

# Gamification of eHealth Business Cases to Enhance Rich Learning Experience

Kari Björn

## I. INTRODUCTION

**Abstract**—Introduction of games has expanded the application area of computer-aided learning tools to wide variety of age groups of learners. Serious games engage the learners into a real-world -type of simulation and potentially enrich the learning experience. Institutional background of a Bachelor's level engineering program in Information and Communication Technology is introduced, with detailed focus on one of its majors, Health Technology. As part of a Customer Oriented Software Application thematic semester, one particular course of "eHealth Business and Solutions" is described and reflected in a gamified framework. Learning a consistent view into vast literature of business management, strategies, marketing and finance in a very limited time enforces selection of topics relevant to the industry. Health Technology is a novel and growing industry with a growing sector in consumer wearable devices and homecare applications. The business sector is attracting new entrepreneurs and impatient investor funds. From engineering education point of view the sector is driven by miniaturizing electronics, sensors and wireless applications. However, the market is highly consumer-driven and usability, safety and data integrity requirements are extremely high. When the same technology is used in analysis or treatment of patients, very strict regulatory measures are enforced. The paper introduces a course structure using gamification as a tool to learn the most essential in a new market: customer value proposition design, followed by a market entry game. Students analyze the existing market size and pricing structure of eHealth web-service market and enter the market as a steering group of their company, competing against the legacy players and with each other. The market is growing but has its rules of demand and supply balance. New products can be developed with an R&D-investment, and targeted to market with unique quality- and price-combinations. Product cost structure can be improved by investing to enhanced production capacity. Investments can be funded optionally by foreign capital. Students make management decisions and face the dynamics of the market competition in form of income statement and balance sheet after each decision cycle. The focus of the learning outcome is to understand customer value creation to be the source of cash flow. The benefit of gamification is to enrich the learning experience on structure and meaning of financial statements. The paper describes the gamification approach and discusses outcomes after two course implementations. Along the case description of learning challenges, some unexpected misconceptions are noted. Improvements of the game or the semi-gamified teaching pedagogy are discussed. The case description serves as an additional support to new game coordinator, as well as helps to improve the method. Overall, the gamified approach has helped to engage engineering student to business studies in an energizing way.

**Keywords**—Engineering education, integrated curriculum, learning experience, learning outcomes.

Kari Björn is with the Health Technology education, Information Technology department, Metropolia University of Applied Sciences, Helsinki, Finland (phone +358503654770, e-mail: kari.bjorn@metropolia.fi).

TEACHING and learning in business and management studies has traditionally been based on suitably selected and prepared real-life business cases. Recent development in game development tools has brought gaming technologies as a viable and interesting approach to enhance learning through playing.

### A. Gamification in Higher Education

An early literature review of 129 papers for finding positive impacts of gaming on users above age of 14 or above, especially related to learning, skill enhancement and engagement shows that "playing computer games is linked to a range of perceptual, cognitive, behavioral, affective and motivational impacts and outcomes" [1]. Recent findings also support the effectiveness of gamification in educational contexts, although student personality affects the learning outcomes [2]. Proper integration of gamification to support e-learning in higher education is reported to increase satisfaction, motivation and student engagement, but special emphasis should be based on "clearly defined objectives, rules, techniques and mechanisms of gamification that affect the dynamics of the students" [3]. This paper considers gamified approach as an engaging method for learning relative large and complex concepts of business model development, market positioning and business financial management basics in a semi-structured and gamified way.

### B. Educational Program Context

Metropolia University of Applied Sciences (MUAS) "is the largest University of Applied Sciences in Finland. MUAS has around 16.700 students and 1.000 staff. About half of the students are in engineering. MUAS Information and Communication Technology (ICT) is a four-year Bachelor-level Degree Program of 240 ECTS (European Credit Transfer System) credits with around 1000 students" [4]. A rationale for organizing MUAS pedagogy by teaching teams and learning on student teams introduced larger units of learning is discussed in [5].

All ICT students have common first year studies (60 ECTS). These are implemented as four consecutive 15 ECTS integrated modules (Games and Mobiles, Objects, Devices, and Networks) [6]. By the end of the first year, the students can choose and apply for their Major. Major options are: Communication Networks and Applications, Game Applications, Health Technology, Media Technology, Mobile Solutions, Smart Systems, and Software Engineering. This paper focuses on Health Technology. The structure of the major shown in Fig. 1 as three thematic semesters:

Physiological Measurement Technology (PMT), Customer Oriented Software Applications (COSA) and Health Technology Devices and Solutions (HTDS). Each of these is divided into half-semester (Periods) of 8 weeks.

ICT Programme	ECTS	240 Total
Orientation to ICT		60
Games and Mobiles	15	
Objects	15	
Devices	15	
Networks	15	
Foundations of the Major Studies		30
Physiological Measurement Technology		
PMT I	15	
PMT II	15	
Major Studies		30
Customer Oriented Software Applications		
COSA I	15	
COSA II	15	
Health Technology Devices and Solutions		30
HTDS I	15	
HTDS II	15	
Innovation Studies		15
Elective studies		30
Practical Training		30
Bachelor's Thesis		15

Fig. 1 Health Technology within the ICT curriculum

The remaining parts of the program include Innovation studies, a multi-disciplinary working-life oriented concept development course and its supporting theory. For Elective studies we recommend ICT-related themes, but the flexibility here is high. Practical training means work placement already in the industry, as well as Thesis work. The structure of the program leaves relatively little time for business-related studies. Therefore, effective and engaging means to integrate these into the larger thematic semesters are required. This is implemented as part of COSA I, shown as \*) in Fig. 1.

#### C. Previous Work and Research Question

Student feedback on the pedagogical approach was collected using a semi-structured questionnaire after each thematic module and the results are summarized in [6]-[8]. The general approach was considered good but required operative adjustments, as expected. The second year two thematic modules were included in a longitudinal quantitative study of learning outcomes as credits earned in Health Technology major [9], and compared to other majors in ICT [10]. Experimentations on transition into larger learning units in Automation Technology [11] and comparative analysis of ICT student learning styles [12] have been initiated.

The first objective is to describe the two course case implementations with learning objectives and gamification method. Secondly, these provide a structured starting point of further development of the course using the existing lightweight tools, or selection of other gamification methods. A detailed content reflection also serves as a starting point to develop the contents in a multi-disciplinary teaching team.

## II. MATERIALS AND METHODS

The teaching period learning objectives are summarized and the available time and resource capacity to implement the gamification are identified as a weekly activity distribution. Selected business modeling tools and their rationale are introduced. Two learning assignments were used in the first course implementation and three assignments and an exam were used in the second implementation.

Materials for describing implementation of the gamification experiment are based on Excel sheets with protected entry, as well as the feedback of game cycle results. An online workspace is provided for each student team for their assignment returns. The coordinator can then give feedback to each team separately. This allows for group-specific steering.

Applicability of the selected business concepts, especially the student responses and their obstacles of learning and using the gamification tools are reflected. These may reveal development issues in either selection of learning content or in the gamification tools as they are in early stage.

## III. RESULTS OF THE INTRODUCTION TO BUSINESS MODELING

### A. Course Organization

Customer Oriented Software Applications (COSA) theme include six 5 ECTS courses. Courses of the first period and their main content are as follows:

- eHealth Business and Solutions (5 ECTS)
  - eHealth ecosystem and *business environment*
  - ICT systems, software and products
  - Significance of information in health ICT
  - User oriented development
  - Sales and marketing of product and services
- Customers and Users of eHealth Services (5 ECTS)
  - Social/healthcare actors, operating principles and services
  - Roles of customer and user
  - ICT solutions' customers and users and their special needs
  - Customer in product development
  - User perspective to technology
- Web Application Development 1 (5 ECTS)
  - Basic concepts of databases and database management
  - Design and creation database structure, and manage content using SQL
  - Design and development of a simple Web service
  - Database and web service connections
  - Development of a database admin application

Implementation of a 3 ECTS part of "eHealth Business and Solutions" covering the *Business environment* and *Sales and marketing of product and services* is shown in Fig. 2. A class of approximately 30 students is typically divided into 10 teams. Teams of three have proven to be resilient against absence and effective in fair work sharing. Each week (Wk) and its learning content are in the first two columns. The main activity of lecturing type of intro (Le), Steering (St), Self-study in groups (Ss), assignment returns (R) and exam (E) are identified weekly, reflected to even distribution of 3 ECTS work (80 student hours).

Wk	COSA I (2017) 3/5 ECTS part H15	Activity			Return		3 ECTS
		Le	St	Ss	R	E	
1	BMC introduction, VPD assignment	4		6			10
2	Income stat., balance, cash flow	4		6			10
3	VPD steering, market positioning	2	2	6			10
4	VPD presentations, Game intro	4		6	x		10
5	Game steering and decisions I		4	6	x		10
6	Game results, market behaviour	3	1	6			10
7	Game steering and decisions II	1	3	6	x		10
8	Game results, annual rep; Exam	2	2	6		x	10

Fig. 2 Course implementation weekly activity distribution

### B. Business Model Canvas

Business Model Canvas (BMC) provides a single coherent and visual model of describing business concepts [13], [14]. The compact and simple structure is a good learning model for students, as shown in Fig. 3. Therefore, the COSA I eHealth business is first introduced using the BMC. From leaning point of view, the right side represents the (strategic) marketing perspective and the left side describes company management decisions and operations.

Key Partners	Key Activities	Value Propositions	Customer Relations	Customer Segments
	Key Resources		Channels	
Cost Structure			Revenue Streams	

Fig. 3 BMC elements in a visual template

Confirming a foundation of a valid business model links this part of the course to other learning objectives of the eHealth ecosystem and user oriented development. Therefore, the right side of the BMC and the potentially generated revenue streams are fundamentally important. Customer segments refer to a group of decision makers with identical needs and must be large enough to support the revenue stream. Channel represents the way to deliver the product or service. Specific interest in eHealth is the potentially needed channel for the physical product and the online part of the service. These are related to revenue stream by generating single or continuous stream. Customer relations represent the way to maintain the relationship. Value propositions are the selling/buying arguments of the service.

The match between the value propositions with the customer segments need to be validated. Therefore, the learning case proceeds in introducing the student to two practical concepts: The Lean Start-Up [15] and Value Proposition Design [16]. Both concepts are seemingly simple, but applying the concepts to practical cases invokes critical thinking. This was decided to be learnt in student teams instead of frontal lecturing in theory.

### C. Case learning from Lean Start-Ups

The BMC represents a particular business case in a static way. This view has been further developed by modeling the dynamic nature of a startup company. Lean Start-Up

emphasizes the dynamics of confirming the validity of the value proposition by repetition [15], as shown in Fig. 4.

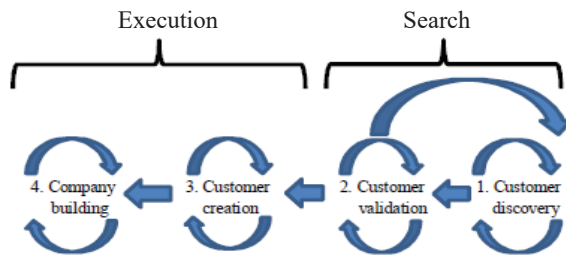


Fig. 4 Principle of Lean Start-Up aligned with BMC model

The Lean Start-Up approach emphasizes two very distinct phases of a successful business creation: search phase repeatedly tries to (1) translate company ideas into business model hypotheses, testing the assumptions about customer's needs, and then test their "minimum viable product" and proposed solution with the customers. Testing continues to validate (2) the business assumptions. Customer interest is validated with early orders or trial use. In case of failure, the start-up can quickly pivot back to correct the assumptions (1). Therefore, the idea is to fail fast and with minimal cost, and still be able to continue the search, before entering the costly execution phases of the company building. A start-up is likely to fail several times before entering the execution phase [15].

The execution phase is then expected to be linear, after the reasonably reliable validation. In customer creation (3) the product is further refined enough to sell, based on the well-proven hypotheses. At this stage the expenditure on marketing, sales, and production increase rapidly. Finally, company building stage (4) will establish the formal organization and business infrastructure [15].

From learning objective, the original order of the Lean Start-Up is reversed in Fig. 4, thereby matching the search phase to the right side of the BMC and execution phase to the left side of the canvas. The right side therefore represents the conditions for incoming cash flow, i.e. the fact that there is an actual customer need and a product/service offering to satisfy it. The roles of a service user and a service buyer are often the same in consumer market, but may not apply in Health Technology market. The service user may be the patient, but the payer to be governmentally funded healthcare institution. Therefore, in eHealth business development, particular care needs to be exercised in validating the business model.

### D. Value Proposition Design

Considering the eHealth business models, the search phase was introduced using the BMC as a general framework, followed by introduction of the Lean Start-Up principle. Gamification of this learning task was considered feasible. The students were introduced a list of healthcare companies and they were instructed to search interesting cases for their group presentations and discussion.

Value Proposition Design (VPD) is a rich set of tools, templates and trigger questions to help in searching and

validating the business models [4]. The VPD toolset was used as a presentation template for the chosen business cases. Group steering was available in selection process of finding companies with 1) reasonably small size so that their business model is simple enough to be analyzed as exercise; and 2) enough public information of their products. The VPD case assignment was introduced in week 1, steering in week 3 and presentations in week 4 of the period. Overall, this being the first assignment, the students were still focusing on the VPD format and relying on the marketing information from the company. It has been proven to be quite time-consuming to invoke source critique on commercial information. This completes the first assignment.

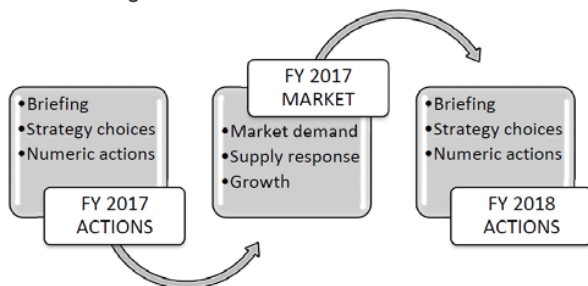
#### IV. MARKET ENTRY AND FINANCIAL POSITION AS A GAME

##### A. Gamification Principle

The students continued in the same groups of three, taking the role of a company board or steering group. In a typical Start-Up they would most likely be the owners as well. These companies target now to enter a service-oriented e-Health market of four already established companies (A-D). Market information is briefed to the teams who play against the existing companies and against each other. They decide their market positioning independently by investing product R&D and pricing their offering under uncertainty and incomplete market information.

The game is not fully automated. It is steered by game coordinator, initially briefing the rules and the market situation to all groups. Each team analyzes the market and makes its strategic choices. These are documented as minutes of a meeting and using a numeric budget template. This is shown as FY 2017 ACTIONS in Fig. 5.

##### Game steering workflow



##### Game player workflow

Fig. 5 Market game cycles of actions and responses

The market consolidation is done by the game coordinator from the returned actions. Team results are reported back as Income statement and Balance sheet of the company. The response takes into account the market demand, although growing, but not infinite. Therefore, not all offered products are necessarily sold, or the price may drop. General market views are provided, not including too much detail on direct competitors, thus simulating a real business situation. The market response is shown as FY 2017 MARKET in Fig. 5. At

this point, the experience on this model of learning is that quite a lot of learning occurs in consulting the decision-making and its limitations and in briefing discussions to understand the dynamics and relationships of the concepts.

##### B. Learning Objectives on Financial Business Management

Execution phases of the BMC contain significant amount of business management and financial management literature, condensed into a few elements. The learning objective is to achieve a survival level understanding of financial terms, especially relating to source of cash flow and cost structure of the business model. This was realized by taking Income statement defined by Finnish accounting law and decree [17], [18]. For pedagogical reason only, a subset of these is used, omitting more complex details. The model is shown in Fig. 6, where the line numbers refer to the numbered lines [18], for consistency and traceability.

Income Statement by Activity		2017	2018	2019
1	TURNOVER	400000	0	0
2	Raw materials and services	-160000	0	0
3	Gross margin	240000	0	0
4	Sales and marketing costs	-100000	0	0
5	Administrative costs	-50000	0	0
7	Other operating expenses	-40000	0	0
8	OPERATING PROFIT (LOSS)	50000	0	0
9	Financial income and expenses	0	0	0
10	PROFIT (LOSS) BEFORE TAXES	50000	0	0
12	Income taxes	-10000	0	0
14	PROFIT (LOSS) OF THE FINANCIAL YEAR	40000	0	0

Fig. 6 Income statement model for market positioning game

The accounting decree [17] provides two templates. From these the activity-based template was selected, because it shows gross margin (3) and therefore separately variable costs (2) and fixed costs (4-7) in Fig. 6. This is relevant, as eHealth service production may have very high initial (one-off) investment and development cost but low marginal cost in delivering one unit of service. Other costs can be categorized various ways, depending on the business model. Therefore, this opens up many pedagogical discussions on cost structure.

Same principle of simplifying the balance sheet model from [17], [18] is based on limiting the learning scope and complexity to be discussed in a short time. The main importance included in the model is the Equity and Liabilities, where the difference of Subscribed own capital and other free own capital are shown in Fig 7. In this example, the Subscribed own capital is allowed minimum, but the company has a lot of reserves to start the game. The principle of retained earnings (or loss) accumulating into the balance sheet is to be learned. For later use and learning, this part contains differentiation of the shareholder's capital and capital from creditors. The team can take bank loan to finance their operations, but pay interest and the loan back, therefore affecting the financial costs in their Income statement. Bank loans open up also pedagogical discussions on limits, covenants and securing of the creditors interest. In start-ups,



collecting the initial capital and accepting risks are relevant and crucial issues to discuss.

Assets	31.12.2017	31.12.2018	31.12.2019
<b>A NON-CURRENT ASSETS</b>			
I Intangible assets			
1. Development expenditure			
2. Intangible rights			
3. Goodwill			
II Tangible assets			
3. Machinery and equipment			
<b>B CURRENT ASSETS</b>			
I Stocks			
1. Raw materials and consumables			
3. Finished products/goods			
IV Cash in hand and at banks			
<b>Equity and Liabilities</b>			
<b>A CAPITAL AND RESERVES</b>			
I Subscribed capital	2500	2500	2500
IV Fair value reserve	600000	600000	0
1. Free own capital	600000	600000	0
V Retained earnings (loss)	0	40000	40000
VI Profit (loss) of the financial year	40000	0	0
<b>D CREDITORS</b>			
3. Loans from credit institutions	0	0	0
	642500	642500	42500

Fig. 7 Balance sheet model for market positioning game

The Assets side is not much covered due to lack of time and a lower priority. In eHealth and other ICT-related businesses the main concepts of activating relatively high R&D may be relevant and intangible rights may relate to patents obtained. These items were introduced to the game model only to be briefly introduced. The most concrete one that the teams can make is an investment to machinery to lower production costs.

To conclude the scope concepts to be learned, the market response to the management actions is that on each game cycle the team gets their financial reports (Figs. 3 and 10), updated with realized sales and prices. Income statement includes their decided actions and resulted sales quantities and realized market prices. Therefore, their turnover, the product of these two, may be lower than expected.

### C. First Brief in Positioning and the Market Demand Model

The first market situation brief to all teams, in verbal or power-point form, is not being structured too much. An example of summarized initial market information is shown in Fig. 8.

	Existing market knowledge				Cost structure information			
	Sales	Price	Q.P.	Growth	Cost/V	Cost/V	R&D	
A	1200	60	100	50	30	20	100	
B	600	20	50	100	9	6	50	
C	400	10	20	100	6	4	20	
D	300	5	10	150	3	2	10	

Fig. 8 Market and cost structure options in initial brief

Fig. 8 is an example of the available market information in the beginning, typically available from existing market players. Companies A-D are likely to have delivered their tax and fiscal year reports so their turnover with reasonable

accuracy are assumed to be known and are expressed here in €1000's. Market prices of services, especially in eHealth are likely to be known. A market research company or some other source may have published evaluations of the products and these "value propositions" are simplified here into one variable, called Quality Point (QP) with arbitrary relative value, so far between 0-100. Estimates on market pricing segment growth rate per annum may be calculated. The same uncertain estimate is available to all teams. The students are not explicitly informed about sold quantities or existence of the supply-demand market model and the concept of price elasticity. These are shown in Fig. 9.

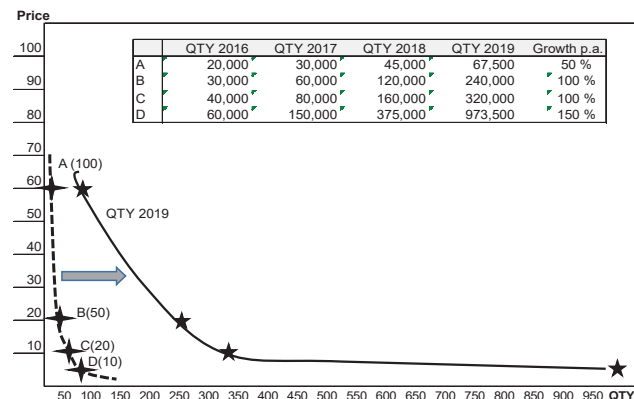


Fig. 9 Market demand growth model based on Fig. 8

For pedagogical reasons it is left to the student teams to conclude that the turnover and price such as in Fig. 8, imply market size on each pricing category, as denoted by four points on the dotted price/quantity curve. It is further left to students to analyze that market growth in each category will move the demand curve to right, as shown by the solid curve QTY2019. This leads to pedagogical discussion on supply-demand and price behavior, once they will see that all intended quantity was not sold at intended price, due to competition. This leads to discussion of market positioning strategies, such as differentiation, cost-leadership, and niche-markets.

Information on cost structure is briefed in a simplified format: Unit prices of Raw material and services are given as variable cost (Cost/V) with an option to invest on production server equipment, which reduces these unit costs by 1/3, as shown in Fig. 8. This investment is depreciated over next 3 years and it also reduces fixed costs, saving some salary cost in maintenance. It is left to the management to decide if they do the investment or use their funds in new product development.

The management may develop one or more new products at any cycle, up to maximum of three. The R&D investment relates to the intended quality point of the end product. In Fig. 8 one-point equals to €1000 R&D cost. The amount of available funds in Capital and Reserves may or may not be sufficient for all aggressive ideas of the management. Therefore, they are forced to consider their available options

under limited resources quite carefully. Minor details of fixed cost structure, interest rates etc. are omitted from this discussion.

#### *D. Market Letters and Unexpected Information*

Normally the company receives direct feedback from the market and customers through its marketing and sales operations and personal contacts. This is hard to simulate in a gamified environment. Some industries with relatively mature markets have also organized collection of sales information from all players in the market to enable market share calculation by a neutral and independent actor. This may be in a form of a newsletter or the information might be gathered by some independent research institution.

In order to help the student teams to better evaluate the markets and to make more analytical decisions, a market newsletter is published after each game cycle. These are shown as FY2017 MARKET in Fig. 5 as part of the Game steering workflow. The newsletter was in verbal form describing the market demand and growth information. More importantly the letter gave at least partial information of how each pricing and quality category was developing when the existing players (A-D) and the new players (T1-T9) were aggressively pushing their offering into the market.

As it can be expected, four existing players and nine new ones are unlikely to fit into the market, at least in the same pricing category, even when the annual market growth is significant. Pedagogically this leads to several interesting observations: 1) the students notice that they are not only competing against a closed problem of their own company against static situation of A-D, and these four are potentially acting through the game coordinator. In addition, they have a number of competing market entrants who are also making their strategic market positioning independently. Therefore, the game coordinator needs to manage the gamified learning process in a way that all teams reasonably survive at least close to the end. There are several ways to soften the serious positioning mistakes.

Mistakes in mismatch of offered price and product quality may lead to turnover to be close to zero, probably causing serious difficulties to continue. These can be resolved by not making the market share calculation fully automatic, but leaving flexibility for steering the learning. Extremely aggressive marketing experimentations may exhaust the cash flow of the team with very high risk that if the intended quantity is not accepted by the market, or if market prices are forced to drop, the company does not survive. The lesson to learn here is the basic balance of supply and demand quantity so that the price elasticity is realized. In case of very large supply in same price category, the game coordinator has an option to exit one or more of the established players (A-D) from the market. This is a reasonable scenario, especially if their technology and cost structure are outdated. The other players receive this kind of news via market newsletters.

#### *E. Executing the Management Actions on Market*

The student group acts as the board of the company, being

liable on the decisions and potential risks. In the simulation the board records their minutes of the meeting to express and clarify the company decisions to the game coordinator. The numeric format of the decisions is entered in the Excel-sheet, as shown in Fig. 10 for product A and year 2017.

		2017	2018	2019
PRODUCT A OFFERING	Quantity	20000		
	Unit sales price	20,00 €		
	Unit purch/manuf.cost	8,00 €		
	Cost structure			
	Unit sales margin	12,00 €		
	Sales margin %	60,0 %		
	Critical point	15 833	#VALUE!	#VALUE!
Sales & marketing cost for A		20000		
Product development expenses of A		30000		

Fig. 10 Product offering action in market positioning game

The example in Fig. 10 shows offered quantity of 20,000 at €20.00 with purchasing or manufacturing cost of €8.00. Additionally, the team promotes the product marketing and sales with €20,000 and targets the product to 30 quality-point category with development cost of €30.000. The sheet shows their intended cost structure with sales margins and the critical point, which is the minimum viable sales quantity which covers the fixed costs (lines 4-7) in the income statement of Fig. 6. Fixed costs not associated with any particular product are updated by each student team as shown in Fig. 11 for the year 2017.

		2017	2018	2019
Sales & marketing cost fixed		80000		
Administrative costs		50000		
Other operating expenses		10000		
Loans from (+) / payments to (-) banks				

Fig. 11 Other actions in market positioning game

As shown in Fig. 11 the team invests €80,000 on sales and marketing of the products, uses €50,000 for general administrative costs and €10,000 for other general expenses. Initially, the same basic cost structure is given to all teams together with the allowed actions to change them. The other column are entered during next game cycles.

#### *F. Shareholder Meeting, Annual Report and Exam*

During the second implementation, a third student team assignment was added. First implementation feedback indicated some frustration on evaluation of the learning outcomes by student teams only. The most advanced students wanted that a part of the final evaluation is personal, therefore giving them advantage and a wider distribution of grades. To help to evaluate their learning results gained via the gamification and to more formally review the simulated content, this task was added. Each team prepared for the shareholder meeting by writing a short summary of their company's financial performance, based on well-established key ratios [19]. A private small company is not obliged to prepare this, unless the minority shareholders demand it to protect their interest. Therefore, in their start-up this was the case. Specifically, the teams prepared trend analysis over the

simulated gaming time, particularly focusing of the key ratios: gross margin, operating profit, and profit before taxes. Development of these reflects the validity of their business decisions and helped to review their learning one more. Additionally, as they prepare their response to the shareholders, some elements of the Equity and liabilities need to be observed. Each team had minimal share capital but significant reserves to use in the simulation. No credits were initially present. The teams had a choice to fund their R&D and marketing operations also using bank loan, with appropriate payback and interest cost. Within the limited time it has not been possible or relevant to discuss details of financing, but the student teams were requested to check return on equity and to consider potential risks related to debts. As the full set of financial key ratios and their definitions were available also online, the students found this analysis as a relevant exercise in preparation to their personal lightweight exam on interpreting the financial statements and ratios. Based on the coherent outcome of the exam, this task prevails in the game.

#### V.CONCLUSION

A multi-disciplinary Bachelor level degree program of Health Technology was introduced. One challenge in such program implementation is the limited time to cover any particular topic area in detail. The ICT-oriented students may also indicate low motivation to business studies, especially before gaining work experience. Health Technology is particularly challenging special field of ICT, because in addition of the technical challenges, it is strictly regulated, and the service user and the service payer, i.e. decision-maker may not always be the same. Therefore, for any engineer engaged in Health and eHealth applications should have basic business knowledge.

In order to enhance the learning experience to be richer and more interesting within the limited time, partial gamification of the business cases were explored with two repeated course implementations in 2016 and 2017. The first assignment to understand the customer value creation was introduced using the BMC approach, followed by introduction of the Lean Start-Up model. The first practical group assignment was to analyze real-world companies, preferably small and medium size enterprises. In order to structure this task, yet one more practical toolset of VPD was introduced, because it provided directly applicable templates and checklists. This exercise has proved to be still challenging, especially for students to be critical in their use of company-provided material on their evaluation of products and services. As a teaching method, group presentations and active discussion on the different aspects has proved to be of crucial importance. During these steering sessions the students we encouraged test the underlying business hypotheses, as suggested in [15]. This part of the course implementation still needs more detailed briefing and steering.

Search of the customer segments and validation of the business model in terms of revenue streams provides a rich set of examples of what various value propositions may be.

Unfortunately, the right part of the BMC is challenging to be included in the gamification process.

The gamification model was implemented using simple Excel sheets with limited richness of VPD: at each cycle each student team could develop one or more products to be offered in the market with three parameters: offered quantity, price, and quality. Within each price and quality category, a reasonable market share was estimated by the game coordinator in case when the total offering of many teams exceeded the market demand. Within same price range, the product with higher quality took larger market share. If some teams used extensive marketing expenditure, this was noted on evaluation of probable marketing share, and in some cases allowing the total market to grow faster. The experience is that the marketing model, even with all its limitations and simplicity is not easy to fully automate. The various innovative strategies of the students trigger many interesting discussions of their applicability and limitations in the real world. However, even with its flaws, the simulated business and market entry game raises engagement and interest.

Running a business simulation game like this has challenges: all groups must return their decisions and respond in synchronized time in order for the market to work. This was noted as a lesson to learn for company management: The market will not stop on one company's inactivity; neither will the tax authorities wait unreturned documents. The market provides zero turnover and tax authority estimates the tax and apply tax penalty. A gamified learning model is intensive for student and the game coordinator. Ensuring reasonably correct and meaningful decisions for each following market cycle requires student steering and discussions. This could be referred as game-driven learning. The alternative way would be developing the entry of data and its validation procedure significantly. This seems unfeasible and may not improve the learning results. It is likely that the third course implementation will have improved linkage from the income statement to the balance sheet, especially on the assets side. Some of the most advanced student groups entered the analysis of investments and their depreciations, which was not fully supported in the 2017 version.

In consideration that this 5 ECTS course was implemented by two teachers in 8-week period, a lot of material was exposed to students. This part of the course was only 3 ECTS. We estimate that 7 out of the 9 student groups performed well with the simulation. Two groups had challenges with their allocation of study time on this and also the other parallel courses. Overall it is possible to conclude that the gamification approach has allowed to cover and discuss more material than compared to normal lecture-style approach. Gamification has engaged the students in a learning-by-doing way to the utmost uncertainty that the business management is facing. Especially for young engineering students the decision making under high uncertainty, incomplete information, and hard timing deadlines has been an eye-opening experience.

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