MATHEMATICAL MODEL OF OPTIMIZING DECISION MAKING FOR WORK FORCE INTEGRATION IN THE KNOWLEDGE SOCIETY

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Abstract:

According to Vygotskian theory, individuals develop within particular cultural groups. Then, as adults, they are likely to integrate in work groups with features similar to their original formative group. The Internet has revolutionised social

organisation and business patterns to bring forth collaboration as a major asset. Our study draws on theories of collaboration-based learning originally developed by Lev Vygotsky and aims to extrapolate them to the business environment. Based on Vygotskian theory and on the stakeholders' interest influence matrix, we will design a method of developing work groups within a company by means of Web 2.0 technologies. By means of statistical analysis, we will determine the optimum configuration for grouping interested stakeholders. Finally, we will set up a mathematical model for organising the required relationships for the correct functioning of a work group that uses Web 2.0 tools to build relationships.

JEL clasiffication: C02, C61, D83

Keywords: stakeholders' interest influence theory, Vygotskian theory, statistical analysis, work group, Web 2.0

1.INTRODUCTION

In the second stage of Web evolution, also known as semantic Web, collaboration is the keyword of any activity carried out online and offline. At present, human labour and activities are governed by collaboration. In our opinion, in a period when all fields of activity are confronted with important changes on short-term notice, the human resources development/ training as well as their increasingly intense professional and social relations need the implementation of Web 2.0 collaborative tools. Our study aims to determine whether the use of a collaborative tool will stimulate/ enhance the level of activities in employees. We believe that Lev Vygotsky's theory can be applied to this issue, by transferring it from the development area into the sphere of company-based professional and social relations. In the following, we will present the Vygotskyan learning theory and extrapolate it to the level of stakeholders interested in adding plus value to a company.

The bases of collaborative learning were laid by Lev Vygotsky, Kurt Lewin (1947), Morton Deutsch (1920) and David and Roger Johnson. (Lund2008) Collaborative learning theory is closely related to the theory of social interdependence. In Morton Deutsch's view, there are three variants of social interdependence: positive, negative and null (no social relations) (Marin,2004). Collaborative learning (Marin,2004) is based on the positive interdependence of persons who work/ study together. Positive interdependence is also known as stimulus-reflex or cooperation-

stimulation interdependence, in other words the members of a group unite their forces to attain a common goal. Consequently, the interaction among persons working together stimulates in a straightforward way everyone's success in attaining a common objective. Vygotsky develops the idea in similar terms (Lund2008). He states that individuals develop socially when collaborating with more capable peers. (Uwe1999) In this context, individuals learn in accordance with their own aspirations to reach the social level they initially planned to attain. As early as childhood, each person builds their individual knowledge, trying to bring down to zero the distance between the level of independent performance and that assisted by the group or the teacher.(site3)

According to Lev Vygotsky, the definition of the zone of proximal development (ZPD) (Uwe1999) is the distance between an individual's actual development level and the potential (probable) development level as determined by the interaction with more skilled peers or under the guidance of a tutor (teacher, adult). (Vygotsky 1978, p. 94) (Uwe1999) (Lund2008), As individual progress is recorded, the potential development level becomes actual and other potential developing levels become visible. (site1) Consequently, an individual's culture and social environment play an important role in the learning process. In Vygotsky's view, learning is a process based on social relations developed between individuals with different development levels (Uwe1999) (Lund2008), namely a more capable individual offers aid/ professional support in acquiring new abilities needed at the work place, a fact that has a positive influence on both parties. The recipient of the information will acquire new knowledge whereas the information provider will gain an enhanced explicit understanding of own knowledge in meta-cognitive terms (Vygotsky 1978, p. 94). Vygotsky claims that only by interacting with others can individuals become aware of their knowledge level and improve on them. He is the adept of direct learning (site1) (Lund2008), from a teacher/ tutor or more skilled peer and maintains that an adult should develop reflective capacities in order to understand new knowledge better. (Uwe1999) (Vygotsky 1978, p. 94).

Based on these theories, we will determine whether positive interaction or the double stimulation concept is achieved during the process of defining relations between parties engaged in the good functioning of a company and the online collaborative environment. Namely, we will investigate if Web 2.0 technology aimed at fostering online communities can take over the role of teacher/ tutor or moderator within work groups formed in a company.

2. Web 2.0 technologies. Aspects of collaboration

According to Friedman, 1962, Grossman, 2005, Jensen şi Wygant, 1990, a company must provide a stable environment for the activities of its employees. (Friedman,1962) (Freeman,1984) (Grossman,2005) (Clark,2010) At the same time, collaboration relations should also exist among stakeholders interested in the progress of the company such as shareholders, customers, employees, suppliers, etc. (Clark,2010) (Grossman,2005) Currently, these can be fostered by means of the Internet, particularly of Web 2.0 tools. The use of the Web 2.0 online tools would definitely be beneficial for maintaining and developing relations among parties interested in a company's welfare. By means of these tools, we can define relations between persons who:

- interact to carry out a certain task. In this case, communities have a provisional character determined by the contract duration. Following such an action, the researcher can analyse collaboration patterns and if the results match the expected outcome, then a similar format will be used for carrying out other tasks. In case of failure, then the history of the relations and the activities developed within the online community can be analysed to identify mismatching among participants.
- 2. interact for continuous training at the work place. Continuous training is a compulsory requirement of modern society. Companies with Internet access have replaced old training methods involving courses organised at preestablished time intervals at physical locations with online training tools. The advantages of these tools pertain to material and temporal conditions so a company's personnel will have immediate access to the needed information. The shift from Web 1.0 to Web 2.0 has brought about enhanced online training tools that have transformed the learning process in a collective effort perfectly matching, in our opinion, Vygotsky's theory.
- 3. interact to establish social and friendship relations between participants to a work community, a fact that will benefit both the company and the persons involved.

The setting up of an online community (Dowling,2005) of stakeholders provides a major advantage to the company because the employer can determine the character of the employees. Based on the history of employees' interaction, the company can define interaction groups in order to obtain maximum results of their work. Moreover, it can offer continuous assistance to each employee by a more skilled tutor. We believe that such assistance would be compulsory at all work places, resulting in advantages for all parties. This statement is supported by Vygotsky's view according to which interactions among individuals allow each party to become aware of their own actual level of knowledge so as to be able to enhance it.

Web 2.0 technology plays a major role in organising stakeholders. The basic idea of Web 2.0 is defining collaboration patterns among subjects involved in solving a problem. Currently, any service/ product or activity is assumed to derive from stakeholders' collective effort. Web 2.0 technologies have all the features and characteristics necessary to support collaboration in all fields of activity.

Until the apparition of Web 2.0 technologies, the forming of work groups within a company was difficult and in many cases, collaboration was not performed at the level and intensity necessary for successful accomplishment of the task for which they had been designed. Web 2.0 technologies allow the uncomplicated creation of groups in accordance to interests/ tasks and compatibilities/ affinities.

3. Statistical method and data processing

The stakeholders' theory relies on the fact that managerial decisions are developed following the analysis/ projection of their impact on the company and on the actors involved in its good functioning (Freeman, 1984) (site2). Based on this theory, we analysed the reactions of a company's stakeholders to the introduction of Web 2.0 technology meant to foster collaboration by means of online communities. More precisely, according to Vygotskyan theory, online communities will be able to play the role of teacher/ tutor or moderator within the work groups formed within a company.

We initiated a questionnaire-based study on a sample of 110 male and female subjects aged between 25 and 65. They had to answer to the question: "Have online communities enhanced professional relations with stakeholders on all levels (information, quality, time) in comparison with the traditional system of establishing such relations?" The participants answered before entering an online community and after they performed within an online community dedicated to solving professional assignments.

The null hypothesis is that there is no significant difference between the answers given in the two stages, respectively before and after affiliation to an online community. The alternative hypothesis is that there is a significant difference between the responses before and after affiliation to an online community.

	First Questionnaire		Total
The 2nd questionnaire	YES	NO	
YES	45	15	60
NO	26	24	50
TOTAL	71	39	110

Table 1. Table of contingency – Observed

Table 1. Author's calculations

The previous table was created based on the following principle: a sample of N>30 answers to a question with YES and NO twice, namely before and after the creation of the online community. By this action, we tested whether the number of YES and/or NO answers given to the first questionnaire differ significantly.

Next, we elaborated a theoretical table of contingency based on the previous step.

Table 2. Contingency Table - Theoretical

	Primul chestionar		Total
The 2nd questionnaire	YES	NO	
YES	38.7	21.3	60
NO	32.3	17.7	50
TOTAL	71	39	110

Table 2. Author's calculations

Based on the data obtained, we continued their statistical processing. The results are: α =0.05; df=1; Chi-square critical value=3,8; p-value=0.01; Chi-square observed=6.3; Sensitivity=0.42 Specificity=0,62. Note should be made that pvalue<0.05, soothe test is statistically significant (confirmed by the values of sensitivity and specificity) but p value does not influence the acceptance or rejection of the null hypothesis. This is based on the values returned by Chi-square observed as compared with the Chi-square critical values.

Chi-square critical values<= Chi-square observed rejects the null hypothesis and accepts the alternative hypothesis, namely that there is a significant difference between the answers before and after the set up of online communities presented in our study. Consequently, in order to increase the quality of task solving, it is recommended that stakeholder communities (groups) should be created. Such an effort would result in added value to work assignments performed by a company's employees.

4. Mathematical model of organizing work relations

An ordered set (M, F, ρ) where M and F are sets and ρ is a subset of the Cartesian product M × F is called a relation between the elements of the M and F sets. If M=F, then the relation is called homogenous; (Purdea,Pop,2003) (Purdea,Pic,1977) (Rignet, 1976) in the contrary case, it is called non-homogenous. If M and F are fixed, then the relation (M, F, ρ) equals ρ . Be it X \subseteq M, Y \subseteq F, $\rho(X) = \{y \in F | \exists x \in X, (x \rho y)\}$

$$\rho^{-1}(Y) = \{ \mathbf{x} \in M | \exists \mathbf{y} \in Y, (x \rho y) \}$$

where x r y means $(x,y) \in \rho$. The relation ρ is called univocal or partial function, respectively function if $\rho(x)$ contains at most, respectively exactly, one element for $\forall x \in M$. Let M be the set of candidates for admission in the economic tertiary education in 2009 and F the set of faculties of economic studies. Between the elements of M and F, we define the relations:

$$x \rho y \Leftrightarrow x$$
 accesses site y

 $x\rho_1 y \Leftrightarrow x$ applies for y

 $x\rho_{2}y \Leftrightarrow x$ is enrolled at y

 $x\rho_{2}'y \Leftrightarrow x$ is enrolled on subsidised places at y

 $x\rho_2$ " $y \Leftrightarrow x$ is enrolled on fee-paying places at y

It results

$$\rho = M \times F \Leftrightarrow \forall x \in M, \ \rho(x) = F \Leftrightarrow \forall y \in M, \ \rho-1(y) = M;$$

$$\rho_1 = \rho_2 \Leftrightarrow \forall y \in F, \ card \ \rho_1^{-1}(y) \le number of places at \ y$$

and

$$\rho_2' \cup \rho_2' \subseteq \rho_2$$

And there is equality if and only if $\rho_2(x) \mid \rho_2(x) = 0$ for any $x \in M$.

The relation ρ_1 , respectively ρ_2 is univocal if and only if each candidate is enrolled/ is accepted at one faculty only. If ρ_1 respectively ρ_2 is a function, then the relation

respectively

$$((x_1, x_2) \in M \times M | \rho_2(x_1) = \rho_2(x_2))$$

is an equivalence relation on M and the set of M's subsets, and for $i \in \{1,2\}$, the correspondence $\{\rho^{-1}(y)|y \in F\} \rightarrow F, \in \rho_i^{-1}(y)$ y carries out a bisections function.

The purpose of mathematical modelling was to exemplify and demonstrate the accuracy of the organisational pattern of participants to a work group to obtain an optimum fusion between information and participants. After organising participants in online communities according to the previous mathematical model, we can determine easily the optimum definition of the relations between parties involved. Thus, the mathematical model is meant to offer a relation pattern necessary for a work group to function correctly within a company that uses Web 2.0 tools to develop these relations. In further investigations, we will elaborate a model of determining/ defining relation patterns within a community whose aim is to solve various tasks by means of methods derived from the game theory.

5. Conclusions

At present, due to the development of the Internet, collaboration has become paramount in all fields of activity. Our research has tried to demonstrate the importance of organising stakeholders in work groups. We based our investigation on Vygotskyan theory, namely on the idea that interaction among persons who work together stimulates everyone's success in attaining a common goal. We believe that Web 2.0 technologies can foster collaboration in such groups.

Based on the stakeholders' theory, we analysed the reaction of stakeholders to the introduction of Web 2.0 technology dedicated to fostering collaboration by creating work groups carrying out a part of their activities on Internet/ Intranet network. Following our statistical study on a sample of 110 subjects, we concluded that creating stakeholder communities (groups) is highly recommendable because the result of such an effort would bring added value to collective work in a company. Then, we deemed necessary to create a mathematical model of work relation organisational patterns for the correct functioning of work groups in a company using Web 2.0 tools.

In our future research, we will elaborate a model of determining/ defining relations within a community whose aim is to solve various tasks by means of methods derived from the game theory. We will also focus on the design of an online device prototype meant to assist the decision maker in the process of accepting/ integrating an individual in a particular work group that would offer a social and professional optimum.

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