

CONSTRUCTION GIANT - A MULTI-PURPOSE BUSINESS GAME FOR EDUCATION AND TRAINING IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

This paper will give a general overview of the design and the implementation of a multi-purpose business game, with special reference to the training of civil engineers. This experiential learning concept is intended to inspire other teaching areas and is described as general as possible to enable the transferability to other domains. In addition, this paper should trigger a lively discussion on the design of modular-oriented business games which will enable the facilitator to address a variety of learning outcomes / addressees with only one business game.

INTRODUCTION

The Universities prepare students not only for professional life (and give them a basis for a successful career), they deliver qualified and competent young professionals for various economic sectors. Hence, universities are responsible for the creation of an adequate and efficient workforce to support the relevant economic sectors in their development.

In this respect, the University is a distinctive supporting element in the human resource and organizational development of different industries. This is reflected both in the design of study programs and individual courses.

On the level of individual courses, especially experiential learning concepts like business games have demonstrated their value. Due to the fact that the development of computerized business games lead to extensive cost (Wilson et. al., 2008) and Andlinger & Greene (Andlinger, 1958) have proved in the sixties, that manual business games can be even successful, here the design and implementation of a multi-purpose board-based business game will be presented. Besides the lower costs, a particular advantage is furthermore that board games can be conducted independently of IT infrastructure at almost any location. The detailed theoretical background of the business game was already introduced and discussed in Karl 2012. How a business game like Construction Giant could be integrated in a course is described in Karl 2013.

Following, different stages (planning, analysis, design and implementation) should explain the development of the business game. The results of the execution of the game will be discussed at the end of this paper.

ESSENTIAL PREREQUISITES

As a fundamental step in the planning stage a first model is

build, including the following aspects: a) the prospective addressees, b) boundary conditions, c) requirements and d) limitations of the course. Based on this the basic educational goals and learning objectives for the macro level of the course should be identified. Here, this is a one-semester course in the 2nd semester of the Master Program in Construction Management and Economics. Minimum number of participants in this course is 20 persons. Form of examination is a test at the end of the course. For this course a seminar room with separate seating and media like overhead projector, white board, flip chart and beamer is available.

The general educational objective is that participants apply previously learned knowledge and techniques in the field of construction and business management within a virtual reality (the business game). Further, the following mandatory skills should be addressed within the design concept: a) communication/ negotiation skills, b) teamwork and c) decision-making skills. Participants should make situational decisions under time pressure, too.

Each student should operate his own virtual construction company. This construction company has to prevail against other participants on the construction market (competitive game). Mandatory tasks should be a) work preparation, b) resource planning, c) costing and cash flow planning and d) market monitoring.

ANALYSIS

The target group in this course consists of former students from both the bachelor's program in construction as well as other participants from other areas such as architecture or economics. Due to the fact, that the master program is also open to international students, both linguistic and cultural aspects must be taken into account (diversity issues).

To address the previously acquired knowledge the foregoing semester were analyzed to locate tie points in different areas. For this reason, the content from already completed courses such as contract law, construction and project management and business economics were analyzed.

The sum of knowledge and skills from these courses should be connected in the business game. These are:

- Construction contracts can be analyzed and assessed.
- Awareness of rights and obligations.
- Awareness of typical forms of cooperation in the construction industry.
- Perform calculations for construction projects.

- Knowledge of tendering, contracting and billing of construction work
- Knowledge of resource planning.
- Knowledge of project management techniques to organize projects, monitor and control them.
- Knowledge of business strategies and their purposeful use.

DESIGN

COMPETENCY MODEL

Before proceeding with the development, the goal of the business game has to be determined on the basis of a general competency model. The current requirements for civil engineers in the field of construction management are based on an extensive research (literature and empirical study in the field ref. Karl 2012).

From the previous findings, a competency model is developed. This forms the basis for the further concept of the course and accordingly the business game (see fig. 1).

From this competency model curricula and teaching methods are extracted. Beside the existing skills and knowledge, the following aspects should be involved within the business game:

- Analytical thinking, creativity and innovation,
- Recognition of relationships and interactions, business management skills, professional English,
- Teamwork, communication and negotiation skills, conflict resolution skills,
- Work under pressure, readiness to assume risk, ethics awareness,
- Awareness of global economic connections, decision making, skills to avoid risks, flexibility, initiative, optimism

Participants will also be supported through an online-

learning environment. These elements will not be considered further inside this paper. However, the further development of the business game will be discussed in detail in the following.

EMULATION MODEL

Participants in a business game are moving within a triangle consisting of market, product and company. These three subsystems can be assigned to the previously identified competencies (see fig. 3). The objectives of the individual subsystems can be derived from this association.

Based on these three elements, it makes sense to structure and to modularize the business game. Doing this, the facilitator is able to adjust the complexity in several areas with the following objectives:

- Multiple participants can be addressed with one business game (students, young engineers, managers).
- The learning progress can be considered during the course (skills of the participants evolve -> game complexity increases -> keep / increase the motivation & prevent boredom).
- Different backgrounds of participants can be considered (construction sector, corporate area, decision-making level etc.).

In the modeling of the elements market, product and company on the one hand, the principle of reduction (Stachowiak, 1973) is appropriate; on the other hand, a sufficient realism must remain. In this regard, the Johns Hopkins University Academic Games Project at the Center for Social Organization of Schools performed under the leadership of James Coleman a comprehensive assessment of gamed simulations in the early sixties (Boocock, 1994). This research showed that gamed simulations could be effective as teaching tools, but to result in effective learning outcomes, the activity must have a connection to reality. This point is particularly important for the acceptance of the business game by the

FIGURE 1
[Competency model]

Area	Vocational competence						
Methodological	Analytical thinking*	Feeling for future developments	Interdisciplinary thinking	Creativity and innovation*	Structured thinking	Recognition of relationships and interactions*	
Expertise	Construction management skills	Business management skills*	Problem-solving in construction management		Expertise in contract law	Professional English*	Skills in project development
Social and communication	Teamwork*	Communication skills*	Negotiation skills*	Conflict resolution skills*	Representative / Representational ability		Skills in public relations
Personal	Work under pressure*	Openness	Willingness to perform	Readiness to assume risk*	Awareness of sustainability	Ethics Awareness*	
Activity and implementation	Awareness of global economic connections*	Decision making*	Skills to avoid risks*	Flexibility*	Initiative*	Optimism*	
Existing skills and knowledge							
analyze and assess contracts	rights and obligations	Cooperation forms	Perform calculations	tendering, contracting and billing	resource planning	project management techniques	business strategies

* Possible aspects covered through business game

participants. For this reason, the individual elements are developed indeed simplified, but as realistic as possible.

THE MARKET

Main aim of the design of this element is to encourage the recognition of relationships and interactions within the construction market. As a first step, the market will be defined through the types of potential tender: public, private and single tender. In the light of realism and acceptance, different project categories are involved like residential buildings, office buildings, industrial buildings, hospitals, theatres and others.

The area of public tender is divided furthermore into road construction and other projects. Road construction projects are included as a tactical element which will be described later in detail. Additionally, the emulated construction market contains a market for rental equipment with which a further variance in complexity is possible.

By including several different game board realities (each with specific characteristics), individual national construction industries can be represented. Unless they are played parallel, actions on the one game board (national market 1) can affect the other game board (national market 2). This would mean that tenders could be executed in one country by companies from other countries. This will support the awareness of global economic connections.

THE PRODUCT

Unlike other businesses, the construction industry usually does not affect the product design or the building materials to be used. These components are defined as well as the construction process by the client. This industry is the only one who acts as an executor in accordance with the wishes of the awarding authority. Accordingly, construction projects in business games must be conceived as specified by the client. For this reason, project cards will be developed that contain the

details of costing and resource planning.

Depending on the audience and the learning progress the project cards describe the project in a simple (construction costs are given as a sum, surcharge for risk and profit has to be chosen by the participant) or complex manner (detailed calculation of the production costs, surcharge for risk and profit like before). Thus, a further complexity variance is possible. By the fact that projects can be carried out in cooperation with other participants, teamwork and communication/ negotiation skills will be supported, too.

THE COMPANY

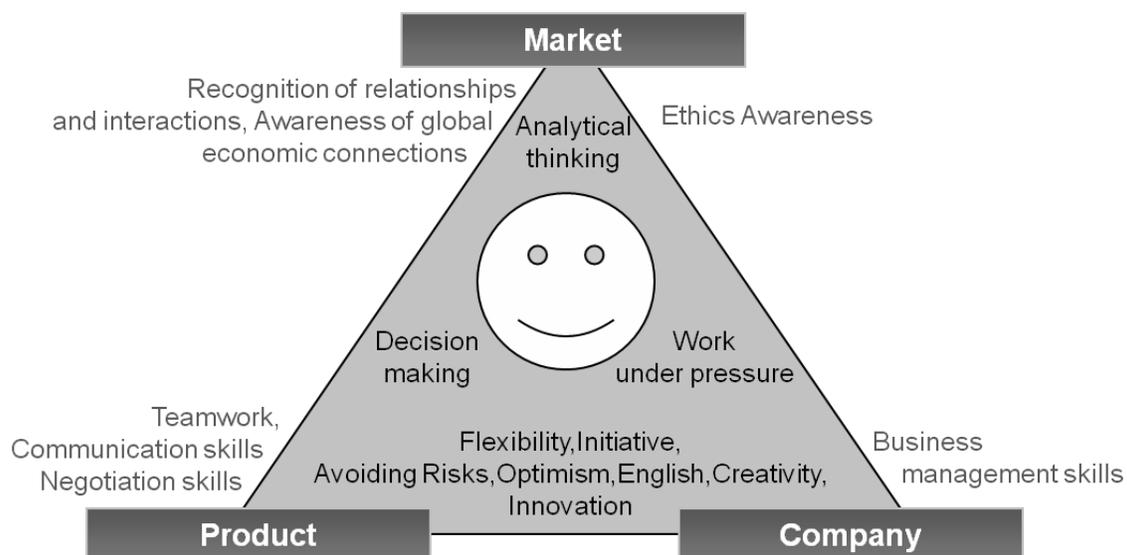
The company is described by two parameters: a) resources (manpower and equipment) and b) capital. Workers as well as construction equipment can be used universally. There are no specializations. In addition to its own devices rental equipment can be used, if allowed.

Depending on the individual company status, each participant gets his capital as paper notes. This enhances realism and makes the capital expenditure more tangible. These notes also promote awareness of physical consequences, particular due to miscalculations. The participants take responsibility both for the financial and the technical management of the company. This means, business management skills like cost estimation, accounting and resource management are among the tasks. The above mentioned relationships can be contextualized in a general business game diagram (fig. 6). Using such a diagram both dependencies and influences can be made visible (This diagram should be used during the debriefing process, too. This enhances the understanding of the emulated reality and increases the learning outcome.).

IMPLEMENTATION

The participants are in charge of existing construction

FIGURE 2
[The three dimensions of a business game]



companies. To be the Construction Giant at the end of the session, the company must be successful as long as possible (The circumstances for the success will be discussed later.). Second, as an overarching goal the joint construction of a city is defined. Thus, an individual and a common goal are determined.

GAME EQUIPMENT AND DOCUMENTS

This board game is equipped as mentioned in table 1.

The project cards are provided next to the board. The projects vary by the type of tender (client) as mentioned before. In one stack there are public and private tenders, in another stack there are only single tenders. Depending on the desired complexity, the different event cards, additional cards, bonus cards and the small, square cards with road construction projects are also available next to the board: Each company receives at the beginning of the business game the following documents:

- A guide,
- A card with calculation data (wages, costs for gas/oil, material costs etc.)
- An individual company report regarding financial situation, resources and existing projects,
- A bidding card,
- A form for own calculations.

These documents will be handed to each participant in a sealed envelope. In order to train the demanded language skills, both the documents as well as the rest of the business game are in English.

RESOURCES AND CAPITAL

The following resources are assigned to each company: a) Workers (black tiles) and b) own devices (blue tiles). The amount of each resource is provided in the individual company report. Every participant should sort the partially used resources within the existing projects in a separate box. The remaining resources (available for prospective projects) should be sorted in the lid of the box. Each participant will receive a pawn in an

individual color and 15 wooden houses of its corresponding color.

In addition, on the market available rental items (red tiles) will also be introduced. Depending on the level of complexity there is limited or unlimited rental equipment in the market (This fact alone can already make a considerable difference in future decisions.). Corresponding to the individual company situation each company receives capital as paper notes.

GAME MANAGEMENT

Two participants take the game management (This role can rotate between the players during the game play.). Their tasks are:

- Administration of the Bank,
- Check the offers with the project price list (usury, collusion etc.),
- Logging of tenders (bidders list),
- Holding of the joint venture contracts,
- Holding of additional cards (insurance policies, etc.).

The project price list is to be kept concealed (lying on the front). Depending on the number of participants, the tasks can be distributed among several participants.

VARIATIONS

As mentioned above, the business game model should be variable depending both on the target group as well as of the learning progress. This requirement is implemented through nine possibilities of variation: a) Supply and demand, b) event cards, c) additional cards, d) rental equipment market, e) cooperation, f) cost estimation, g) time, h) experience and i) bonus cards.

Supply and demand is represented by using different segmentations of the playing field (hexagonal elements with three projects on each element) and/or by pre-sorted project cards. Through the arrangement of various segments of the board, the probabilities of tenders will be affected in general. The native set of project cards contains about one-third from each tender type (other than road construction projects). By pre-

FIGURE 3

[Definition of the construction market]

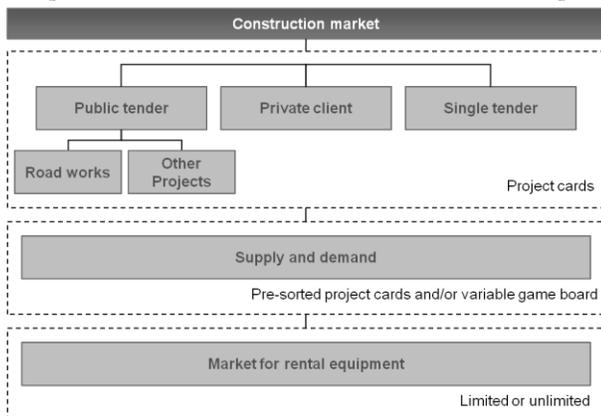
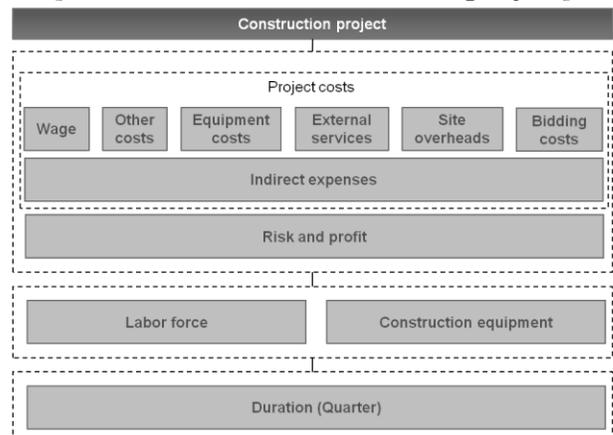


FIGURE 4

[Definition of the construction project]



on the target group, the game progress and the available time for the tendering.

To emulate work under pressure the tendering can be done with or without a time limit by using an hourglass. Those who have not submitted their offer until the end of the time will be treated like losing bidders. They must pay in any case the bidding costs. The bidder who chose to make no explicit offer is exempt (corresponding entry in his bidding card necessary). The involvement of the temporal restriction can happen in two ways. Option 1: The first quarter will be played without time limit. Subsequently, the time will be limited for the tendering using an hourglass to about 3 minutes. Option 2: As above, but with a 2 minutes hourglass. These variants can be combined with the variants of the calculation. For example, simple cost estimation must be done in 2 minutes and the complex in about 3 minutes or depending on experience and progress in the game in about 2 minutes.

Depending on the selection of projects, companies have the opportunity to bring in their gained experience both in tendering and in the construction as follows:

- Experience in tendering: The participant has already won three tenders next to one another on the board (all projects on one hexagonal element).
- Experience in the construction: The participant has already completed two projects on a specific road.

For both the project costs for the next project (which can be also a joint-venture) will be reduced by five per cent, but only if the counted projects are on one's own responsibility and not within a joint-venture.

If required, bonus cards are mixed into the event cards. These cards include knowledge issues. The correct answer to a question will be rewarded with a monetary amount, which is set on the bonus card. This supports the aspect of expertise, plus the possibility of a knowledge test for the participants. Furthermore it encourages the aspect of gaming and fun which could motivate the participants additionally.

EXECUTION

Each round corresponds to a quarter of a year. All companies start at the starting field. The one who rolled the highest number begins. Thus begins the first quarter. It is rolled in a clockwise direction. At the beginning, no payments for

existing projects have to be done (All payments for the previous quarter are already done.).

ACQUISITION OF PROJECTS

The acquisition of projects takes place in two ways: during the game process and to the beginning of a quarterly period.

If a participant arrives during the game process on a P-field (project-field), than he must draw a project card from the stack with the public and private tenders. With a group size of less than five each participant has to take even two project cards to ensure a sufficient number of projects. According to the different types of tender, the following consequences appear:

- Public tender: Completely open situation. All companies have the opportunity to bid.
- Private tender: Limited situation. Every second company has the opportunity to participate in the tender. But at least three! The dice will decide on four participants.

The private tender will appear only at the beginning of a quarterly period. Then, each participant gets an exclusive tender through drawing a card from the stack with the private tenders. This project is for the company that it has drawn. Only this company can make an offer. All the tenders will be registered in the bidding card (always) and the calculation card (only if an offer has been submitted). If a company refuses to submit an offer for a project, then "no" (no offer) should be entered in the bidding card.

SUBMISSION PHASE

The bidding cards are given to the game management or another participant who can not or may not offer. This person performs the submission phase through three stages:

1. Formally considerations: Are all fields in the bidding card filled out? The bidding card must be filled out completely. If missing data are identified, the bidder shall be ineligible for submission. The bid costs are still due! This is also the case if the bidder should have entered only "no" and nothing else.
2. Competition: Was there competition in public or private tenders (at least 2 offers)? If no competition has taken place the project will not be awarded. Expenditure because of bid

TABLE 1
[Equipment of the board game]

1 Board (fixed of with hexagonal elements)	Simple project cards	For each participant: 1 pawn (in its own color) 15 houses (in the color of the pawn) 30 black tiles (own workers) 20 blue tiles (own devices) For the whole game: 100 red tiles (rental devices)
1 Cube (Numbers 1 to 6)	Complex project cards	
1 Cube (Numbers 1 to 3)	Project price list	
	Project event cards	
	Company event cards	
	Market event cards	
	Additional cards	
	Bonus cards	
	Small, square cards with road construction projects	

- preparation (bidding costs) must be paid by all bidders.
3. Price: Is there an excessive bid in private or single tenders (if maximum amount exceeded compared to project price list)? For each available private or single tender a maximum price is defined. This reflects the fact that private clients, in case of a too high price, will withdraw the project. Public authorities have to perform (usually) the requested project. Therefore, for such projects, no examination of the price is carried out.

Within this business game it is assumed that all bidders are qualified for the available projects. For this reason, an assessment of the qualifications of the bidders is not considered.

After approval, the project is awarded to the lowest bidder. This participant sets a house with the gable site on the appropriate field on the board (If the project is completed, the house is placed on the base side.). In the case of a road project, the participant sets the corresponding small, square card to the board. With this action a blank field will be filled on the board. Such a project can affect significantly the end of the game. Furthermore, she/he writes the official reported costs of the project (from the project price list) in its calculation card. This value is the basis for the project expenditure, regardless of what the participant has calculated. The project starts in the next quarter. At least now, the participant has to plan his resources by sorting the required resources out from the lid (available) to the box (used). The first payment according to the expenditure plan of the project (available on the project card) must be done at the beginning of the next quarter.

In the event that multiple bidders have submitted the same offer amounts a negotiation takes place with these bidders. In the bidders list a new line with the project number and a following "-N" (negotiation) has to be recorded. The negotiation costs the parties further 10% of the offering expenses. The losing bidders have to pay that amount immediately after the final submission. The winning bidder pays at the end of the quarter.

RESOURCES AND JOINT VENTURES

Devices can be bought from the market (bank) or from competitors. They can also be sold in the same manner. The price has to be negotiated with the competitors in the business game. The market (bank) has his own fixed prices. Staff can only be obtained from the market (bank). It can also be dismissed. This results in firing costs which are not insignificant (this includes a social component within the business game). Rental equipment and temporary staff from competitors are not allowed. For such a situation a joint venture contract should be chosen. If joint ventures are allowed, the following principles apply:

- Not more than two companies can be involved in a joint venture.
- The joint venture contract must be done before submitting the tender.
- In the contract, the deployed manpower and equipment for each party should be entered.
- The negotiated interests for each party should be fixed in the contract. These shares are treated for both the expenditure and revenue as well as for the offering expenses.
- The contract belongs to the bidder cards of the involved companies.
- In the bidding cards not the share offer price is entered, but the full bid price in each card.
- It is also necessary to include in each bidding card the name of the joining company.
- The joint venture is considered as one bidder.

The game management reviews the offer as mentioned in the submission phase. In addition, the joint venture contract is inspected regarding the required resources of the project. Are these resources are insufficient for the project; the offer falls out of the ranking. The bid costs are still due.

EVENTS

If a participant arrives on an E-field (event field), he throws with the second dice (In case there are more than one event category included in the business game.). The number rolled on the dice (1, 2 or 3) corresponds to an event category and therefore the number after the E (E1, E2, E3). If not all the event categories were included, the dice is rolled as long as a number corresponds to the existing event category. Following a corresponding event card is taken from the stack and the content is announced to the participants. After that, the card is usually mixed below in the appropriate stack.

Event cards, which are equipped with a black dot on it (occurs on E3-cards), remain until the next quarter by the participant who took this card. Such an event will influence the company for the rest of the quarter. That has also consequences regarding expenditure or other aspects. After the end of the quarter, they are mixed below in the appropriate stack. Event cards, which are equipped with a black circle on it (occurs on E1-cards) remain visible to all next to the board. An event of this category will influence the market for this or more quarter.

END OF A QUARTER

The quarter ends if all participants have thrown once. Construction companies are tending to build first and get paid for it later. Because of this fact, the revenues will be determined

TABLE 2
[Feasible market situations within the board game]

Consumer Supplier	one	few	many
one	Bilateral monopoly	Limited monopoly	Monopoly
few	Limited monopsony	Bilateral oligopoly	Oligopoly
many	Monopsony	Oligopsony	Bilateral polypoly

for the last quarter according to the project cards or the list of the existing projects. These are paid by the bank (Basis of revenue is the bidding price.).

Also, the expenditure for the projects of the next quarter will be determined (Basis of expenditure is the cost out of the project cost list). In addition, spending on unused resources (in the box) should be calculated, because unused equipment or workers still produce costs within a company. All these expenses are paid to the bank. The resources out from completed projects are available for the coming quarter, now. Any consequences of event cards will also be charged at this time.

THE CASE OF INSOLVENCY

If a company is insolvent, two options are available: At least one competitor makes a loan to the bankrupt firm or the bank makes a loan. These alternatives must be set before the game. If a credit is awarded, a credit agreement must be negotiated between the parties. The contents of the agreement such amount of the loan, repayment and interest rate are negotiated. If none of these options is used, the following happens.

The ongoing projects of the insolvent company will be offered to the former second-place bidders. The bank offers these projects to them for the offer price of their own bid plus 5%. Unless they decline, the other bidders according to the ranking of the former submission result get the same offer.

Projects, which no one wants, will go into the possession of the bank (Including the replacement of the houses on the board.).

END OF THE SESSION

The business game ends after the following variants. Option 1: At least one participant has placed all his houses on the board. Option 2: A predetermined time has expired. Option 3: A predetermined number of quarters have been reached.

At the end, the final settlement has to be done. For each company, the following accounting principles are possible (depending on the decision of the facilitator, other principles could be reasonable to address specific learning outcomes):

- Each completed project/ house (house stands on the base side): 2 points Projects with short durations will be rewarded more in this case.
- Each ongoing project/ house: (house stands on the gable side): 1 point Every gained project will be rewarded.
- A contractor has completed all projects / houses on the same street: 1 bonus point
Special bonus if the contractor was able to build every project (e.g. by using his experience).
- Projects/ houses of an entrepreneur are continuously connected with a road. What matters is the shortest connection, for instance the fewest number of roads between the projects. It is sufficient if the linking road is

FIGURE 7

[Example of the execution of the business game (version with fixed game board elements)]



under construction: 1 bonus point for each field where at least one own project was started.

Special bonus for tactical considerations.

- A loan was needed: -1 point for each loan
- A loan has been repaid: 1 point for each loan

The participant with the highest score is the Construction Giant. At the same point scores, the following order should be applied: The total number of workers in the company (social aspect), the total number of devices in the company (tied-up capital) and the available capital (free capital).

For the assessment of the group, the following accounting principles are possible:

- Each completed project/ house (house stands on the base side): 2 points
- Each ongoing project/ house: (house stands on the gable side): 1 point
- Each completed road construction project: 3 points
- Each ongoing road construction project: 2 points

The determined group score can be used to compare other gaming groups.

VALIDATION AND DEBRIEFING PROCESS

As mentioned before, this business game is integrated within a didactical concept of a whole course. According to Karl 2012 the evaluation of the course is divided into three elements: a) central evaluation, b) evaluation of the online-learning environment and c) individual evaluations of single events. The evaluation of the business game is one of the latter.

On the one hand, the business game itself is rated, on the other hand, the performance of the participants.

The evaluation of the student's performance starts already with the beginning of the gaming session. Before starting the session, participants must specify what goals they want to proceed with their company. Here, different targets have been found. Some just wanted to win others followed more differentiated goals, such as full employment, expansion or specialization. At the end of the business game, the results, such as completed projects, market and company development, available capital, amount of workers and equipment were introduced by the participants in a short presentation with special focus on representational abilities. These results are compared with the objectives from the beginning and discussed with all participants in the course.

In particular, the question regarding the market development was often discussed by the participants. Inadequate development of the own company was frequently justified with an unfavorable market trend or dice pitch. While it is acknowledged that the poor market development is also due to the behavior of the participants (mainly through price competition and calculation errors), but nearly anybody admits to have been involved in savagely price competitions.

Some of the participants realized only in the last quarter that the construction of roads might result in a tactical advantage for the final settlement. Those who have previously thought about it have offered with lower prices compared to competitors for road construction projects to use this benefit. The same is true for participants who wanted to use the factor of experience.

An excerpt of the participant's feedback shows table 3.

The two aims, increasing competencies and to make the relationships more clear were achieved. Nearly every participant would play such a game for a second time. Only two companies required a loan. Company 5 calculated incorrectly, got only an insufficient amount of projects and kept too long unneeded workers and equipment. Company 1 started with the aim to acquire a high amount of projects right from the beginning. Their method was to work with low prices (partially even underneath the production costs), but during the game, company 1 was not able to level the losses with profitable projects.

CONCLUSION

Due to the fact that the feedback from the participants was positive, shows that board based business games for university education may be well be appropriate. This multi-purpose business game was well accepted due to its correspondence to reality and its modular design, which permits a wide variation. The participants commented that they have heard a lot of theoretical content before, but now they can use this in practice and understand more clearly their meaning. They said that they finally understood both theory and application of the different topics. In particular, the relationships within the construction industry and the consequences of bad decisions have been particularly aware of. During the discussions, the participants showed that they achieved most of the required competency goals. Further information and illustrations of past Construction Giant sessions are available on www.construction-giant.com.

TABLE 3
[Evaluation of the business game]

Evaluation criterion	Percentage
The business game encouraged my competencies	91%
The communicated teaching and learning objectives have been achieved	88%
The business game has made relationships more clearly	86%
Would participate again in such a business game	96%

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