3%	p<0.001
2. The game is aligned to lesson/course learning objectives.				
n=	2	12	182	203.524
%	1.0%	6.1%	92.9%	p<0.001
3. The game allows me to build on my knowledge in this course.				
n=	4	16	176	182.095
%	2%	8.2%	89.8%	p<0.001
4. The game enhances my ability to make connections to real-life issues.				
n=	3	19	174	177.429
%	1.5%	9.7%	88.8%	p<0.001
5. The game allows me to make meaningful connections to concepts taught in class.				
n=	4	17	175	179.095
%	2%	8.7%	89.3%	p<0.001
6. The game makes sense to me.				
n=	7	26	163	145.024
%	3.6%	13.3%	83.1%	p<0.001
7. The game allows me to learn at my own pace.				
n=	31	43	122	57.230
%	15.8%	21.9%	62.3%	p<0.001
8. The game provides me with timely feedback for my learning.				
n=	15	22	159	127.206
%	7.7%	11.2%	81.1%	p<0.001

a. Survey scale: 1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neutral; 5 = slightly agree; 6 = agree; and 7 = strongly agree

Responses were grouped into “Disagree” (responses 1, 2 and 3), “Neutral” (response 4), and “Agree” (responses 5, 6 and 7). Table 4 presents the frequency distributions and statistics on the effectiveness of the Bidding Game. Chi-square statistic and p-values were calculated to

test the frequencies of the responses for each rating question. Almost nine in ten students agreed that the Bidding Game has enhanced their learning (χ^2=170.914, p<0.001). Majority of students also agreed that the Bidding Game was aligned to the lesson/course learning objectives (χ^2=203.524, p<0.001) and allows building of knowledge in the course (χ^2=182.095, p<0.001). Majority of students also agreed that the game helped them to make connections to real-life issues (χ^2=177.429, p<0.001) and concepts taught in class (χ^2=179.095, p<0.001). The Chi-square is significant for all questions. These findings are consistent with notion that the bidding game is effective in enhancing student learning.

Besides the effectiveness of the Bidding Game, we also asked students to rate their immersion in the game on a seven-point Likert scale ranging from strongly disagree (=1) to strongly agree (=7). Table 5 reports the student survey results regarding students' immersion in the game. Majority of the questions achieve a rating of above 5 (=agree). The results indicated that students enjoyed using the game for learning (M=5.56, SD=0.96) and felt energized (M=5.49, SD=0.97) and good (M=5.47, SD=1.07) when they are playing the game. Students indicated that the game stimulated their curiosity in the costing topic (M=5.63, SD=0.97) and motivated them to explore the topic further (M=5.54, SD=0.97). Students also found the game challenging (M=5.7, SD=1.02) but were able to stay focused (M=5.61, SD=0.89) and work on the game until it was completed (M=5.63, SD=0.91).

Table 5. Descriptive Statistics for Immersion in the Game

	Questions [a]	Mean (n=196)	Standard Deviation
1.	The game stimulates my curiosity in the costing topic.	5.63	0.97
2.	The game motivates me to explore further.	5.54	0.97
3.	The game is challenging.	5.70	1.02
4.	I work on the game until it is completed.	5.63	0.91
5.	I was focused when working on the game.	5.61	0.89
6.	I enjoy using the game for my learning.	5.56	0.96
7.	I feel energized using the game.	5.49	0.97
8.	I feel good using the game.	5.47	1.07
9.	I do not feel frustrated when using the game.	4.55	1.65
10.	I do not feel bored during the game.	4.89	1.60

a. Survey scale: 1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neutral; 5 = slightly agree; 6 = agree; and 7 = strongly agree

Table 6. Frequency Distributions and Statistics for Immersion in the Game

	Frequency Distribution (%) (n=196)			
	Disagree (Response 1, 2 & 3)	Neutral (Response 4)	Agree (Response 5, 6 & 7)	Chi-square p-value
Please rate the immersion of the bidding game in terms of the following [a]:				
1. The game stimulates my curiosity in the costing topic.				
n=	6	20	170	162.762
%	3.1%	10.2%	86.7%	p<0.001
2. The game motivates me to explore further.				
n=	8	18	170	160.381
%	4.1%	9.2%	86.7%	p<0.001
3. The game is challenging.				
n=	6	12	178	186.762
%	3.1%	6.1%	90.8%	p<0.001
4. I work on the game until it is completed.				
n=	3	21	172	172.048
%	1.5%	10.7%	87.8%	p<0.001
5. I was focused when working on the game.				
n=	4	21	171	168.048
%	2.0%	10.7%	87.2%	p<0.001
6. I enjoy using the game for my learning.				
n=	5	26	165	152.548
%	2.6%	13.3%	84.2%	p<0.001
7. I feel energized using the game.				
n=	5	31	160	143.381
%	2.6%	15.8%	81.6%	p<0.001
8. I feel good using the game.				
n=	9	29	158	132.190
%	4.6%	14.8%	80.6%	p<0.001
9. I do not feel frustrated when using the game.				
n=	54	33	109	19.048
%	27.6%	16.8%	55.6%	p<0.001
10. I do not feel bored during the game.				
n=	40	32	124	42.667
%	20.4%	16.3%	63.3%	p<0.001

a. Survey scale: 1 = strongly disagree; 2 = disagree; 3 = slightly disagree; 4 = neutral; 5 = slightly agree; 6 = agree; and 7 = strongly agree

Similarly, responses were grouped into “Disagree” (responses 1, 2 and 3), “Neutral” (response 4), and “Agree” (responses 5, 6 and 7). Table 6 presents the frequency distributions and statistics on immersion in the game. Chi-square statistic and p-values were calculated to

test the frequencies of the responses for each rating question. Majority of the students agreed that they enjoyed playing the game (χ^2=152.548, p<0.001). Eight in ten students agreed that they felt energized (χ^2=143.381, p<0.001) and good (χ^2=132.19, p<0.001) when they are playing the game. Almost nine in ten students agreed that the Bidding Game stimulated their curiosity in the costing topic (χ^2=162.762, p<0.001) and motivated them to explore the topic further (χ^2=160.381, p<0.001). Majority of students also agreed that they found the game challenging (χ^2=186.762, p<0.001) but were able to stay focused (χ^2=168.048, p<0.001) and work on the game until it was completed (χ^2=172.048, p<0.001). The Chi-square is significant for all questions. These findings indicated that students had a positive experience playing the Bidding Game.

Table 7. Selected Student Comments Regarding the Game

Selected student comments
• The bidding activity allowed me to use whatever I have learnt to apply in a real business concept and being able to do that helps me add all the conceptualization in my mind. I think it is very interactive and it keeps me engaged to learn more.
• The digital learning resource reinforces all the concepts taught during the past few weeks of class. It required us to apply our content knowledge to a simulated "real world" example. It makes me feel excited about playing the game and it encourages me to apply my content knowledge.
• It has allowed my teammates to think more critically and engage in deep discussion about applying the concepts. Allow me to apply concepts in very interactive manner.
• It was conducted in a game and was different to how we usually learn concepts which was refreshing and helped enforce my learning. I like that it was interactive and applicable to course content.
• It helps me to understand the concepts better. Fun, challenging and keeps you in deep thought.
• It stimulates our thinking on MA concepts and allow us to apply this to actual scenarios as given. It is fun as compared to the traditional classroom method.
• The game design itself gets us to apply our knowledge of MA in order to win the game. It engages the students and gets them to think and apply the concepts to a real-life example.
• It encourages group conversation and thinking. Am increasing the learning process.
• The digital learning resource helps me understand more about the cost concepts learnt in MA, how the demand, variable, fixed costing would affect the overall net operating income of the company. It is an innovative way for us to apply the MA concepts to real-life decision making of a company.
• Allow us to apply the concepts using Computer tools and larger data. It's competitive and interactive. Also the teamwork.
• I can better visualize the concepts and formulas taught.
• It helps us apply the concepts we learnt in class into real life situations and to think more about competition and external factors. It is a fun hands-on way to learn.
• More practical and it can relate to the real-world concepts. It is competitive - makes us want to think further.
• It's more interactive and allows me to learn from mistakes.
• It allows me to compare the efforts of the different teams and learn from them.

Students also provided qualitative feedback (see Table 7 for selected students' comments). Students valued the Bidding Game to improve their knowledge of the costing topic. They appreciated the refreshing and innovative approach to learn the costing topic via an engaging game instead of traditional forms such as lecture slides. Students also liked the fact that they can immediately apply their knowledge in the game. The qualitative students' feedback corroborates the findings of prior studies that game-based learning can enhance student learning.

4. Conclusion

The Bidding Game was developed with the motivation to facilitate active learning as students apply the theories that they have learnt in a fun and interactive manner. It aims to reinforce the understanding of cost behavior and cost concepts taught in an introductory management accounting undergraduate course. The results suggest that the game significantly improves students' perceived knowledge of the costing topic. Students also agreed that the game enhanced their learning and that they had a positive experience playing the game.

There are a few limitations in this study. First, this study examines students' perceived knowledge of the costing topic, which may not reflect the actual knowledge of the costing topic. Second, as the instructor decides to introduce the game to all students enrolled in the course for fairness reasons, there is no control sample where students do not receive the game treatment for comparison analysis. Third, the student survey questions currently appear in a positive form rather than in a reverse coded format. This implies that the likelihood that some respondents may simply select one value exists and this may affect the outcome of the questions. Lastly, the benefits of game-based learning may not be generalised to other topics and courses.

Future studies can examine the relative effectiveness of online games versus other learning interventions for accounting courses. Future research can also study how to effectively integrate online games with other learning interventions in a holistic manner.

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Appendix: Selected Screenshots of the Bidding Game

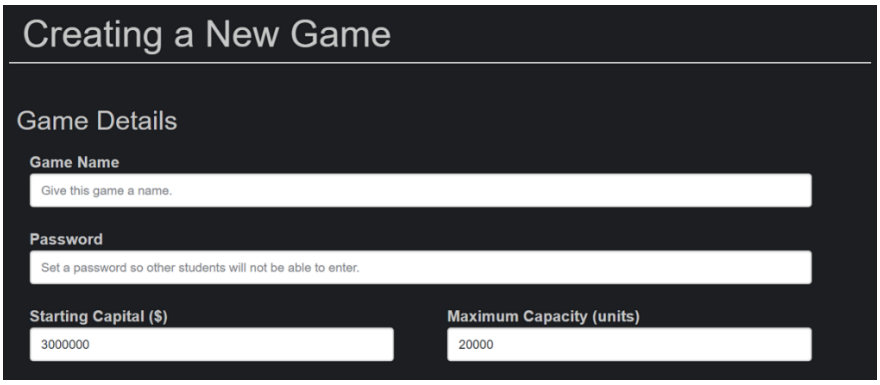


Figure 1. Create a New Game

The instructor creates a new game and specifies the starting capital and maximum production capacity of the business.

Businesses that exhaust the starting capital will exit the game. Thus, it is suggested to set higher starting capital to enable students to learn from their mistakes and stay in the game.

The maximum capacity and the number of businesses in the game will enable the instructor to simulate the market competitiveness by varying the tender quantities during the game.

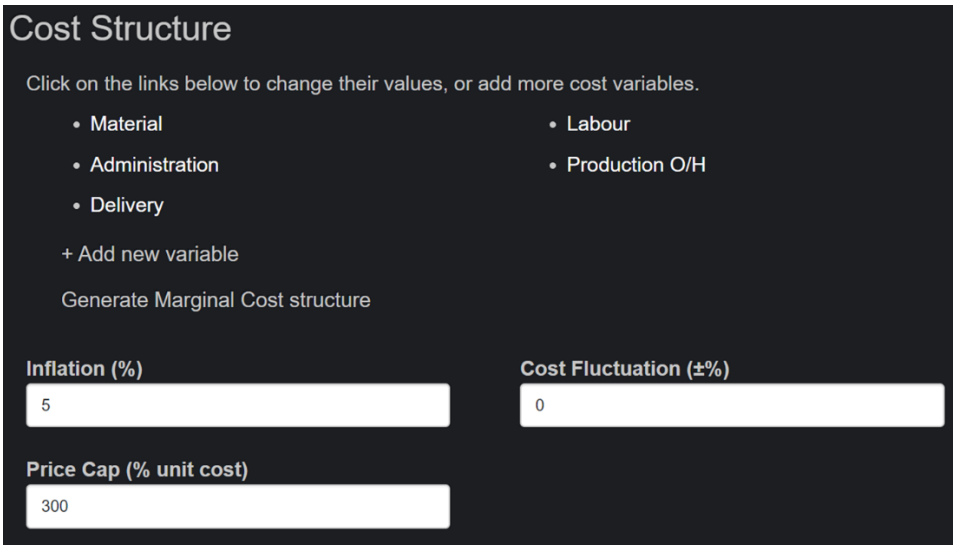
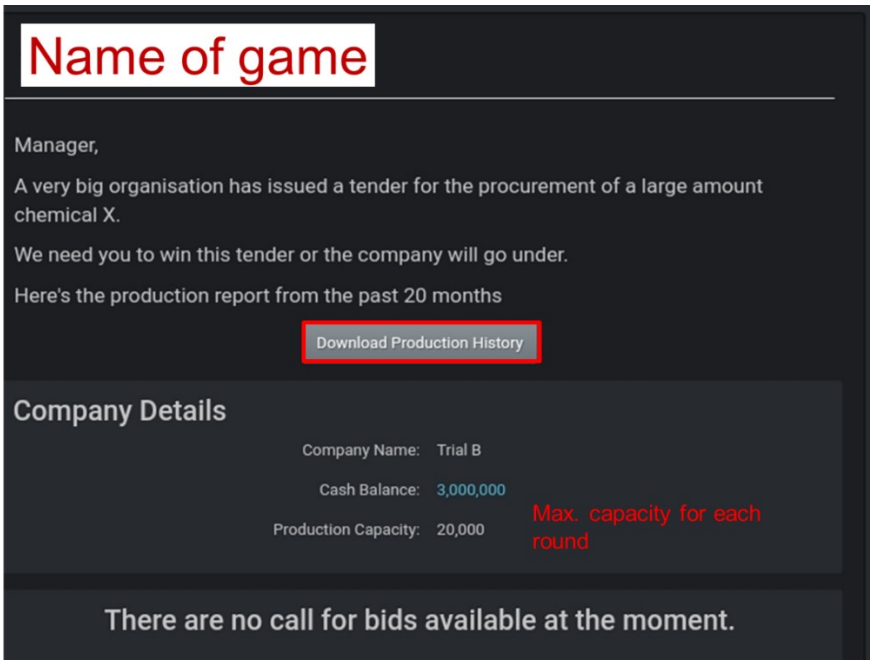


Figure 2. Instructor Defines the Cost Structure and Values

The default cost behavior of the business is stepped. At the game setup, the instructor can change the cost variables and their values. By specifying the inflation rate and cost fluctuation that will apply during the game, the instructor injects uncertainty when historical cost data is used for cost prediction. In addition, the instructor defines the cap of the bid price to ensure successful bid prices are within reasonable limits.



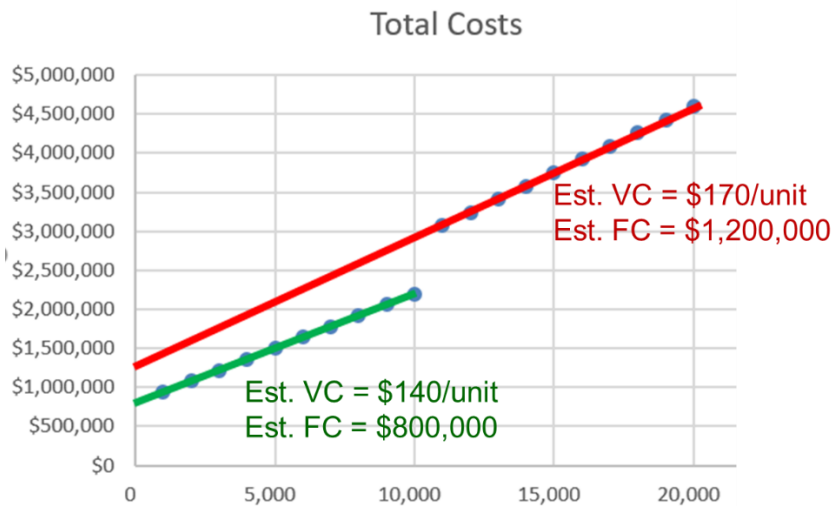


Figure 3. Before the Start of the Game, Students Download the Production History and May Analyze the Data Using Excel

Using the downloaded spreadsheet of historical cost data, students may estimate the unit variable costs and total fixed costs using the High-Low method or Regression method.

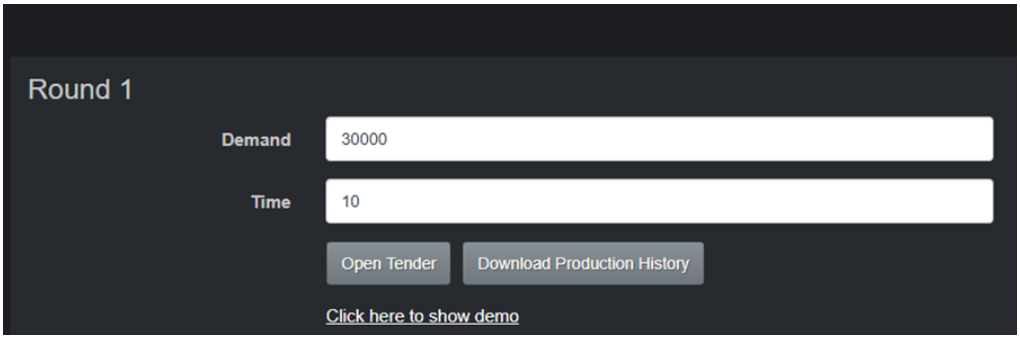


Figure 4. At the Start of Each Round, the Instructor defines the tender quantity and Time Allowed to Submit the Tender

The instructor may play as many rounds as desired. By varying the tender quantity according to the number of businesses in each round, the instructor may simulate various states of market competitiveness.

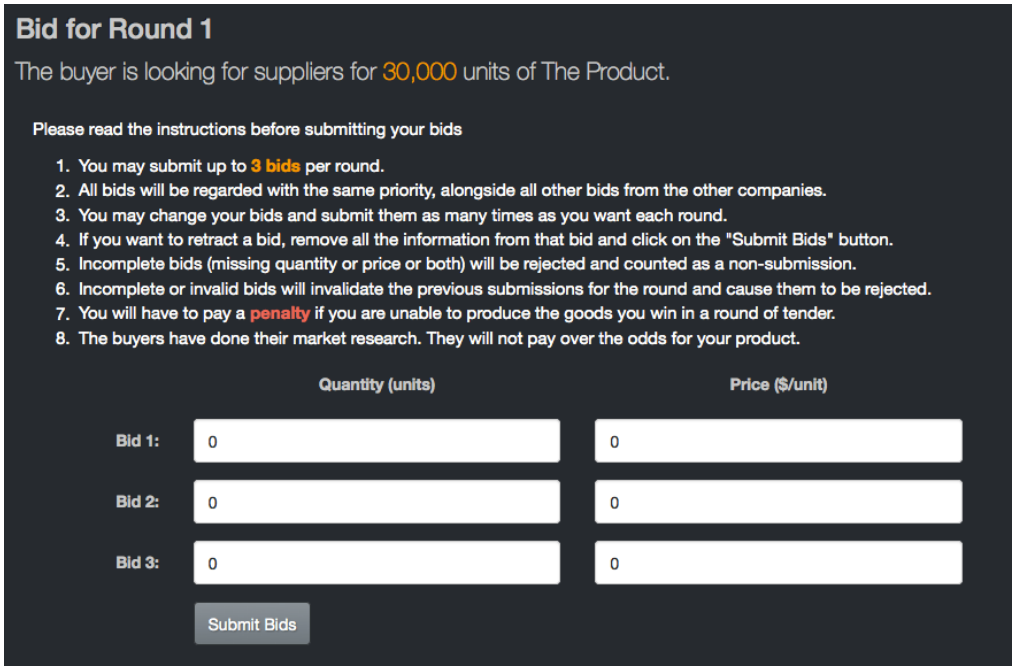


Figure 5. Students Decide the Bid Quantity and Bid Price

The business may submit a maximum of three bids for each round. To decide on the bid quantity and bid price, students will have to consider the cost structure, market competitiveness, industry structure and strength of their competitors among other factors.

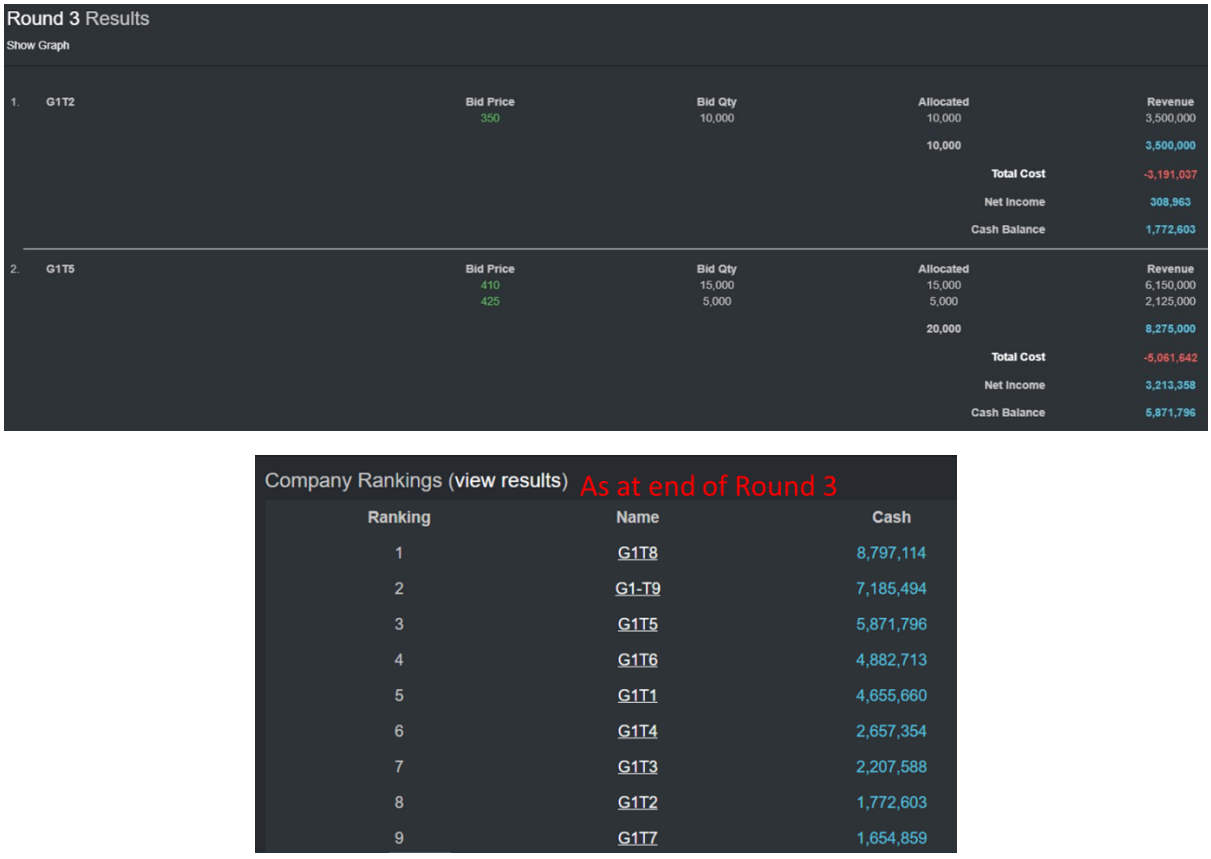


Figure 6. Results after a Round and the Company Rankings Based on the Cumulative Results

The successful bids and company rankings are announced after each round. To motivate low-ranking companies not to give up, it is suggested that instructors make the final round a 'catch-up' round so that it is possible for any of the company to win the game.

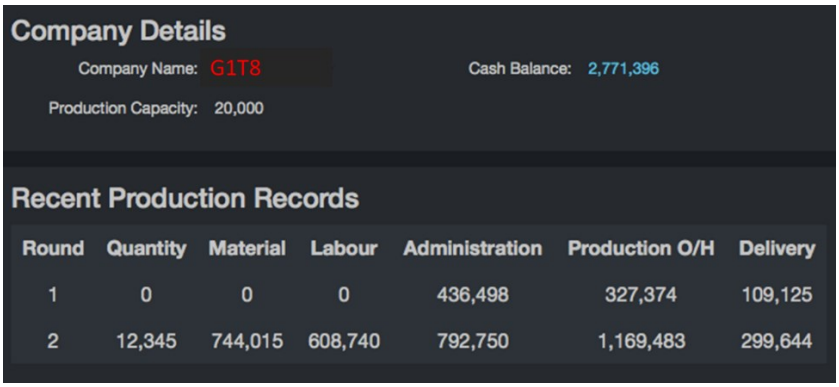


Figure 7. Each Team can View Their Own Performance

After each round, students may analyse the data to assess the accuracy of their cost prediction approach, review mistakes made in the bidding decision and fine-tune their strategy in the next round.

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