A Collaborative System for Corporate Performance Evaluation using Gamification and the Learning Vectors Model

Michelle G. Cacais
Instituto de Educação, Ciência e Tecnologia do Ceara (IFCE)
Programa de Pos-Graduação em Ciência da Computação
Fortaleza, Brazil 60040–215
Email: michellecacais@gmail.com

Gilvandenys L. Sales
Instituto de Educação, Ciência e Tecnologia do Ceara (IFCE)
Programa de Pos-Graduação em Ciência da Computação
Fortaleza, Brazil 60040–215
Email: denyssales@gmail.com

***Abstract*—Corporate strategies should contribute to the achievement of the objectives of companies, and, consequently, guarantee their sustainability. In order to keep the employees engaged and committed to their own income, we propose Process Planning and Institutional Evaluation (PIPA), a gamified system that uses the Learning Vector Model for corporate performance evaluation and follow-up of tasks. The system can be applied in entities and companies with the purpose of socializing, motivating or promoting the interaction of users. It was verified through field research, that PIPA improved the performance of the evaluated team and motivated the professionals. The evaluation using the Learning Vector Model helped in the monitoring and the progress of the evaluated ones, since besides accompanying their own income through constant verification and feedback of the supervisors. They also could interact more with the work team.**

I. Introduction

Human Capital consists of the skills and competencies that favor the performance of a work. It is one of the main instruments of resource generation, and the value of this is materialized in the contributions that each one brings to the enterprise. This value can be increased depending on the stimuli offered by the company, for example, a new training or learning a new technology that will help in the processes performed by the employees. It can also be diminished, as in situations where people are induced to a process of obsolescence or when the work environment leads to widespread demotivation of the teams [6]. Thus, it is important to keep Human Capital at a satisfactory level of performance, what is fundamental to the achievement of organizational objectives.

The evaluation of corporate performance can be a great ally to empower, motivate and reward employees. Through this practice, it is possible to focus employee activities properly, align individual goals with the organizational ones, joining performance at work with the medium-term objectives and strategies of the corporation and to maximize the potential of individuals and the team to benefit the organization. The evaluation allows the identification of potentialities and make a career progression, and also, alert those who are not doing well.

The Learning Vectors Model (LV) is an evaluation methodology which uses geometric representations of the performance, making possible the classification in a qualitative and quantitative way [7]. It was originally created to help teachers, tutors and students of distance education, allowing a semi-automatic evaluation. The evaluated ones have continuous feedback and grades are given from an association between a horizontal and a vertical component representing the positive and negative contributions of the interactions between the class.

Besides the constant evaluation, the adoption of a collaborative system could also improve the performance of the teams. This way, we had the idea to create a system for corporate evaluation and follow-up of tasks that uses the LV Model. This have been chosen for being a dynamic tool, since it allows the semi-automatic evaluation. So, there is no time loss for those who already have a running routine and want to facilitate such tasks as employee evaluations. On the other hand, employees will have access to constant feedback, an important resource for those who want to make a career progression and know which points to improve. In addition, it is very intuitive to use, as it is based in the Likert scale of appreciation, what does not require much learning to use and it is easy to remember.

The motivating factor of the program is the gamification, a technique to streamline the learning process or training, and make tedious or repetitive tasks more enjoyable [11]. Consists in the use of game elements in varied contexts, for purposes that are not exclusive of entertainment. Through this practice, you can improve employee performance, promote socialization, and generate a sense of achievement desired by people working for their goals and those of the company. When well used, gamification is an ally that gives positive returns by keeping people focused and at the same time entertained.

This way, we aim to provide a free software to help companies with the corporate evaluation and the follow-up of tasks. PIPA allows monitoring of individual or group projects, promoting more interaction between the members of the team. Here we present the system and the results obtained with our

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field research in a real company.

II. Learning Vectors Model

The Learning Vectors Model is a qualitative-quantitative methodology of non-linear evaluation, that allows constant monitoring for the evaluated ones. LV Model focuses on the interaction of the group with the virtual learning environment, mainly in the use of distance activities. The LV Model is based in dynamic systems and uses vectors and numerical equations in a two-dimensional way, determined by projections on the Cartesian axis. These values represent the bipolarity between the qualitative and quantitative dimensions [7]. Visually, the vector is indicated by an arrow that rotates counterclockwise and allows users to check how his learning is going. Figure 1 shows the vectors of the LV Model.

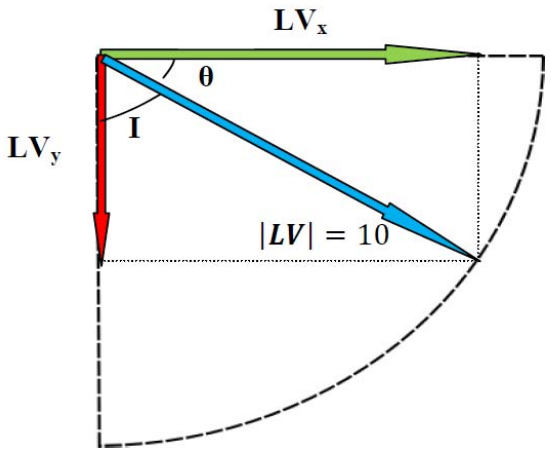

Figure 1: Graphic representation of the vectors of LV Model [7, p. 88]

Through the vectors, the scores obtained by synchronous and asynchronous activities, are presented graphically by means of a vector and numerical values. The vectors have a fixed module of 10 units, with directions starting at the angle $\theta = -90$ (lowest score), until the value of $\theta = 0$ (highest score). The geometric representation consists of the axes LV_X, horizontal projection, and LV_Y, vertical projection. These are related to positivity and negativity factors, respectively. The module of the component LV_X is the score obtained by the user in different fulfilled activities. Equation 1 shows how the value of LV_X is obtained.

$$LV_X = 10 \times cos[(-12\alpha + I)] \quad (1)$$

The calculation of component LV_X takes into account the variable α, value of the standard learning step, stipulated in 7,5, and the variable I, for the total angular variation (Δ_T) of the vector and function of the α angle. The movement of the vector depends on the variable I and α. The value of α was determined as 7,5 for dividing the angle of 90 in equal parts. The vertical component LV_Y, related to the negativity of the performance of the user, is determined by the Equation 2.

$$LV_Y = 10 \times sen[(-12 + I)] \quad (2)$$

From the positivity and negativity factors, similar to bipolar dimensions, it is defined a non-linear pedagogical metric called β Factor, which indicates the level of the user. This factor is related to the qualitative nature of the LV Model, and involves the good and bad results of the contributions of students in tasks performed in the virtual environment. Equation 3 shows the calculation of the β Factor.

$$\beta = \frac{Positivity}{Negativity} \quad (3)$$

The evaluators have access to an iconic representation associated with the scale of qualitative statements (Likert scale) to assign value to the evaluated ones' performance. The LV Icons, similar to emojis, can transmit sentimental aspects, since they are graphical representations of emotions. They present categories associated to the degree of what have been presented, as well as the level of interaction with their peers. Table 3 presents the LV Icons, what they represent and the value associated with them. Table **??** shows the values of each LV Icon that will make part of the equations.

TABLE I: Description of LV Icons

Icon	Description	SC*
	**Very good:** in-depth reflections	4
	**Good:** good reflections	3
	**Regular:** medium reflections	2
	**Weak:** empty content reflections	1
	**Unsatisfactory:** person who assumes a passive position	0
	**Neutral:** messages or files that do not bring contribution	-

* Step Coefficient

Adapted from [7, p. 113]

The values of the LV Icons are called Step Coefficient, and they are important for the calculation of the quantitative grade, influencing the the variable I. The neutral icon does not increment the note, but serves to compute the presence of the person in the activity. It is also important to point out that each type of LV activity has a different calculation that better fits this one.

The LV Model was evaluated and validated, when it was verified the effectiveness of use as a continuous process of formation. The degree of satisfaction of teachers, tutors and students was verified too. The use of the methodology proposed in this system collaborates to differentiated actions

throughout the teaching and learning process. The implementation and testing of the LV Model proves that it is possible to construct a model that relates numeric values with the subjective scale of mentions, and at the same time, presenting qualitative and quantitative values.

III. Related work

Gamification is used in different areas to influence the behavior of people. The work seen in Steffens et al [10] proposes a framework applied to the context of software engineering, to verify the most common issues in the collaboration of the development team and how to apply game elements to overcome this issues. Other work that involves gamification, but applied to the area of enterprise environment, is Stanculescu et al [9]. These paper brings an experiment performed in a multinational company to verify how gamification could influence the performance of the employees. The results provided evidences of how a gamified experience affects the learning and the social behavior of the team in an enterprise context. The level of engagement achieved by them was high in general.

The design and development of systems for corporate evaluation is also a trend. The work seen in Ng et al [5] is one example of a system faced to these topic. The authors explain how they developed a Key Performance Indicators (KPI) system for Maintenance, Repair and Operation (MRO), in order to resolve corporate problems. The results have shown that these program enables the users to conduct analysis and develop a long-term strategy. Another work about corporate evaluation can be seen in Falcinelli et al [4], which evaluates the devices for e-learning aimed at compulsory training. The contributions of this article is the introduction of a UNI-like standard for e-learning, bringing more quality to it.

The LV Model was used in works, as Sales et al [8] and Gonçaalves et al [3]. The first one addresses possible impacts that changes in the management of learning could lead to the distance education. It was compared two methodologies: spreadsheet and the LV Model. It was noticed that, with the constant monitoring of the activities through the LV Model, it is possible to infer changes in the avoidance rate. The second work presents an application of the Instruction by Peers Methodology, associated with the LV Model, to the Forum "Questions and Answers" of the Virtual Learning Environment Moodle. The authors presented a computational conception design of non-linear evaluations, as a result.

TABLE II: Summary of related work and contribution.

Reference	Gamification	Valuation	LV Model
Steffens et al [10]	√		
Stanculescu et al [9]	√	√	
Ng et al [5]		√	
Falcinelli et al [4]		√	
Sales et al [8]			√
Gonçaalves et al [3]			√
PIPA	√	√	√

As seen in Table II, gamification has been used in the corporate environment with success, including to make performance evaluation of employees. Systems to make corporate evaluation are also been developed to make it easier the measurement of the actual performance and make progressions to improve the employee income. LV Model is addressed in an educational context, and has showed itself as an alternative way for qualitative and quantitative evaluation. PIPA is the only gamified system faced to corporate evaluation that uses the LV Model.

IV. PIPA: design and development

The development of PIPA was planned with several studies of which technologies to use and what the final appearance would look. Firstly, technical details were considered, such as the language that would be used, the extensions and libraries that would help the system functionalities and which ones would better fit the proposal. The system was built using the PHP programming language, the script language JavaScript, HTML markup language and the CSS styling language. PHP was initially chosen because it was the same language used for programming the LV Model. In addition, MySQL database was used and some libraries, as Bootstrap[1], to make the application responsive, and RGraph[2], to generate dynamic charts.

The architecture of the program follows the model known as three-tiered application (3-Tier), architectural style in which the system is organized into three main layers [2]. The layers used for the architecture of PIPA are the user interface, the presentation screens that will make the interaction with people; the business layer, with the logic of the application; and the database layer, which will store score information, personal data, and employee appraisal history.

Regarding the classes of the application, a hierarchy was considered. They are three user profiles: administrator, manager and user. The users can be enrolled in activities by managers and administrators, and can access the notes assigned to them, update the status of tasks and send files and comments. Managers are responsible for registering activities, recruiting users for them and doing the evaluation at the end. They will have access to the scores of the users. The administrator is the profile that will handle the system. The manager can do what a manager does, but it is also possible to register people and classify them into any of these categories.

The design of PIPA was inspired by the minimalist design, which has the least graphic resources and texts. It does not mean that it has little content, but rather broadens the essence of what is really important, to the point of making everything else expendable before the very focus of creation [**?**]. The reason for choosing minimalist themes is to focus the attention of the users on the content, that is, tasks, and to divert the focus of graphic elements. The home page of the system can be seen in Figure 2. This screen contains only the dialog boxes for login, with the option of password recovery. Just like the home screen, the others also try to follow the minimalist design.

[1]http://getbootstrap.com/
[2]http://www.rgraph.net/

As soon as the user logs on to the system, he / she will see the last evaluation and the game elements, as ranking and badges. Figure 3 shows the user home. Other information on the home screen is the tasks still waiting to be completed or updated. In the navigation bar it is possible to see the options to view all projects, including those which have been completed and those that are still open, the general projects, and the project register, available only for manager profiles. Figures 4 and 5 show the screens of the projects of the user and general projects, respectively.

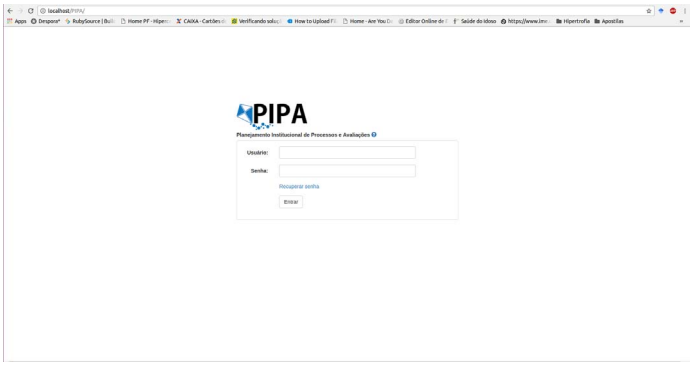

Figure 2: Home page of PIPA

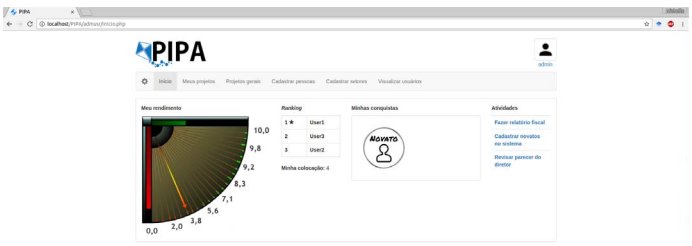

Figure 3: Page of the user of PIPA

The page of projects shows the tasks of the person is registered as a member of a team or individually. This screen shows the number, unique code of each registered task, name, type, priority and whether it is completed or not. This information is previously registered by the manager who opened the task in the system. The types are related to the sectors to which it is related, such as administrative or financial. In the projects tab, it is possible to have an overview of everything what is being produced in the company, not only the processes assigned to the user. This page is important for monitoring the projects of the colleagues. Authors are the people who registered the activity in the system, it means, users with a manager profile. 'Assigned' is related to the person who is intended the task.

The system has been made available to the general community, especially to the target audience of developers and people who want to use PIPA to manage their activities in the

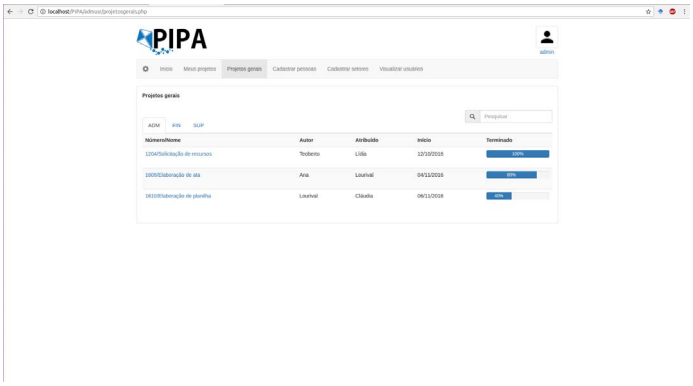

Figure 4: Page of projects of the user

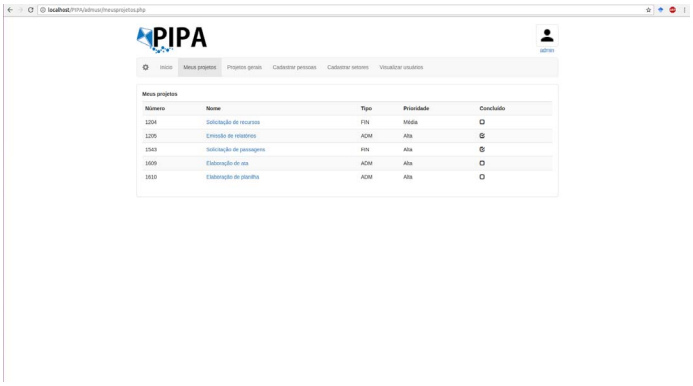

Figure 5: Page of general projects

company. The repository used to store the code, as well as do version control, was GitHub[3], and can be accessed in this link: https://github.com/Cacais/PIPA.

A. *Learning Vectors applied to PIPA*

The score obtained in the system will be made from the Learning Vectors Model adapted to PIPA. Like this evaluation proposal, PIPA point counting system aims at non-linearity. The scores will be given by the same formulas of the LV Model to calculate the positivity and negativity, and the values for LV_X, which indicates the positivity obtained by the person, are used for the point system. For better understanding, the points will be called P. It is possible to observe the relations of the equations to the values obtained in Equation 4. The value of P initially is zero and then the actual P count plus the value obtained by the calculation of the previous value of P.

$$P = P + (10 \times cos[(-12\alpha + I)]) \quad (4)$$

Scores are obtained by calculating LV_X, while total points are the sum of all scores obtained. The ranking depends on the scores, but consists only of the sum in the week, since it is updated weekly. This can also help in accomplishing more tasks, since the more evaluations is achieved, the more

[3]https://github.com/

punctuation and more chances of joining the first positions of the ranking are reached. It is possible to access the average of those evaluated at the time of reporting, but the scores that will appear on the system home page will be the last assessment.

The β Factor is indicative of whether or not to level up. As in LV Model, the β Factor is calculated by dividing positivity by negativity. At the beginning, passing the phase is easier, but with each level reached, the difficulty increases. The levels are numerically divided, for example, level 1, 2, 3, ..., n. There is no limit number. To increase the level, the score obtained must always be the double of the previous one. The calculation of the number needed to reach levels depends on other variables, as unlock badges and keep reasonable valuations.

The LV Model was chosen as a mechanism to support dynamic evaluations and to provide a constant feedback to those involved in the educational process, as well as to verify negativity and positivity. We aim to unite valuation with gamification and encourage employees to adopt positions that improve their performance, but in a fun way, trying to change the paradigm of currently available performance appraisal systems. Through these resources, it is assumed that, having in hand the mechanisms necessary to know their own performance, those evaluated will identify factors that hinder and those that improve performance and take measures to modify or maintain the progress of the task resolutions.

V. Preliminary Results

For the field research, we choose a company of representation of seals and enclosures for the mineral water and beverages segment. It consists of a microenterprise with 7 employees, a receptionist, an accountant, two proprietary partners and three representatives working externally, located in the Passar neighborhood of the city of Fortaleza, Cear. The test period was a little more than a month in the first quarter of 2017. A week before the start of the tests, a meeting was held with the owners and employees for explanations of how to use the system, and then began to use our system. In this context, the system could be an ally to control the activities of everyone who works in person, but especially those who work outside.

A. Methodology

We scheduled a day for installation of the program and explanation of how to use it for all employees. On that day, employees who work externally were also present, and it was possible to teach everyone. A local server was used inside the company and was explained individually as access, register tasks, evaluate and monitor their performance through the system. They all collaborated and seemed excited to use it. After the training, the contacts were left in case any of the employees had any questions or to solve technical problems.

The system was used for a month, more precisely thirty-six days. At the end of the process, another meeting was scheduled for delivery of software evaluation forms and feedback. Two forms were applied: one for self-evaluation and another for supervisors to evaluate the employee's income. The questionnaires had objectives and subjective questions. It was made clear to the participants that the procedure would be anonymous, with the sole purpose of raising data for an academic research, and that colleagues would not have access to the answers. At the end of this period, the forms were collected.

The forms contained questions about the adequacy of the software to the environment, employee satisfaction and performance improvement. Thus, the evaluation models were divided into two parts: one for self-evaluation, aimed at employees in general, including the owners; and one for employee evaluation. The purpose of this would be to analyze whether employees perceived changes in their income and whether the bosses noticed it. All answered the self-assessment questionnaires, while only the owners answered the evaluation of the results of their collaborators.

B. Results

The results of the questionnaire are organized together with the questions to which they refer. In general, the system improved employee performance. When asked about this, they said they were able to pay more attention to how the tasks were going and that the employees were more focused. As for the ease of evaluation, they felt a bit of difficulty at first, but with little time have been able to evaluate. The results can be checked as follow.

1) Questionnaire of the evaluators:

1) Did the employees obtain improvement in income through PIPA?
2) The level of difficulty of evaluating employees by PIPA was:
3) Did the monitoring of the activity of the employees by PIPA helped the company?
4) Did you use to evaluate employees beforehand by any other method?

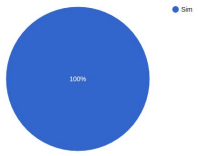

Figure 6: Question 1

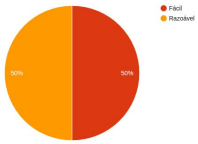

Figure 7: Question 2

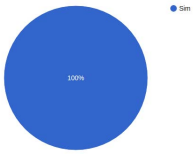

Figure 8: Question 3

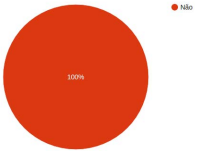

Figure 9: Question 5

2) Self-assessment questionnaire:

1) In a general way, how do you evaluate your experience with PIPA software?

2) In your opinion, do your performance improved with PIPA?
3) Do you think your interaction with others improved using PIPA?
4) Was the evaluation by PIPA a positive, negative or neutral factor?

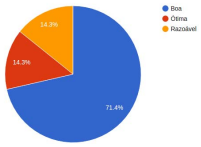

Figure 10: Answers for the first question

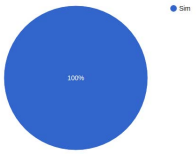

Figure 11: Answers for the sec-ond question

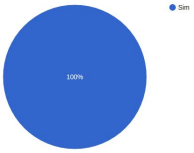

Figure 12: Answers for the third question

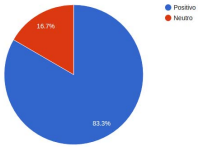

Figure 13: Answers for the fourth question

The questions were elaborated to verify the length of the work objectives. From the responses of the users, it was possible to conclude that the system was able to motivate and interact among the members of the company. Also, the evaluation enabled the evaluators to be monitored and evaluated.

VI. Conclusion

PIPA come out as a proposal of a free code system that aims to stimulate the employees through monitoring of processes and evaluations. This technique proved efficient in engaging users to adopt a certain posture, so employees reach the levels of high performance teams.

Testing process was very helpful in uncovering the strengths and weaknesses of the system as well as collecting suggestions for improvements. The objectives we had at the beginning were verified and it can be concluded that, for this evaluation in the field, the system was carried out in a profitable way, fulfilling the established goals. According to the answers of the questionnaires applied, it is presumed that the one planned in the beginning was fulfilled.

It is expected that PIPA software encourages the improvement of employee performance, which will be stimulated through gaming elements to have more productivity, since mechanisms will be added for constant checking of evaluations and feedback. It is also intended to improve the monitoring of what is being produced in the company, in order to identify armful factors, and thus be able to take preventive measures. This way, both evaluators and evaluators gain in the process. In future works, it is hoped to improve the visual aspect of PIPA, making it more attractive and intuitive to the public and improving the user experience in using it. It is also one of the future objectives to use Fuzzy Logic for PIP Model LV.

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