C-Negotiation Game: An educational game model for construction procurement and negotiation

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ABSTRACT

Construction procurement and negotiation is one of the key subjects in construction management education. However, most related courses involve only lectures without engaging students in real cases. Although educational games have been reported to be effective in motivating students’ learning, a limited number of studies have focused on developing a realistic negotiation game as a teaching instrument in a class. We developed a web-based negotiation game, named C-Negotiation Game, for enabling students to make simulated decisions in construction procurement and negotiation processes. The game enables students to play the role of either contractor or supplier, schedule the required procurement, evaluate prospective negotiating parties, conduct parallel negotiations, allocate materials to projects, and manage the cash flow. The game is also equipped with randomization features such as assigning random quality performance levels to different suppliers. An experiment was conducted using 72 participating students, and the results indicated a significant improvement of at least 20.16% in the students’ posttest scores regardless of the pretest scores.

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1. Introduction

Construction procurement and negotiation is one of the key subjects in construction management education. Erdem [1] reported that case-based teaching and learning are crucial in educating students in procurement negotiation. However, most related courses involve only lectures without engaging students in the actual procurement and negotiation process. The resulting disadvantage is that students gain no hands-on experience in making relevant decisions, even though they may have learned the essence of the lectures.

Numerous researchers [2,3] have advocated the advantage of learning with educational games. Games encourage active learning and motivate participation and persistence. In addition, games provide instant feedback on the user’s actions. In some domains, games may be the only possible means of simulating and practicing real-world problems. In the military, for instance, simulations have been used to train pilots [4]. Several studies have confirmed that games have positive effects on problem solving, achievement, and interest and engagement in task learning [5,6]. As advocated by the concept of learning-by-doing, students usually learn effectively through hands-on experience. This is particularly true for learning construction procurement and negotiation. Traditional teaching on this subject often relies only on providing lectures on procurement principles and negotiation strategies and does not provide students with the chance of practicing and actually making decisions.

Researchers have studied the learning effects of applying computer games to in-class teaching. For example, Van Eck and Dempsey [7] employed a computerised simulation game in a mathematics course and found that the students derived optimal learning outcomes in a noncompetition setting. Kim, Park, and Baek [5] reported that children could develop higher-level cognitive competence through interacting with peers in educational computer games, indicating that such games have high potential for helping students improve their learning performance. Cagiltay [8] indicated that educational computer games could provide a more interesting learning environment for acquiring knowledge in comparison to traditional teaching. Several studies have also further reported that educational computer games can enhance the learning motivation of students [9,10]. For example, Ke [11] indicated that educational computer games were considerably more effective in promoting learning motivation in comparison to traditional paper-and-pencil drills.

Numerous Researchers have investigated and developed game-based applications for schools. For example, Facer [12] investigated several empirical studies on educational computer games and reported that the findings of these studies supported the motivational effectiveness of such games in the classroom. Kirriemuir and McFarlane [13] reported an increased interest in the potential of commercial off-the-shelf computer games (COTS) in the classroom. Ebner and Holzinger [14] investigated the effectiveness of educational computer games in civil engineering...
courses. Several studies have further revealed that educational computer games can enhance students' learning motivation [15–16]. For example, Tüzün et al. [6] examined the motivational effectiveness of such games in geography courses, Hao et al. [17] and Liu and Chu [18] have investigated their motivational effectiveness in language courses, Chang et al. [19] and Kiili [20] have explored their motivational effectiveness in management courses, and Yien et al. [21] investigated their motivational effectiveness in nutrition courses.

Similar developments have also been observed in construction engineering and management education. For example, Halpin and Woodhead [22] explained that variation is a function of the highly stochastic characteristic of construction environments, and this is the major factor distinguishing between the management of construction projects and the management of projects in other fields. AbouRizk [23] developed a stochastic bidding game that allows students to practice quantity take-offs and bidding. Tomboklein et al. [24] developed the Parade Game that can be played either by hand or by using a computer. This game enables students to experiment with alternatives to observe the stochastic impact of workflow variability on construction trades and their successors. Nassar [25] developed a multiplayer simulation game for enabling students to practice buying and selling company equipment from the perspective of economic performance. Sacks [26] developed a simulation game that enables students to play the roles of clients, general contractor, and subcontractors to grasp the lean construction concept by applying pull scheduling, work restructuring, and upskilling in the management scenario of high-rise apartment buildings. The Hong Kong Game, developed by the Department of Real Estate at Hong Kong University for Marsh and Rowlinson [27], focuses on teaching students planning of on-site construction activities. Students are required to select activities and sequence them for the designated task with alternative methods and activities, and describe the rationale for their selection of methods.

Among the existing games for the construction domain, only the Negotiation Game [28] was developed with a focus on construction negotiation. The game involves the negotiation between two roles (i.e., a gas and design/build firm) on several matters such as duration, penalty for late completion, bonus, report format, and frequency of progress reports. The research discovered that most agreements were not Pareto optimal with approximately 10% of possible improvement. This was consistent with the findings of the negotiator expert system developed by Dzeng and Lin [29], which was designed with the objective of determining the optimal agreement regarding the utility preference of negotiating parties. Nevertheless, in practice, considering a project that requires procuring materials, a contractor must simultaneously evaluate multiple prospect suppliers in a competitive market, instead of a single pair of negotiating parties. Furthermore, a contractor may also choose to face multiple prospect suppliers with different strategies (e.g., cooperative or competitive). From this perspective, the Negotiation Game, which allows only one-to-one negotiation, is not suitable for the scenario. The process of playing the Negotiation Game also relies on the honesty of the players (i.e., students). Therefore, the game is not suitable to be played on a larger scale, such as in an entire classroom as a teaching supplement.

Yaoyuenyong [30] also developed the Virtual Construction Negotiation Game, which is an online game in which students play the roles of either clients or contractors and negotiate with one another according to a predefined scoring table between negotiation terms (e.g., duration and price) and value points. However, the game does not accommodate the random characteristic of a contractor’s performance and the requirement of scheduling multiple procurements in a single project. Therefore, in the current study, a game model was developed for providing students with hands-on practice on procuring construction materials through negotiation to supplement the traditional approach of teaching construction procurement and negotiation; this game model can enable students to meet the standards of the industry. The proposed game model differs from the virtual construction negotiation game in several ways. First, the included player roles are contractor, subcontractor, and wholesaler. Second, multiple students can play each role simultaneously and thereby form the virtual competitive market through which the winner is determined, instead of through a predefined scoring system. Third, the randomness of the game enables students to play repetitively with fairness. Finally, students playing the game gain experience not only in negotiating with additional negotiation terms (e.g., payment terms, prepayment, and delivery terms) but also in procurement planning, resource allocation, storage, and cash flow management. Other essential factors influencing procurement decisions, such as uncertainty about a supplier’s delivery schedule and work quality, individual-independent choice of suppliers, and simultaneous negotiation with multiple suppliers, as well as cheating prevention schemes, such as anonymous communication, are incorporated into the model.

The proposed game model was implemented in two versions, namely paper-based and web-based versions. Dzeng et al. [31] presented the initial learning performance levels, including learning motivation, learning satisfaction and learning effectiveness, observed among a traditional teaching approach, paper-based game approach, and web-based game approach. The current study focused on describing the design, development, and evaluation of the web-based version of the proposed game, named C-Negotiation Game. Compared to Virtual Construction Negotiation Game, the proposed game model is unique.

An experiment was also conducted in two universities to evaluate the effectiveness of the proposed game. In addition to a survey, the experiment includes a pair of pretest and posttest measurements that were conducted based on the existing indicators proposed for measuring learning motivation [32–35], satisfaction [36–38], and learning effectiveness [37] as well as course-related test scores [39,40].

2. Characteristics of the proposed game

This paper describes an educational game, named C-Negotiation Game, for construction procurement and negotiation. The purpose of the C-Negotiation Game is to simulate negotiation processes in the real world and provide students with hands-on experience in making procurement and negotiation decisions. To maintain the simplicity of the game and prevent unfair competition or cheating among students, the game involves the following scope and limitations.

- The target procurement is limited to specific types of building construction bulk materials such as steel, formwork, and concrete, and labourers are subjected to penalties in the event of a delayed delivery or poor work quality.
- The main purpose is to train the negotiation instead of bidding; therefore, in the process, each contractor is assumed to be awarded with the same set of projects without bidding and that each contractor receives the same amount of contract revenue unless penalties are imposed.
- Negotiation matters and available options are limited to a predefined set.
- Long-term collaboration or strong bonding of supply chain relationship is prohibited.
- The players remain anonymous during the game to prevent illegitimate alliance among them.
- No verbal conversation is allowed among players, and all negotiations are conducted computationally to ensure a complete recording of negotiation processes.

2.1. Basic flow

The objective of the C-Negotiation Game is to expose players to a simulated competitive environment and enable them to gain hands-on experience in decision making in a typical procurement process. Fig. 1 illustrates a typical procurement process in the construction
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