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Team collaboration model of a project learning process

Abstract: The ability to create the project team and manage their knowledge is commonly recognized as one the most important quality of the knowledge and innovative organization. The management of knowledge and skills, as well as the management of project competencies has turned out to be essential factors influencing performance of project process. In the paper, the authors present the method and tools for incentive modelling for project knowledge management. The kind of open distance learning systems is represented, that can be used as a model of project process aimed at active behaviour of students in the project development of not only knowledge, but also acquiring of competencies.

Keywords: project learning process, incentive model, project team, competence management, game theoretical model, repository development

1. Introduction

The ability to create the project team and manage their knowledge is commonly recognized as one the most important quality of the knowledge and innovative organization. The management of knowledge and skills, as well as the management of project competencies has turned out to be essential factors influencing performance of project process. In this paper, the method and tools for incentive modelling for project knowledge management is presented. Also the kind of educational systems is examined, that can be used as a model of project learning process aimed at active behaviour of students in the project development of not only knowledge, but also acquiring of competencies.

In open distance learning (ODL) conditions, as an incentive model we consider scenario of a game (interaction, interplay) between the teacher and the students/project team, conducted in a specific education situation and oriented on performing the actions which allow to raise the level of student's involvement in subject-specified task realization and to extend the repository with complex tasks performed in the project (Zaikin et al., 2016).

The project process in every education situation includes the didactic, research and education aspects and takes place at the following levels: cognitive, information and computer-based (Gomez-Perez et al., 2004). At each of these levels the teacher and the students (participants of project team) have their own roles corresponding different competencies in the project and involvement intensity. At the cognitive level assumptions are made and tasks are solved. At the information level the information is exchanged between the participants of the project learning process. The computer-based level is characterized by repository organization and ability to use it. The role of the teacher is to develop an ontological model reflecting the project of the education situation, showing the source of information, formulating tasks and presenting methods and examples of their solutions. All ontological models are stored in the repository (Różewski et al., 2011).

In the discussed approach the project tasks are created on the basis of the ontology and differ in their complexity level (Kushtina, 2006). The proposed scenario assumes that the role of the student is to choose a set of project tasks relevant to his/her competence and solve it. The final grade depends on the correctness of the solution and the complexity level of the tasks. The project tasks solved by the student team and highly graded by the teacher is placed in the repository and will serve as an example solution for other students. All materials stored in the repository are copyrighted. This way the students of the project team participate in the didactic activity and we assume that it will raise his/her self-esteem, what has a positive influence on learning, meaning that it will be a part of the project team reward function. At the same time filling the repository with a wide spectrum of high quality solved project tasks gives satisfaction to the teacher, for his/her laborious, requiring intelligent efforts of preparing the repository and this will make up the *teacher's reward function* (Small and Venkatesh, 2000).

Teacher's and students' interaction with the repository can have a research character. We assume that thematically the content of the repository is in concordance with the teacher's scientific-research interests, what causes appearance and extension the repository with the tasks differing from the complexity level. For helping to solve project tasks stored in the repository, the teacher will pay more attention and spend more time with the students. We can assume that for a certain part of students participation in common research is a challenge and the obtained results are an extra added value (Miller and Brickman, 2004).

The educational aspect is reflected in the *repository development* as a common success of all participants of the project process. Making the material copyrighted shows and visualizes the contribution and involvement of each participant of the project. Feeling the synergy effect motivates to develop collaboration skills and tolerance. Collaboration in distance conditions requires a more logical formulation of questions and answers. All this reflects the interests of both the teacher and the students (Tuckman, 2007).

2. Organization of team collaboration in developing the project

The problem of organizing the team collaboration in project learning process is very similar to the problem of selecting staff for project development, when the project goal, time and financial limitations have already been established.

The project's success guarantee consists of:

1) Sufficient summary competences of specialists involved in the project.

2) The way they are organized (specific scenario, game model).

3) Assessment of information certainty that participants will be able to use both outside and inside the project through mutual communication.

The development of a formal model that will take into account the listed constituent factors is complicated and needs an explanation of the source that predetermines the scale of specialists' competence or a description of how to describe them. In innovative situations, which include the problem of developing a project in ODLS conditions (the need to respond to market requirements), it is not possible to rely on a fixed scale of competences with an orientation on graduate profiles.

For this it is important to find the right method to determine the required competences. The selection of competent partners, regardless of the criterion for assessing the results of solving this problem, should be considered within the framework of motivational management. Motivational management (as opposed to institutional and information management) consists in creating a stimulation system aimed at achieving maximum competences at a minimum cost.

Tasks of this type are considered in game theory (Owen, 1975). An analysis of the interests and goals of participants in the process of developing a project shows that the solution to this problem can be implemented in the form of a cooperative game, where the players' goal is the aggregate profit of a stable coalition (Malawski et al., 2004). Methods of team creation for the consortium implementing scientific research project involve the use of multiple criteria decision making. One of them is the criterion of having competences. In the analysis of the criterion the teams-candidates for the project are compared from point of the view of having competences required to solve the task. The teams, which have all the competences necessary to execute the project are preferred. If the team does not have all the required competence must incur a cost related with getting the missing knowledge and skills. It can be stated that the usefulness of the team according to criterion of having competence is inversely proportional to the cost of obtaining the missing competencies required for effective implementation of the task (Różewski and Zaikin, 2015).The model of the process, which use an analysis of the cost expansion of the ability of person or team is shown in figure 1.

The whole process of determining the cost of the missing competence consists of three stages:

1) identification of a set of competencies required for the task.

First, based on the description of objective and scope of task, all the competencies needed to effectively implement it must be identified. In the simplest case, if the task of the project is one of the typical frequently realized tasks is possible to find standardized competencies using one of the existing standards or norms. When the task is atypical and any standards of competence does not exist, the skills necessary to implement this task may be identified through expert analysis. The expert making analysis may base to their own experience and various sources of knowledge in the field of the task. These can be all kinds of books, articles, compendia of knowledge, whose analysis can help identify the typical competencies related to task domain. For example, the competencies related to solving mathematical problems or solved using mathematical methods can be identified on the basis of the Classification of mathematical terms (called Mathematics Subject Classification) which categorizes as taxonomic mathematical discipline (American Mathematical Society, 2000);

2) identification of a set of competencies having by the team.

On the basis of a set of competencies required to complete the task identified at the first stage it is then possible to identify these competencies in teams-candidate. This can be achieved by analysing their experiences in the form of previously completed projects, experimental research, publications, reports and so on. The most reliable source of knowledge about the competence of the team is to analyse the formal qualifications of its members, or obtained diplomas, degrees, certificates of completion of training, etc;

3) determining the cost of obtaining the missing competencies required for the task.

Quantitative analysis of the cost extension of the competencies by comparing the sets of the competence of the team with the set of skills required to accomplish the task. This analysis is performed using mathematical models of competence outlined in section 2. The costs of extension of the competencies for each team-candidate are used for comparing them according to the criterion of having competencies in the proposed method of choice of teams for the consortium.

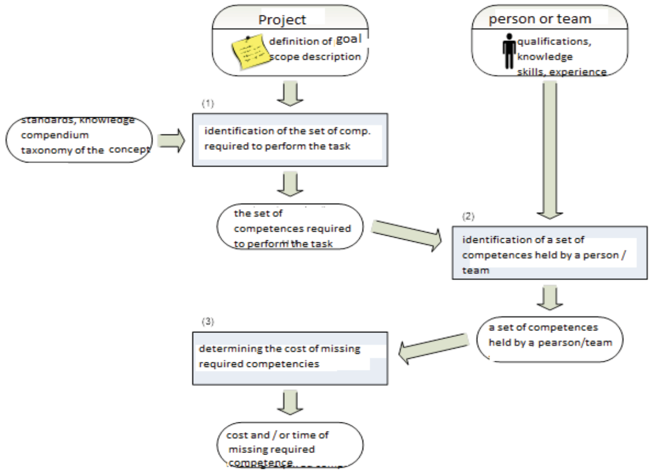

Figure 1 – Model of process to analyse the competence to perform a project

3. Team collaboration model and competence expansion algorithm to perform the project task

Basic components of the project situation

a) $\{P, N^P, S^P\}$ - participants of the project situation,

where N^P – co-ordinator of project P, $S^P = \{s_k\}$ -project team, where $k=1,2,...k$ - index of team participant.

b) $\{p, C^P, G^P\}$ - ontological/hierarchical graph of the project domain (figure 2),

where p – is a root vertex of the graph $C^P = \{c_1^p, c_2^p, ...c_{i*}^p\}, i = 1,...i*$ – competence portions of the project / subordinate nodes of the ontology graph, $G^P = \{G(c_1^p), G\{c_2^p\}, ...G(c_{i*}^p)\}$ – a set of tasks, having to solve in the project, $G(c_i^p) = \{g_1^i, g_2^i, ...g_{j*}^i\}, j = 1,....j_i*$ - subordinate tasks of the project competence c_i^p,

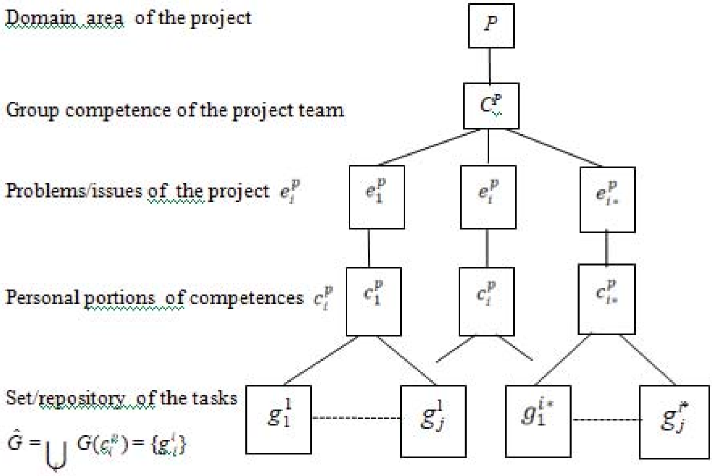

Figure 2 – Hierarchical graph of the project domain

c) $\hat{G} = \bigcup_i G(c_i^p) = \{g_j^i\}$ -set/repository of the tasks,

where g_j^i – task *'j'* consisting for competence portion c_i^p,

j=1,....j$_i^*$ – index of task

i=1,...,i* – index of acquired competence,

d) $q(g_j^i), j = 1,....j*, i = 1,...i*$ – degree of complexity of a task, which can be expressed in numerical scale (depends on number of concepts included in the task, solution method, etc.)

$0 \le q(g_j^i) \le 1$

e) $R_g^q = r(e_i^p, g_j^i), j = 1,....j*, i = 1,...i*$ – relationships between the vertices of the graph *P*

If the task g_j^i is a *base task* of the problem e_i^p, then between them exists the *relationship* $r(e_i^p\ g_j^i)$ of value

$$0 \le r(e_i^p, g_j^i) \le 1$$

f) Power of personal competence required for solution of the problem

is determined on *the principle of maximum*

$$\alpha(c(e_i^p)) = \underset{j=1,..j*}{Max}\ (c(g_j^i)\, r(e_i^p, g_j^i))$$

g) Minimal potential of personal competence, required for solution of the problem

$$\beta(c(e_i^p), i = 1,....i*$$

h) Relation of a project and problems

$$R_i^P = \{r(p, e_i^p)\},\ \ i = 1,....i*$$

If the problem e_i^p is a *base problem* of the project *P*, then between them exists the *relationship* $r(p, e_i^p)$ of value 0< $r(p, e_i^p)$ $\le$ 1.

i) Power of group/team competence required for solution of the project

$$\alpha(c^p) = \underset{j=1,j*}{Min}\ (c(e_i^P)\, r(p, e_i^p))$$

is determined on *the principle of minimum*

Decision variables:

a) Project team $S^P = \{s_k\}$, where *k=1,2,...k**- index of project participant.

Numerical characteristics of the project participant:

$\alpha(c(s_k))$ - power of competence of participant $s_k \in S^P$

$\beta(c(s_k)$ -potential of competence of participant $s_k \in S^P$

b) Matrix of assignment of the project problems/issues to participants of project team

$$H = h(\|e_i^p, s_k\|), i = 1,\dots i^*, s = 1,\dots s^*$$,

where

$$h(e_i^p, s_k) = \begin{cases} 1, \text{if the problem } e_i^P \text{ is assigned to participant } s_k \\ 0, \text{otherwise} \end{cases}$$

Constraints on decision variables

Relation one-to-one of the project problems and team participants

$$\lambda_{s_k \in S} h(e_i^p, s_k) = 1 \qquad \lambda_{q_i \in Q^P} h(e_i^p, s_k) = 1$$

i.e. only one problem assigned to one participant and vice versa.

Criteria

3 kinds of individual competence:

1) The power of person competence more required competence of the problem

$$\alpha(c(s_k)) \lambda \alpha(c(e_i^P), s_k \in S_1, e_i \in E_1$$

It is no important potential of the person $\beta(s_k)$ and minimal potential of personal competence $\beta(c(e_i)$, required for solution of the problem. Here no cost and time are required for solving the problem e_i

2) The power of person competence less required competence of the problem

$$\alpha(c(s_k)) < \alpha(c(e_i^P)$$

and potential of the person $\beta(s_k)$ more minimal potential of personal competence $\beta(c(e_i)$, required for solution of the problem

$$\beta(s_k) > \beta(c(e_i)$$

Here some cost and time are required for solving the problem e_i

$$f[\alpha(c(e_i^P)) - \alpha(c(s_k)], s_k \in S_2, e_i \in Q_2$$

3) The power of person competence less required competence of the problem/issue

$$\alpha(c(s_k)) < \alpha(c(e_i^P)$$

and potential of the person $\beta(s_k)$ less minimal potential of personal competence $\beta(e(q_i)$, required for solution of the problem

$\beta(s_k) < \beta(c(e_i)$

Here additional efforts are required to increase the potential of the person and after it some cost and time are required for solving the problem e_i

$f[\alpha(c(e_i^P)) - \alpha(c(s_k)] s_k \in S_3, e_i \in E_3$

Therefore the criterion is the following

$$f = f_1 + f_2 + f_3 = \lambda_{s_k \in S_1} \lambda_{e_i \in E_1} h(e_i^p, s_k) \times 0 +$$

$$\lambda_{s_k \in S_2} \lambda_{e_i \in E_2} h(e_i^p, s_k) f[\alpha(c(e_i^P)) - \alpha(c(s_k)]] +$$

$$+ \lambda_{s_k \in S_3} \lambda_{e_i \in E_3} h(e_i^p, s_k) f[\alpha(c(e_i^P)) - \alpha(c(s_k)] + g[\beta(c(e_i) - \beta(s_k)]$$

Conclusion

1. To summarize the above considerations, competence is a general concept, which defines the ability to perform different patterns of behaviour based on accumulated knowledge and experience. While the qualifications relate to all kinds of formal evidence confirming possessing by person the specific knowledge and skills. Simply put, the qualification is formal evidence of specific competences.

2. Computer-aided management of human resources in the project requires the use of formal model of competence, which enables to quantify the usefulness of the research team to participate in the project. The above definitions and integrated model of the competence reflect only the nature of the competence and don't provide tools for quantitative analysis of competence. In cases when exact quantitative analysis of competence is required, it is necessary to rely on a model that will provide mathematical foundations and tools to carry it out. This model can precisely describe the competences, their comparison, determining the cost of the competence increase, determination of the adequacy of the

competence of the individual to the aim of the tasks and to solve many other problems of a quantitative nature.

3. The results can be used by a decision-maker or, on the basis of the organization consisting of several organizational units. Basing on knowledge assessments of participants of the project or organizational units the method allows to estimate the cost of team's training necessary to meet the requirements of the project. The competence expansion costs are then used as criterions to assign project tasks to participants of the project defined. All steps of the proposed approach were illustrated in the case study, where it is proposed a practical method of team's knowledge estimation in the knowledge and innovative organizations.

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Быстров В.В., Маслобоев А.В., Датьев И.О.

Инструменты цифровизации управления кадровой безопасностью регионального производственного кластера

Аннотация: Для повышения эффективности управленческой деятельности в сфере обеспечения кадровой безопасности социально-экономических систем разработан модельный и программный инструментарий информационного управления кадровой безопасностью региональной экономики. Созданы прикладные средства информационно-аналитической поддержки управления кадровой безопасностью регионального производственного кластера: прикладная онтология и предметно-ориентированный тезаурус кадровой безопасности, комплекс имитационных моделей прогнозирования кадровых потребностей, архитектура мультиагентной системы сетецентрического управления кадровой безопасностью для организации сервис-ориентированной цифровой платформы.

Ключевые слова: кадровая безопасность, управление, поддержка принятия решений, моделирование, региональный производственный кластер

Исследование направлено на решение актуальной научной проблемы повышения эффективности управления кадровой политикой региона с целью обеспечения баланса между спросом и предложением трудовых ресурсов для осуществления устойчивой