Gamification of Project Business Studies

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Abstract. During the recent years, gamification of education has received increased attention and interest. Although critics argue that gamification derails the focus of learning and increases stress and competition, most scholars see that benefits outweigh the risks. They believe that gamification increases student engagement and reinforces their problem-solving skills, collaboration, and communication. In this paper, gamification is applied to skills required in the management of the company's project business. In project business, the focus is not on individual projects but on the organization's project portfolio. The project portfolio refers to the company's all simultaneous projects and project opportunities that have common strategic goals and that are competing for the same resources. In the empirical part of the study, post-graduate students' feedback on the project portfolio management (PPM) exercise was investigated using both manual and machine learning based content and sentiment analysis. The results of the experiment indicate that students' sentiment towards the PPM workshop was positive and gamification seems to be a good method of learning project business skills especially in the creation of the management and decision-making system and in managing a diverse project portfolio.

Keywords: Gamification of Education, Project Business, Collaborative Learning.

1 Introduction

Demand for project management skills has never been higher. Organizations are constantly creating innovations, and projects are the main method of bringing us products or services that has not existed before. The increased popularity has lead to more complicated projects and above all increased the number of simultaneous projects. Managing a large number of projects also known as project portfolio management (PPM) is not an easy task because it involves many challenging decision-making tasks including resource allocation, scheduling, risk and financial management and project prioritization. New project environment with the large project portfolios and the increased importance of project business, requires wider skills and new learning methods.

The aim of the paper is to analyze the suitability of gamification for learning project business skills. Our paper is organized in the following way. In Section 2, we briefly review gamification of education and project business with an aim to develop a model for learning skills required in project business. The model serves as a framework to analyze student sentiment towards a PPM exercise carried out in a Finnish university

of applied sciences. The study on the gamified PPM workshop is described in Section 3. In the study, the student feedback is analyzed using both content and sentiment analysis. To limit unintended errors machine learning was used to verify the feasibility of the model and the correctness of the manual sentiment analysis. Finally, in Section 5 we discuss the results and draw the final conclusions.

2 Literature Review and Model Development

2.1 Gamification in Education

In recent years, games and game-like elements have been introduced to several domains, including entertainment, business, and education. In education, practitioners have applied two different approaches: Game-Based Learning (GBL) and gamification. In GBL, the game is the starting point and at a simple level, game-based learning has been defined as "learning that is facilitated by the use of a game." [1]. Gamification instead, has been defined as "the use of game design elements in non-game contexts" [2], and "the process of making activities more game-like" [3]. Both of these definitions emphasize that in gamification the focus in not on the game but on the learning process.

Gamification of education typically aims to improve students' motivation, engagement [4], participation and learning outcomes [5] and it combines play-like simulation, functional proficiency and social interaction with learning [6]. Many scholars have reported the positive effects of gamification on learning outcomes at different education levels and subjects [7]. Naturally also some critical views have been reported (e.g. [8] and [9]) but most of the empirical studies on gamification in higher education have provided positive outcomes [10].

Researchers have modeled gamification of learning in different context (e.g. in MOOCs [11] and in eLearning [12]). For our purpose, a model for virtual team collaborative learning (LIC) based on gamification of education, collaborative learning, virtual teams and technology [13] is especially interesting. The model consists of the following three main parts: a learner as a player, an instructor as a coach, and a classroom as an arena.

2.2 Project Management and Project Business

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements and to complete a project [14]. Project business, on the other hand, goes beyond a single project and it is defined as "the part of business that relates directly or indirectly to projects, with a purpose to achieve the objectives of a firm or several firms" [15]. In project business, many projects are managed simultaneously with the aim to fulfill the organization's strategic business objectives. Managing a diverse project portfolio is not an easy task because PPM involves many challenging decision-making tasks including resource allocation, scheduling of the individual tasks, risk management and project prioritization. To solve this

problem organizations have created different kinds of PPM tools for increasing efficiency and productivity.

Researchers have paid a lot of attention to the success factors of a single project, but project business success has received far less interest. Scholars have analyzed project business from many related perspectives like trust [16], outsourcing [17] and project selection in the project portfolio [18]. However, Artto et al. introduced a framework which can be used to analyze the success factors of project business [19]. This model is presented in Fig. 1. The model has the following four elements: a management system, financial management, project portfolio management, and managing customer and supplier networks.

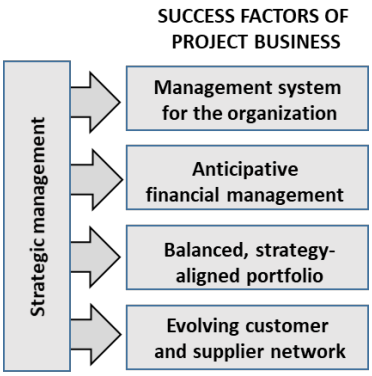

Fig. 1. Project business success factors [19].

2.3 Framework for Gamified Learning of Project Business Skills

In the previous sections, we introduced some models for gamified learning and the key success factors of the project business. Based on these discussions a theoretical framework for gamified project business education is now created. The model (see Fig.2) has two parts: project business and gamification representing the subject of the learning and the learning method, respectively. The project business side of the model is based on the four key success factors introduced earlier, namely organization's management system, financial management, portfolio management, and customer and supplier management.

Gamification side instead has three elements: a learner and learning, a learning session and environment, and finally an instructor and instructing. Here the learner is seen both as an individual and as a member of a team, because learning takes place in a team and project business and portfolio management contains decision making both alone and together with others. The learning session refers to all activities of the exercise and environment contains both physical and virtual learning environments. Finally, the instructor's role contains all the teaching and supporting functions as well as materials provided before, during and after the learning session.

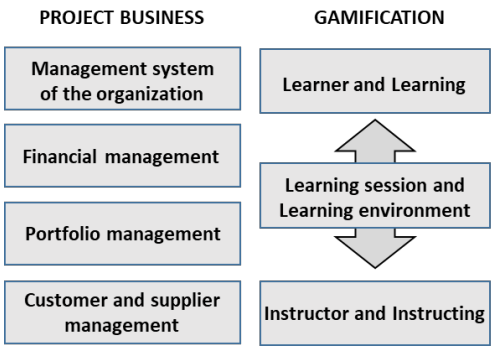

Fig. 2. Framework for gamified learning of project business.

3 Study Design

3.1 Research Methods and Data Collection

As mentioned earlier the aim of the study is to analyze the suitability of gamification for project business education. To collect some empirical data, we organized a small-scale learning experiment in a Finnish university of applied sciences. In the experiment, a group of post-graduate engineering students (N=42) took part in a project portfolio management exercise. In the exercise, they worked in teams of four or five students and they managed a project portfolio of a fictional company. During the exercise, students carried out typical portfolio management tasks like allocating resources, scheduling tasks, creating reports and prioritizing projects with PPM software. All participants were adult learners with full-time jobs and at least some work experience in the project organizations.

After a six hour exercise, students gave written feedback about the learning session. The total number of the feedback sentences was 358. The sentences were analyzed in two different ways. First, content analysis was used to assess message characteristics systematically. Second, sentiment analysis was applied to interpret and classify students' emotions towards the different parts of the model. Because of the researchers' human nature, both content and sentiment analysis are prone to the researcher bias. To avoid any unintended errors in the research process, we used machine learning to verify both the feasibility of the theoretical framework and the correctness of the sentence classification.

3.2 Design of Gamified Learning Exercise

Design of the gamified learning exercise was based on the following five questions that designers of gamified learning have to consider [20]:

- Why is gamification used?
- What is the focus of the exercise?
- Who is the target or learner in the gamified exercise?

- How is the gamified exercise shown and presented to the learners?
- How does the gamified exercise work (steps of the game)?

Answers to the first three questions have already been presented in Section 2. Gamification is used to improve students' motivation, engagement, participation and learning outcomes. The focus of the exercise is learning various skills needed in project business management. The learner is of course the participating student but his or her learning takes place both at an individual and at a team level because the exercise contains decision making both alone and together with others.

In meaningful gamification, designers have to focus on the aspects of the underlying activity to understand where an integration of game elements makes sense [21]. In order to do that, presentation and implementation of the exercise were guided by Marczewski's general game element principles [22] as shown in Fig. 3.

GENERAL GAME ELEMENTS	IMPLEMENTATION HERE
Narrative/Story	You are a member of the management team
Theme	You must run the project business of the company
On-boaring/tutorials	Short demo by the instructor and learning videos
Signposting	Instructions for the next task
Progress/feedback	From instructor after completing of each task From software during the tasks
Curiosity	Unknown events in each task
Strategy	Decisions about the team rules and working methods
Time pressure	Limited time and feel of hurry
Scarcity	Limited resources to complete the projects
Consequences	Decisions in one project affects others
Loss aversion	Wrong resource allocation leads to lost bonuses
Investment	Students spent the whole Saturday in the workshop
Flow	Balance of skills and challenges

Fig. 3. Framework for gamified learning of project business.

The exercise consisted of the following four steps. In the first step, the instructor revealed the theme and the narrative followed by short introduction to the PPM software. Because the students needed guidance to the program also during the exercise, they had access to short task specific video tutorials. In the second step, the participants added their own projects to the project portfolio and allocated resources to their project. Each team had the same projects but all members of a team had a unique project. This way the outcomes of the teams could be compared against each other.

Next in step three, students had to shift their perspective from a single project to the project portfolio and its success. The scarcity of resources forced them to prioritize projects, reschedule tasks and reallocate resources as well as react to the new orders from the company headquarters. This step was the most essential part of the exercise and it involved a lot of co-operation, negotiations and decisions on team rules, working methods under time pressure. After each step, all participants met in a short feedback meeting. These meetings also provided guidance to the next tasks. Finally, at the end of the workshop the instructions for homework or step 4 were given.

3.3 Content Analysis

Content analysis is a popular research method used to determine the presence of certain words, word groups, or concepts in text, speech or some other form of qualitative data. The content analysis has different approaches and here a directed content analysis (DCA) is used. DCA is a structured process guided by existing theory [23] and researchers use the key concepts of the theory as coding categories. In this case, seven elements of the model described earlier created the framework for categorization.

In this paper, content analysis was used for two different purposes. First, it was used to validate the new model introduced in Sec. 2.3. Like always, the model represents the conceptual world and therefore, it is a more or less simplified version of the real world. The aim of model validation is to find out if the suggested model is useful, addresses the right problems and provides accurate information about the system being modeled [24]. The main question, in this case, is how well the new model encapsulates the key elements of the gamified learning of the project business. In order to find this out we used a simple n-gram based content analysis for the student feedback. The analysis was done with Microsoft Azure Machine Learning Studio and the workflow contained the typical data processing steps including data selection, cleaning and preprocessing before extracting the n-grams as shown in Fig 3.

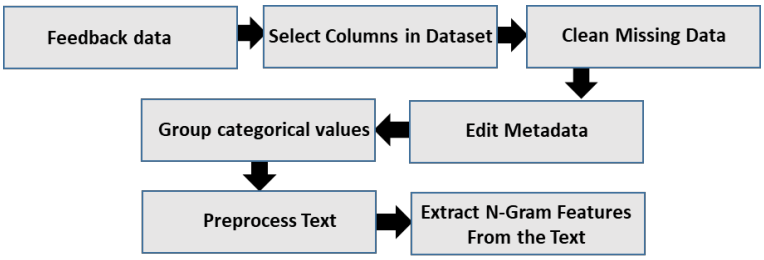

Fig. 4. Workflow to extract n-grams from the feedback data.

The analysis identified 50 key words or word groups from the text. Then the n-grams and the items of the model were manually mapped together to find out how well the model and the content of the feedback matched. The results are shown in Table 1. From 50 n-grams 28 were related to project business and 17 to gamification. Five n-grams were not associated to any item of the model. Bearing in mind that all models are wrong but some are useful, the results suggest that the framework contains the key elements of the phenomenon and it can be used for analyzing gamified learning of the project business.

Table 1. N-grams and their associations to the elements of the model.

Element of the model	n-grams	N
Management system of the organization	manager, project_manager, decision, problem, leader, operate, realization, advantage, company, operation	10
Financial management	budget, anticipate_control, anticipate_control_economy	3
Portfolio management	accordance_strategy, portfolio, resource, work, creation_portfolio, strategy_company, different_project, progress, view, point_view, point,	11
Customer and supplier management	network_subcontract, customer_network_subcontract, network_subcontract_network, customer_network_subcontract_network	4
Learner and learning	group, deal, opinion, like, easily, succeed, understand, able	8
Learning session and environment	time, place, open, think, program, software	6
Instructor and instructing	support, facilitate, follow	3
Not mapped	surely, level, really, accord, , possible	5

Second, we carried out a manual content analysis and assigned all feedback sentences to corresponding categories. As mentioned earlier, we used directed content analysis (DCA) and the new model for classification. If a comment contained opinions related both to the subject of study (project business) and the learning method (gamification), it was classified to both categories. Portfolio management and the learning session or environment were the most often commented areas with 80 and 71 sentences. Instructor and instructions together with customer and support networks received least feedback from students. More details can be found in Table 2.

Table 2. Feedback sentences in each category

Element of the model	Number of statements
Management system of the organization	51
Financial management	40
Portfolio management	80
Customer and supplier management	26
Learner and learning	59
Learning session and environment	71
Instructor and instructing	15

3.4 Sentiment Analysis

Sentiment analysis, in general, aims to identify opinions and determine attitudes towards a particular topic. In sentiment analysis, classification can be done different ways using binary, ternary or ordinal classification. It this study, binary classification (positive or negative) was used. Initial manual classification gave the following results: 232

positive, 79 negative sentences. 47 comments did not have a clear positive or negative attitude and they were therefore removed from the further study.

As pointed earlier, manual classification is an error-prone method. Therefore, a dictionary-based machine learning approach was used to analyze the quality of the manual classification process. The simplified ML workflow is shown in Fig. 4. First, we had to preprocess the data in order to get it in correct format. Second, we divided the data into two parts – one for model creation and second for using it. In model creation, we used supervised learning with a neural network algorithm to create a binary classifier, which divided the sentences either into positive or negative category. Our neural network algorithm used one hidden layer with 100 nodes and maximum 100 learning iterations. After running our model, we compared the outcomes of manual and machine learning classifications and the accuracy of the machine learning model was 0.78. In other words, the algorithm classified 68 sentences differently than we had done manually. After reviewing all differently classified cases, we found out three clear errors in my original manual classification and we corrected them.

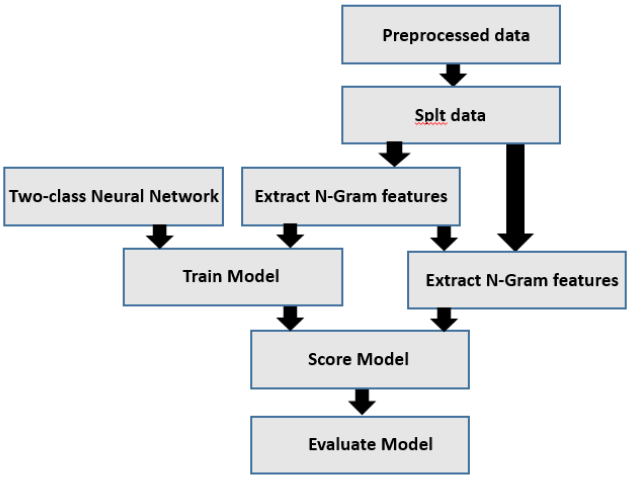

Fig. 5. Simplified machine learning based sentiment analysis workflow.

Finally, we combined the classification and sentiment results to find out the students' sentiment towards different elements of the model. In Table 3 numbers of positive and negative statements, the relative sentiment score and qualitative sentiment evaluation are presented. Sentiment score was calculated as follows: difference between the number of positive and negative statements is divided by the total number of statements. Qualitative sentiment assessment follows the logic presented in [25] for correlation coefficient interpretation. According to the results, students expressed strong positive sentiment towards the management system, portfolio management as well as learner and learning. The only dimension receiving more negative than positive comments and thus a moderate negative sentiment was customer and supplier management.

Table 3. Amount of positive and negative statements and sentiment of each element.

Element of the model	Positive statements	Negative statements	Sentiment score	Qualitative sentiment
Management system	48	3	0.88	strong positive
Financial management	26	14	0.30	weak positive
Portfolio management	75	5	0.88	strong positive
Customer & supplier management	8	18	-0.38	moderate neg.
Learner and learning	56	3	0.90	strong positive
Learning session and environment	41	30	0,15	weak positive
Instructor and instructing	9	6	0.20	weak positive
All elements	263	79	0.54	moderate pos.

4 Conclusions

The study contributed meaningful evidence in two areas. First, the study demonstrated how to support manual content and sentiment analysis with machine learning. In this study, machine learning was used to validate the model and to verify the correctness of the manual sentiment classification in a simple but successful way.

Second, the study provides valuable information on gamification of the project business education. The positive sentiment of the students' feedback clearly points out that their attitude towards the workshop was positive and they found the exercise useful. The more detailed analysis also indicated that a gamified PPM exercise is a good and motivating method to learn how to create and operate the management system, allocate resources, schedule the tasks and prioritize the projects. Similarly, exercises of this kind seem to be a less suitable way to study financial management and especially the customer and supplier network management.

There can be many reasons behind these findings. However, an obvious explanation can be the role of the PPM software in the general information system architecture of a company. The PPM software serves as production information system for a project-oriented company and provides support for managerial decision-making. Organizations have typically dedicated customer and supplier management systems as well as finance and accounting applications and therefore these areas cannot be covered fully in an exercise utilizing PPM software. Further studies are naturally needed to find more detailed information.

Although, sentiment towards learning was strongly positive, student feedback provided also some suggestions how the current learning session and instructions could be developed further. The main sources of criticism were related to the timing. A large number of students reported that their team had to hurry in some parts of the exercise, which limited their possibility to compare different alternatives. Some students also pointed out that they would like to get familiar with the PPM software before the exercise. Based on these comments, the exercise will be in the future divided into three

separate parts before, during and after the exercise. In this new implementation, students will use video tutorials to get familiar with the software before the workshop. This allows students to concentrate on decision-making and teamwork during the learning session. Finally, most of the reporting will be carried out after the learning session offering students more time to reflect their experiences.

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