

The Spread of Lean Construction among Workers in Civil Construction by the Game “Challenging the Production”

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Abstract

The lean construction runs the management of sites to the production process and continuous improvement. For its understanding, the promotion of learning among workers is necessary. This paper suggests that games can fill the blanks and intend to present the game “Challenging the Production” as an alternative to the spreading of lean construction concepts, considering the civil construction labor’s characteristics. The use of games for learning are still considered an innovation. The experiment showed that the understanding about lean construction is possible and that the game is a pleasant form for this practice. The game was tested with the players approval and for 95,5% of players the game brings fun and learning of the lean construction principles. For 86,4% of the experiments participants, the game helps the learning of new things, 68,2% accepted it as an alternative way of learning that contributes with the concepts memorization and 59,1% thought that the game promotes the business colleagues interaction.

Keywords: Lean Construction, Simulation Games, Civil Construction, Learning

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Introduction

The market is demanding for companies' efficiency, including the industry of civil construction. In this context of searching to the opportunities of increasing, the new theories discussed at universities take lot of time to be introduced engineering. The lean construction is one of the innovative thinking that offers a new sight to the industry (Koskela 1992).

Since 70's, changes of production systems that happened in Japan and the economy globalization made the world's competition grows and production started to be considered strategic. Essential changes must be carried out for the business benefits (Kurek et al 2005).

Games are used by organizations as a learning strategy. From 2000 on, systems are developed to explore the playful look of the simulation games (Santos et al 2002; Nassar 2003; Saffaro et al 2003; Vanhoucke et al 2005).

This paper describes an experiment that results on "Challenging the Production" game that has questions evaluated by games and lean construction specialists, students of a Master Degree and, at the end, played by students of civil construction technical course.

Individual Learning Strategies

Teaching is different of learning. People can teach by passing information, using only the thoughts; but the real learning happen trough experiences, using also the feelings (Bianchini et al 2009). Learning process begins when one receives a new impression that combines with others and, then, he gets ideas and/or manual habilities.

The basic principles of new knowledge learning are: one can learn better when he is prepared for it; when someone use something he had already learned, he will do or understand better it; useful contents cause satisfaction, are easier to learn and provides the desire of learn more; learn something new is easier when it is related to individual experiences; learning must be done step by step and, when well done, stimulate the desire of learning; teacher and student must know what the student had really learned; as soon as the student feels the learning satisfaction, sooner he will be ready to learn more (Leighbody & Kidd 1977).

The traditional methodology values the feelings and intellectual capabilities when their learning techniques are mainly expressed (Bianchini et al 2009). These techniques (seminars, books and papers) are not ineffective in some situations. The individual forget 95% of what he heard in six weeks (Dutra 2000 apud Bianchini et al 2009). In this way, particularly when referred to grown up learning, it is fundamental the searching for new business methodologies between sensitivity techniques and group activities (Kolb 1994; Honey & Mumford 1986; Kirby 1995). "The reality shows that behavior changes are based on learning through experiences. The human learning is a dynamic result of complex relations between information and relationships" (Bianchini et al 2009).

On world's literature there are many approaches, methods and learning techniques. The organizations must choose which of them is better to achieve its strategic goals. An example of how innovative learning can be the simulation games that had been used successfully as alternatives for learning conventional method.

Simulation Games

Games acquire a special status on organizational learning but, only in 20's games – card, board and saloon games – had its potential reveled as a learning support instrument of grown up. This happened when people realized that games can put them in situations that win or lose depends only of chooses (Almeida 2006).

The game's theory has the objective to predict the other players movements – allied or not (Almeida 2006). By game's theory players take places to obtain better results, by understanding the decision making process and collaboration among players.

The main characteristics touched by games includes: anxiety, review of personal limits, own capacity of doing something, autonomy, attention and concentration. Besides, games develop the capability of anticipation and strategy and, enlarge the logic reasoning (Lopes 2000 apud Braga et al 2007). On society, games are more often used to help developing capabilities that can be used also on real life.

The question of the mistake in games situations also deserves highlights. Player may not choose the better option and this can be crucial for win or lose at the end of game. "By realizing about the bad moves, the defeat can make the player think about his actions and chooses, to create strategies to win the game or solve the problem" (Moratori 2003).

The creation process is directly related to the imagination and the game's activity structure let imaginary situations take place. So, in games players can develop its capability of abstraction and start to act independent of what he sees, which is a quality valued for organizations. The sense of balance between theory and practice is tested on the reality that is simulated on games, with more involvement on learning and training processes.

Games are an alternative for education and training that provides balance between theory and practice (Ruohomaaki 1995 apud Sun 1998). Gilgeous and D'Cruz (1996) says that games provides the active participation and, instead of hearing and see how one can do something, games made people practice by themselves. Obviously, games and simulations do not replace the traditional approach of teaching, but supplement it (Nassar 2003). So, it can be used to develop new capabilities or as an additional method of teaching.

Games on Civil Construction

People do not learn in the same way. So, managers must "discover alternatives to provide capabilities development of students and lead them not only to the cognitive knowledge but to knowledge of his human being at all" (Moratori 2003). Through this line, game's environment is attractive, has an easy interaction; provide different environment and situations with different levels of difficulties and activities; happen in real time and give quick answers, challenging curiosity.

On engineering and technological areas, the experiments can be leaded for students' testing and applying their learned theories and concepts (Sun 1998). Games that are referred to production process and operation require certain kinds of physical and material equipment or instruments. Many games have IT systems that can be very expansive. Even the cheaper options, as Lego System ®, are not available for all (Sun 1998). The Board 1 shows examples of game's applications for teaching and training on Civil Construction.

Autor	Ano	Título	Nome do jogo	Descrição	País
Marcelo D. Depexe; Juliana Bonacorso Dorneles; Sérgio L. Kemmer; João Paulo Silveira; Débora de Gois Santos e Luiz Fernando M. Heineck	2006	Programming Balance Line's Learning Technique with Educational Games	Lego System®	The work uses team games to execute a set of 16 houses	Brazil
Maria Aridenise Macena Fontenelle	2004	Virtual Workshop About Educational Abilities of Site Managers and Security Technicians	Na Trilha do Mestre Zé	Civil Construction Accidents Prevention Educative Game	Brazil
Fernanda Aranha Saffaro, Lucia Bressiani, Débora de Gois Santos e Luiz Fernando Heineck.	2003	Discussion of Lean Production Principles through an Educational Game	Lego System®	Discusses the lean production principles using the houses assembly with Lego System®	Brazil
Débora de Gois Santos; Valeska Prada Borges; Renato Lucio Prado e Luiz Fernando M. Heineck	2002	The Teaching of Balance Line and Variability through an Educational Game		It developed a game to teach the balance line and the variability concept, with a paper building assembly.	Brazil
Ricardo Mendes Junior e Carlos Luciano Sant'Ana Vargas	1998	Construction Programming Game: Players Handbook		A player handbook was elaborated for civil construction programming through games.	Brazil
Ricardo Mendes Junior; Carlos Luciano Sant'Ana Vargas e Luiz Fernando M. Heineck	1998	Civil Construction Programming Game of buildings with Internet		Building programming through internet games.	Brazil

Board 1 – Civil Construction Games

Mukherjee et al (2004 apud Bargstädt; Blickling 2009) refers to a great variety of researches in Civil Construction Simulation area out of Brazil (Board 2).

Year	Authors	Game's Name
2005	Rojas; Mucherjee	Virtual Coach
2005	Vanhoucke; Vereecke; Gemmel	Project Scheduling Game
2003	Nassar	Construction Contracts in a Competitive Market (C3M)
2002	Nassar	ER
2001	Shawney, Mund; Koczenasz	ICMLS
2001	Jaafari, Manivong; Chaaya	Vircon
2001	Bichot	The Construction Marketing Game
2000	McCabe; Ching; Savio	Strategy
1999	Hajjar; AbouRizk	Simphony
1999	Martinez; Iannou	Stroboscope
1999	Choo; Tommelein	Parade of Trades
1993	AbouRizk	Superbid
1992	Ndekugri; Lansley	Arousal
1970	Halpin e Woodhead	Constructo

Board 2: Civil Construction International Games

Games and simulations make the learning more efficient by the relation between knowledge and practice, without real situations as complementation of others ways of learning (Depexe et al 2006).

Lean Construction Games

On 90's, Toyota Production System (TPS) started a new time for world's industry by formulating the concept of lean thinking, adapted for civil construction by Koskela (1992) and focused in high productivity, combining philosophy, system and techniques or tools (Kurek et al 2005). In spite of TPS had been developed originally for automobile industry, its principles and applications helps other kinds of industries, as civil construction, moving them from mass production, considered the most traditional conception. One of the TPS's main key is the reduction of waste, defined as any activity that absorb resources and do not create value (Ohno 1997), providing de reduction of production time between client's asking and money entrance.

Due to difficulties of implantation and, mainly, the understanding, sedimentation and use of these concept, there are the challenge of create instruments and strategies to knowledge and learning transference in all business levels (Saffaro et al 2003).

For implantation and successful use of lean construction, it is necessary the change of thinking or the organizational learning, leading the sight trough information, material and labor flows (Koskela 1992).

Games are used as support tools to motivate the learning of civil construction. But, games can be used also to promote the lean construction principles learning. On referring Lego System´s® games, Saffaro et al (2003) and Depexe et al (2006) in spite of use the same tools, have important and different conclusions. The former noticed a big difficult of workers in absorbing concepts like Just In Time and Kanban, over there the value of operation flow and time, as the devaluation of process flows.

Many problems are identified, as the lack of an established process on civil construction: need of more financial resources, more difficulties on production control, complexity on material flow and labor site, big distances of transportation, conflict with labors and more accident's risks (Saffaro et al 2003). The work fronts defended by lean construction happen with the changes in the relationship of precedence between the activities, process that will quit their relation of dependency.

Games can be important supports to organizational learning process for the spread of lean construction concepts (Depexe et al 2006). But, in this case, the subject purposed was comprehended. The authors stresses that it is necessary the previous and effective planning to obtain positive results. The construction organization also has benefits with the spread of relevant information without waste of time or resources.

The Game "Challenging the Production"

The game "Challenging the Production" is considered a progressive game because it uses board, cards and dice, rolled in a construction site, with simulation of real situations of work.

On the development of the game, the strategies and motivated questions were defined, as the interaction with the theme, rules, sequence and time of the game.

On the questions development real situations of site were used, and the concept of lean principles and situations to make easier its understanding.

This game was planned for the interaction of questions and answers, because it focuses on the players relationship purposed by the cards.

“The cards were divided on tree types: “Challenge” that brings questions about real situations of the site; “?” shows the lean construction principles and examples for reflection; and “!” that presents situations and procedures – right and wrongs – in lean construction (Picture 1).



Picture 1: Game’S Components

This game considers a dynamic and funny way of learning the lean construction concepts. By using cards, workers accepted well the game. On the labor intervals, workers are used to play cards for fun, in Brazil.

The game “Challenging the Production” was tested on a group of 25 students of a technical course of Civil Construction of Center of Professional Education of Curitiba, in the class of Machines and Equipment (Pictures 2). Students showed satisfaction on the application of the game.



Picture 2: General View of Players

After the initial explanation of lean construction, that has 30 minutes of duration, the students were invited to organize themselves in five teams, with five players, positioning around the table, with the board. The rules were explained verbally.

The game has de duration of 60 minutes. During its application, the doubts and divergences about the “challenging” cards situations happened and, with that, there was an expected discussion with all players.

After the game application, players looks more familiars with lean construction vocabulary and can judge what is right or wrong on daily procedures, inside the lean philosophy. Other advantage of the game is the possibility of card customization, relating the gaps to the team problems.

This game can be considered a learning method and it must be complemented by other training tools. The game “Challenging the Production” provides the spread of lean construction concepts in a relaxed, clear and objective way. Moreover, the game provides interaction moments between players.

Results Analysis

This research highlighted the benefits of the game "Challenging the Production", that are: the learning of new knowledge and capabilities (86,4%); the awake of the interest in lean construction (31,82%); the retention of acquired knowledge (95,5%), since the memory of game situations; stimulation of relationship (59,1%), important for well succeeded process activities, with teams, as happens on civil construction.

About the game elements, all the components were accepted: the board, that simulate a site of construction (72,7%), attractive (54,5%) and simple (22,7%); the cards were considered easy for the game (63,6%), attractive (72,7%) and pretty (90,9%); the peões in truck forms were approved (90,9%); the rules are understood (90,9%). These elements are related with the game environment that must be attractive, easy to interact, provide a great variety of situations and difficult levels, challenging the players' curiosity. The playful characteristics made a grateful and attractive environment, stimulating the entire development of players.

The game "Challenging the Production" was considered funny (81,82%), clarifying (72,27%), motivator (63,64%), delightful and different (59%). The playful characteristic helps on the information retention about a new knowledge.

The game also surpassed all the expectations research, achieving the goals and for the identified problem. The game purpose has application perspectives on daily work of construction as support tool for training. The test phases demonstrate that the game instigate, generate curiosity, interest and satisfaction for players.

The comments about the game showed the players satisfaction on participate of the experiment. The game was considered very interesting, very good, fantastic and excellent, endorsing the research initiative. The games make fun, motivate and make the learning easier, despite it cannot assume alone the responsibility for the spreading of lean construction principles. This task depends on the managers of the site construction.

Conclusions

Published in two decades, the lean construction philosophy face difficulties of understanding by the civil construction professionals, because of the distance between the conservative position of the entrepreneurs and the low qualification of labor work of the industry.

This experiment identify that games are a support tool to formal and traditional learning, being a useful pedagogical resource that has an educational value inside. The game brings to room class or for training camp the practice, the experience, which is important for professional activities.

On civil construction, by the eyes of lean construction, the mistake is expansive, produce waste and the fall of the effectiveness of the business. With games the simulation of real environment, where professional gas the opportunity of testing his skills and discuss the attitude taken with work colleagues, without risking the results of the project.

After the game application, the players are more familiar with the lean construction terms, as related. The game "Challenging the Production" is the materialization of a didactic purpose of game that provides de spread of lean construction in a challenging way.

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