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Knowledge workers' collaborative learning behavior modeling in an organizational social network

Przemysław Różewski [a,*], Jarosław Jankowski [a], Piotr Bródka [b], Radosław Michalski [b]

[a] Faculty of Computer Science, West Pomeranian University of Technology, Szczecin, Poland
[b] Institute of Informatics, Wrocław University of Technology, Wrocław, Poland

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ABSTRACT

Computations related to learning processes within an organizational social network area require some network model preparation and specific algorithms in order to implement human behaviors in simulated environments. The proposals in this research model of collaborative learning in an organizational social network are based on knowledge resource distribution through the establishment of a knowledge flow. The nodes, which represent knowledge workers, contain information about workers' social and cognitive abilities. Moreover, the workers are described by their set of competences, their skill level, and the collaborative learning behavior that can be detected through knowledge flow analysis. The proposed approach assumes that an increase in workers' competence is a result of collaborative learning. In other words, collaborative learning can be analyzed as a process of knowledge flow that is being broadcast in a network. In order to create a more effective organizational social network for co-learning, the authors found the best strategies for knowledge facilitator, knowledge collector, and expert roles allocation. Special attention is paid to the process of knowledge flow in the community of practice. Acceleration within the community of practice happens when knowledge flows more effectively between community members. The presented procedure makes it possible to add new ties to the community of practice in order to influence community members' competences. Both the proposed allocation and acceleration approaches were confirmed through simulations.

1. Introduction

There is no doubt that the concept of collaboration is closely related to learning. The collaboration process, in which people interact, employs self-critiquing (reflection); inquiry and arguing skills are a solid base for the (social) constructivism pedagogy that is commonly utilized in modern companies (Schaf, Müller, Bruns, Pereira, & Erbe, 2009). Today, almost every company wants to become a knowledge-creating company. Knowledge management pioneer Nonaka, Toyama, and Nagata (2000) claims that making personal knowledge available to others through social networks is the central activity of a knowledge-creating company. It takes place continuously and at all levels of an organization.

In the knowledge management area, the main focus rests on information technologies (IT). The problem of how knowledge can be shared effectively among workers using organizational social relationships has been marginalized (Dong, Johar, & Kumar, 2012). Prior research on knowledge management shows that the proper arrangement of organizational social relationships significantly impacts the efficiency of knowledge sharing. Researchers have noticed a move from a technological-based knowledge management strategy to a socialization-based knowledge management strategy as companies seek to more effectively facilitate knowledge sharing.

Recent works bring some insight to the problem. Long and Qing-hong's (2014) study investigated how to divide users into collaborative learning groups. They utilized the users' educational interests to group them into customized clusters. In each cluster, a genetic algorithm was adopted for collaborative learning group division based on a user's knowledge level in order to approximate the optimal development of a collaborative learning group. Another approach to the problem of efficient design and the use of knowledge flows in order to maximize worker knowledge level (over a planning horizon) through sharing in different organizational environments was presented by Dong et al. (2012). In this approach, organizations that support multiple skills and have workers with varying levels of knowledge in these skills were examined. The algorithm developed identified the best set of

* Corresponding author at: West Pomeranian University of Technology, Zolnierska 49, 71-210 Szczecin, Poland. Tel.: +48 (91) 449 55 72.
E-mail address: prozewski@wi.zut.edu.pl (P. Różewski).

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knowledge transfers in each period in order to maximize the total weighted knowledge level of a given organization over a planning horizon. As a result, the mixed integer programming model and its related heuristics were formulated to facilitate the systematic analysis and understanding of effective knowledge flows. Neither of these approaches included a community-of-practice component or roles in the knowledge flow.

Depending on the analysis concept, there are different approaches to collaboration network analysis (Różewski, 2010). The queuing theory can be used to efficiently optimize a telecommunications network (Różewski & Ciszczyk, 2009). In such a situation, the node represents various computer stations that are able to signal regeneration or data distribution. Another approach to collaboration network analysis is from the workflow point of view (Wang, Shen, & Qi Hao, 2006). In this context the network's unit is a task and we are looking for workload optimization. Moreover, the nodes correspond to workstations with assigned technological operations. The last approach to collaboration network analysis, which is used in this article, treats the collaboration network as an agent's network (knowledge network). The analysis can then use Social Network Analysis (Newman, 2003), network game theory (Jackson, 2008), competence set theory (Yu & Zhang, 1990), or ontology theory (Gomez-Perez, Corcho, & Fernandez-Lopez, 2004). Thus, in the network competence set, knowledge/information object or concept, and knowledge resources all circulate. The control parameters are communication efficiency, completeness, and credibility. The emergency and synergy are the work paradigm. The node represents a social agent.

The insertion point of the research arises with the dilemma of homogeneous and heterogeneous group creation in the network. Graf and Bekele (2006) show that heterogeneity can increase learning effects in collaborative learning. High-ability students help low-ability students, as a result the former can remember the knowledge they have acquired longer. One of the ways to create heterogeneous groups is by taking learning styles into consideration. Felder and Silverman's (1988) model provides four dimensions: perception, reception, processing, and understanding. A similar framework was designed by Conole, Dyke, Oliver, and Seale (2004). Based on a bipolar set of learning styles from the literature, algorithms for heterogeneous group creation are proposed (Bernacki & Kozierkiewicz-Hetmańska, 2014). Moreover, the topic of recommended learning material that is suitable for students' characteristics, needs, and preferences was presented in Kozierkiewicz-Hetmańska's work (2011).

In this article, the research problem addresses collaborative learning through knowledge flows in the design of an organization. Knowledge flows are the most important elements of the collaborative learning process in an organizational social network. For this reason, we want to understand exactly how they move through the network. Besides the cognitive and social abilities of the knowledge workers and their relationships, the knowledge that flows is the main influencer on the workers' collaborative learning process. In addition, an effective collaborative learning process results in competence development. Moreover, we assume that knowledge flow is more intense in a community of practice. As a result, in the presented research, we want to establish different methods to make knowledge flows more efficient with respect to the different roles in the network and the community of practice. In the proposition, a number of concepts are combined into one model and all of them will be described in the upcoming sections of the article.

The approach presented in this article extends the available models toward the concept of knowledge workers, who are described by information concerning their competences (in vector format) and mask data structures, which reflect a worker's ability to labor in a specific area. Moreover, knowledge diffusion in the network is achieved by knowledge resource broadcasting. The workers' collaborative learning behavior is described through a computational model and allows for the analysis of different worker configurations and relationship statuses.

This article is divided into four parts. The following section covers the theoretical background related to the problem. In particular, attention is paid to competence development in an organization, knowledge flow in the description of communities of practice, and the collaborative learning development process. The model for a knowledge network in an organization is described in Section 3. The model is based on the formalization of knowledge resources that are transferred by knowledge flows throughout the network. Section 4 describes the method for role allocation in an organizational social network. The roles involved are those of knowledge facilitator, knowledge collector, and expert. The next section analyzes the problem of community of practice acceleration through the addition of new relationships.

2. Theoretical background

2.1. Competences in an organization

There are a number of ways to understand the concept of competence depending on the origin of the field of science or humanities being referenced. The French word "compétence" was originally used to describe the capability of performing a task in the context of vocational training (Romainville, 1996). Later on, the word found its place in general education, where it was mainly related to the "ability" or "potential" to act effectively in a certain situation. Perrenoud (1997) claimed that competence was not only limited to the knowledge of how to do something but also reflected the ability to apply this knowledge effectively in different situations. Grant and Young (2010) analyzed and summarized the skills and knowledge approach to competence.

The requirements for the development of a competence-based approach come from staff development and deployment; job analysis reveals the need for new approaches to knowledge modeling in organizations (Radevski, Dika, & Trichet, 2006). In modern companies, the competence-based approach is a main component of employment planning, recruitment, training, increasing work efficiency, personal development, and managing key competences. Draganidis, Chamopoulou, and Mentzas's (2008) study showed that a competence-based approach can identify the skills, knowledge, behaviors, and capabilities needed to meet current and future personnel selection needs that are in alignment with various strategic and organizational priorities. Moreover, a competence-based approach can focus on the individual as well as group development plans in order to eliminate the gap between the competences needed for a project, job role, or enterprise strategy and those that are currently available. Sanchez (2004) reported some challenging issues that must be addressed with a competence-based approach, including: the development and use of a consistent set of concepts and vocabulary for describing competences, the classification of different types and levels of activities within organizations that collectively contribute to achieving competence, and the articulation of interactions between different types and levels of organizational activities that are critical in the processes of competence building and leveraging.

The representation of competence in the information system is based on the ontology framework (Draganidis et al., 2008; García-Barriocanal, Sicilia, & Sánchez-Alonso, 2012; Jussupova-Mariethoz & Probst, 2007). Macris, Papadimitriou, and Vassilacopoulos (2008) described why the ontological structure is appropriate for competence processing. The most important consideration is that ontology allows for the definition of an organization-wide role

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