COMPUTER-SUPPORTED INFORMAL LEARNING IN AN ELECTRONIC VILLAGE OF LOCAL INTEREST

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ABSTRACT
We present an approach and a collection of tools, which advance a perspective on learning, informed by sociological theory of 'group stabilization' and 'situated action-reflection'. The former serves as a theoretical guide to reach consensus on the stages involved in computer-mediated learning in the context of on-line engineering communities and accordingly to inform the design of suitable information technology tools. The latter helps to establish an analytical foundation of learning through performing. The tools described offer an integrated mechanism for continued activity-oriented learning which helps learners compile shared representations of engineering problems and artefacts, while maintaining their own individual work practices, tool of preference and pace of working. Such shared representations provide the common ground for learners to perform common tasks and accomplish the learning objective

KEYWORDS
Computer-mediated activities, organizational learning, informal and unintentional learning

INTRODUCTION

This paper is concerned with organizational learning in the context of on-line engineering communities. Community-oriented learning can be viewed as a process by which knowledge that is created during the execution of tasks is incrementally captured, structured and maintained so that this knowledge can be accessed or delivered when needed to inform individual or group work practices. Typically, this type of learning is outside an instructor-student-course context and more likely to be encountered in organizational- and/or community-oriented settings. It is therefore important that we increase our understanding of the functions online communities can serve in a learning organization and what factors influence participation and learning outcomes in these voluntary contexts. A learning organization is typically conceived as a decentralized complex of differentiated sub-units that require some mechanism of integration (Hackbarth & Grover, 1999). Such form of organizations rely heavily on distributed information processing, which in turn, is characterized by the norms and local practices of the sub-unit, customized styles of work and situational influence on problem solving. The sub-units are somewhat autonomous with regards to decision making and may indeed adopt different perspectives upon the same or a similar problem, use different tools to accomplish a task, or generate outcomes which may vary in format, type and scope.

We consider a learning environment to be a particular instance of a learning organization where individual learners constitute the sub-units. Integration of sub-units (e.g. learners) in a learning environment involves building bridges across all potential mismatches to enable and facilitate rich communication, co-operation amongst learners, sustainable growth and persistency of shared knowledge and learning outcomes. Information Technology can play a crucial role as a facilitator of this type of information flow, sharing and knowledge generation. However, the appropriation of such a benefit is strongly dependent upon short-, medium- and long-term targets. These vary from technological aspects to culture, which in turn, determine willingness of individual members to engage

in learning endeavors. One important aspect relevant to the present work is the availability of tools, which allow knowledge to flow and be articulated in generative manners. These tools include low-level communications infrastructure, and more importantly, platforms of integrated and interoperable domain-oriented software.

This paper focuses on computer-supported tools fostering informal / unintentional learning (Huber 1991) and 'double-loop' learning (Argyris, 1977) in virtual experience-based organizations. Our particular interest is on patterns of learning which are observed in the context of an experimental electronic village in the area of tourism, namely eKoNEΣ (Akoumianakis et al., 2007), which is under development in the region of Crete, Greece. The distinctive characteristic of the approach presented is that it becomes the tools' responsibility to progressively help the learning community to reach higher levels of group stabilization and thereby engage in performing tasks successfully. Performing is considered the most advanced level of stabilization to be reached by learners, as well as the ultimate stage where 'learning through doing' can actually take place as a distributed cognitive activity. Specifically, during performing, each member of the learning community observes, reflects and acts upon (i.e. explores, critiques, negotiates) each other's work practices and outcomes irrespective of viewpoint, work-oriented practices or tools being used.

The paper is structured as follows. In the next section we describe the perspective motivating the present work and then present a brief theoretical account of learning in small groups to motivate discussion in subsequent sections. Then, we provide a brief account of a case study from the eKoNEΣ experimental electronic village of local interest. The case study reveals alternative patterns of learning enabled through the interaction between eKoNEΣ communities of practice undertaking the jointly the development of new 'shared' resources. In the discussion section, we recapitulate on the experiences of the case study to identify two prominent but complementary roles of Information Technologies in modern learning environments. The first is the provision of a non-contemporary medium for building learning communities and the second and perhaps more important, is that information technology should provide the tools to promote, encourage and facilitate novel forms of learning. To this effect, the paper identifies integration problems at different levels.

LEARNING IN SOCIAL CONTEXTS

In this section we provide an overview of key issues characterizing informal learning in small groups in an attempt to compile requirements for advanced computer-supported learning environments. We approach this task from three distinct perspectives. Firstly, we consider learning from an anthropological point of view linking the learning endeavor and outcomes to the underlying learning community context. Then, we review sociological research into small group activities, highlighting the distinct stages through which learning is achieved. Finally, we describe the role of codified knowledge and shared experiences as learning facilitators.

Community-based learning

The theoretical construct of communities of practice (Lave & Wenger, 1991; Wenger, 1998, 2001; Wenger, McDermott, & Snyder, 2002) builds upon anthropological perspectives that examine how adults learn through the performance of social practices rather than focusing on environments intentionally designed to support learning. A community of practice is defined as 'a group of people who share an interest in a domain of human endeavor and engage in a process of collective learning which strengthens 'sense of community' (Wenger, 2001, p. 1). Communities of practice are self-organizing systems of informal learning, and they differ from other communities in three main ways. First, they focus on a domain of shared interest, and membership implies a level of competence and knowledge of that domain that distinguishes members from other people. Second, community members interact and learn together by engaging in joint activities and discussions, helping each other, and sharing information. Through these interactions, they build relationships and form a community around the domain. Third, they develop a shared collection of experiences, stories, best practices, and ways of solving problems. This shared repertoire of stories and case studies becomes a common knowledge base

on which they can draw when facing new situations. Irrespective of the domain of practice, such communities consist of people with a common interest in a domain of expertise, who voluntarily learn together about practices that matter to them. Shared learning and interest are what keeps these communities together; in other words, they cannot be mandated into existence, and they exist only as long as participation has value to their members.

This theoretical framework proposes that it is in these communities of practice that people learn the intricacies of their job, explore the meaning of their work, construct an image of the organization, and develop a sense of professional self. Such communities address not only the technical acquisition of skills required by a specific practice, but also the informal and social aspects of creating and sharing knowledge. In a community of practice, individuals learn to function and become enculturated into that community's practices, language, viewpoints, and behaviors.

Community stabilization and learning

In an on-line community of practice, basic communication technology can only facilitate a few types of learning patterns, particularly those experienced during the initial phases (i.e. forming stage) of a learning community. Examples of such 'primitive' forms of learning include establishing contacts, expressing opinion in the course of discussions, obtaining access to materials (i.e. finding out about available documents), group awareness, etc. For this type of learning, established Internet-based, Intranet or Web technologies of prevailing use suffice. However, the 'well-being' of the community will depend critically and principally upon its ability to experience the kinds of advanced learning patterns encountered in the course of more involved forms of co-operation, such as norming, storming and performing. For a community to enter these phases, it will require more advanced tools to facilitate true and advanced learning leading to new knowledge construction. In these phases, the community is likely to require support beyond communication and sharing of information. Specifically, such tools should be geared towards decision-support, argumentation, recommendation and collaboration. To attain these objectives requires bridging across different problem-solving regimes, tool perspectives and tool outcomes. Such bridges will inevitably facilitate inter-operation and interdisciplinary insight amongst the members of the learning community, which in turn are pre-conditions for the generation of new knowledge - a measure of learning.

In this paper we are primarily interested to investigate learning as a form of a social contract between members of a small community, whose dynamic behaviour is tuned to the situation in which activities take place (Suchman, 1987), and it is affected as much by motivational issues as by cognitive issues (Csikszentmihalyi, 1990). Moreover, when such communities are formed as coalitions of distinct organizational units, it is more than likely that members may differ with regards to skills and competences, theoretical and problem-solving perspectives upon a particular class of problems, as well as the tools used to conduct their work and accomplish specific targets. In such a setting, a measure of success is not only the capability of individual group members to attain specific design targets, but also the degree of group stabilization attained in the medium to long-term. Sociological research into small group activities (Tuckman, 1965; Pieper, 2001) indicates that group stabilization is strongly correlated with the group's ability to effectively move from the initial *forming* and *storming* stages into *norming* and *performing* (see Figure 1). In other words, the higher is a group's degree of stabilization as the group progressively moves from forming (i.e., trying out activities, expression of opinions), to storming (i.e., resolving conflicts) and into norming (i.e., enfolding group coherence, setting group objectives) and performing (i.e. carrying out activities towards the group's mission) (Pieper, 2001).

Clearly, technology can help to facilitate all four phases in a group's lifecycle. However, as the group moves from initial to more advanced stages, the demands upon technological tools differ since the type of exchanges and communication patterns between group members becomes more targeted and task-oriented. Thus, infrastructure-oriented and mature technologies, such as basic hardware, local or wide area networks, intranets etc., can help the group attain formation and storming where relatively simple information flows are involved to address, typically, well-structured and understood problems. Once the group's objectives are consolidated, then technological support is needed to facilitate higher-order

social contracts such as cooperation, collaboration and negotiation to address less well-understood or ill-structured problems (Simon, 1973). It is this kind of technology that should bridge the gap that may exist between perspectives on design, tools used to achieve goals and corresponding outcomes. In the course of these stages, information flows are more complex, as they typically extend beyond simple message exchanges (i.e., expression of opinion) to encompass constructions and artefacts in a variety of forms, including mock-ups, segments of code, explanatory narratives, argumentation, etc.

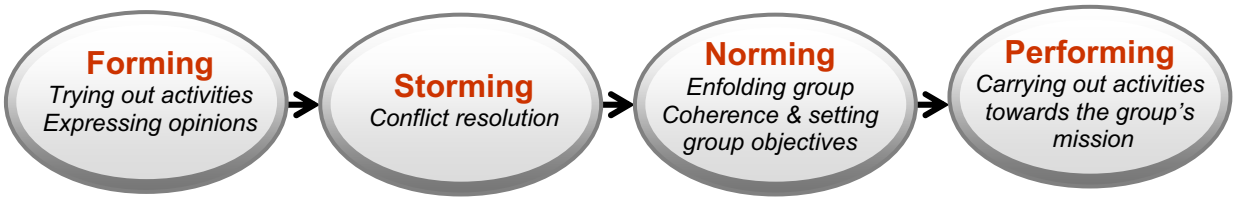

Figure 1. Stages in team stabilization

Codified organizational experience and learning

In designing systems, which aim to facilitate learning through performing, experience (past or current) becomes an important facilitator, provided that it can be codified, explored, revisited, reconstructed and reused. Experience in this context refers to all artefacts generated through the group's transition from the early stage of formation and storming to the more advanced stages of norming and performing. Moreover, such experience includes tangible artefacts codified as models, documents and messages exchanged, as well as tacit (folklore) knowledge, which is embedded into prevailing practices and is less persistent. The distinguishing feature of experience-based learning (or experiential learning) is that the experience of the learner occupies central place. This experience may comprise earlier events in the life of the learner, current life events, or those arising from the learner's participation in activities implemented by other community members (e.g., mentors or facilitators). Much of the impetus for experience-based learning has been a reaction against an approach to learning which is overly didactic, teacher controlled and involving a discipline-constrained transmission of knowledge. It supports a more participative, learner-centred approach, which places an emphasis on direct engagement, rich learning events and the construction of meaning by learners.

LEARNING TROUGH PERFORMING IN THE eKoNEΣ ELECTRONIC VILLAGE

In the context of on-going collaborative research and development, we are developing technology and tools for building local electronic villages as unified collaborative spaces for managing electronic services of local interest / scale. Our primary interest is to design a collaborative environment with tight coupling between virtual and local physical activities, affording a variety of alternative forms of productive and social relations between members. In the reminder of this section, we will focus on the mechanisms and the tools available to facilitate a particular type of organizational learning which is strongly grounded on distributed information processing, local practices and the folklore and experience-based knowledge of participants in an electronic village.

The eKoNEΣ electronic village

In its basic form eKoNEΣ seeks to facilitate community problem solving towards new services by fostering tight collaboration between multi-sector community groups, frequently referred to as coalitions or collaboratives. Coalitions, referred to as eKoNEΣ squads, may be permanent or temporal depending on the set targets. In all cases, eKoNES squads are dynamically formed with an explicit focus on performing tasks to yield added-value products and services in a domain of application, namely tourism, which is of critical importance to sustainable development in the region of Crete. eKoNEΣ squads collaborate to respond to the increasing need for quality in tourist service provision. It turns out that tourists consider very important to be able to plan their vacation to meet personal preferences, not only in terms of destination, duration, or type of accommodation, but also in terms of supplementary local or regional facilities and services. In response to this, the industry is continuously striving for differentiation by creating packages for certain tourist profiles known or anticipated to

express demand. However, these packages are not the result of an articulated user-oriented demand. Rather, it is 'revealed' or 'filtered' demand based on the judgment of intermediaries. eKoNEΣ adopts a slightly different approach. It seeks to bring real end user demand to the surface and have eKoNEΣ squads collaborate to meet this demand. To this end, learning is an essential part of the squads lifecycle and a critical factor for maintaining adaptability (i.e. responsiveness to changing environments, flexibility in work practices, customizable services, etc). Nevertheless, this type of learning is not necessarily intentional.

In doing so, squads are moderated by an eKoNEΣ administrator - a role undertaken by a human and augmented by computer-based tools. This role serves two supporting functions. The first is to act as an experience broker mediating between the virtual assets of an eKoNEΣ electronic village and the active eKoNEΣ squads. In this capacity the eKoNEΣ administrator offers advice on problem solving strategy, tools, and best practices, based on existing experiences. The second function of the eKoNEΣ administrator is acting as a silent critic to mine the data generated by a squad as it works to accomplish its set targets and to codify these data in the form of persistent new knowledge. The tools supporting the eKoNEΣ administrator's work range from simple communications-oriented tools to model building and advanced activity awareness visualization. At the core of these tools is the eKoNEΣ ontology which serves as the main knowledge and experience management tool.

A package has a designated lifecycle (i.e. initialization, elaboration, deployment and tailoring) and is constructed incrementally through negotiation and as an amalgamation of shared resources. Thus, it represents the measurable outcome of a learning organization, which starts with a common pool of resources and proceeds to fulfil an articulated demand. During the lifecycle of a package, eKoNEΣ squad members engage in a variety of exchanges to express opinion (best on own experience), resolve conflicts and establish norms for contributing to a package. For instance, an eKoNEΣ squad may be formed to fulfil demand for local accommodation and entertainment of a group of people interested to visit archaeological sites in a region for a specified period of time. To this end, candidate partners may express opinion, raise concerns and accordingly confirm / withdraw participation in a squad. Once participation is committed squad members collaborate to resolve conflicts, establish norms, suggest solutions and place competitive bits, etc to facilitate package transformation from an abstract state to concrete offerings. End users may also take part in the compilation of the package by expressing interest, requesting modifications, choosing among alternatives, making reservations, etc. The distinctive characteristic of such packages is that they represent added value for all parties concerned including the end user, while they are owned by the coalition for as long as the package is offered. For example, in the tourism sector coalitions may be formed on-demand to facilitate transportation, local accommodation and entertainment of a group of people interested to visit archaeological sites in a region for a specified period of time.

From a functional point of view, an eKoNEΣ electronic village resembles an experience factory (Basili et al., 1993) to facilitate the operation of eKoNEΣ squads. The basic architecture of such an experience factory is depicted in Figure 2 and is adapted from the original formulation of the experience factory by Basili et al., 1993. Parallels are to be drawn between the software development organization and the experience organization in the original formulation of the experience factory and our notions of an eKoNEΣ squad and eKoNEΣ experience organization respectively. However, the processes being executed by an eKoNEΣ squad are different from those designated to software development organizations by the Quality Improvement Paradigm in the experience factory. Similarly, the eKoNEΣ experience organization depicts domain-specific functions and workflows as shown in. Our interest in the context of this paper is to presents insight on the type and form of organization learning, which can be supported by such a functional architectural abstraction.

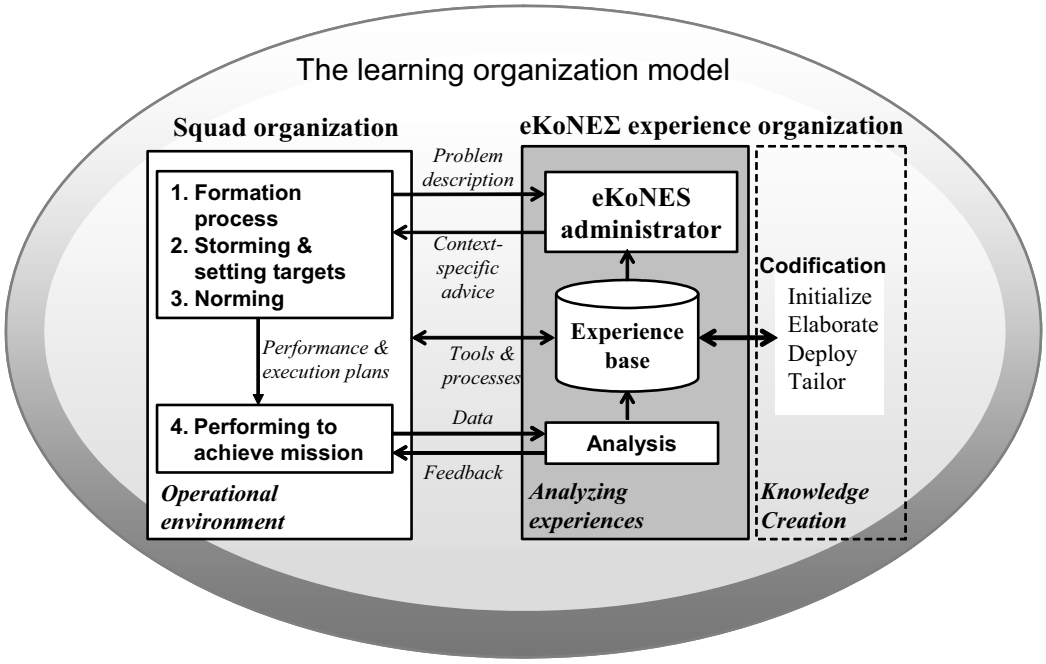

Figure 2. The learning organization model

eKoNEΣ as a learning organization

Organizational learning in eKoNEΣ is a creative part of performing tasks. This type of learning departs from the classical student-tutor-course model and is governed by rules of thump, own practices and tacit knowledge. As Huber (1991) emphasized, this type of learning is not necessarily conscious or intentional. It relies heavily on distributed information processing, which in turn, is characterised by the norms and local practices of the sub-unit, customised styles of work and situational influence on problem solving. As there are no explicit incentives, learning becomes more of a by product of the collaborative activity, rather than a well defined and structured process. To facilitate this type of learning, knowledge that is created during working is incrementally captured, structured, re-constructed and maintained so that this knowledge can be accessed or delivered when needed to inform and feed-though individual or group work tasks. To facilitate these tasks the eKoNEΣ experience organization functions not only as an active experience repository but also as organizational memory making persistent all contributions leading to the creation of a new knowledge. This memory component may be conceived as an active organization-wide resource consisting of (a) the 'collective' minds of a squad (b) record of the exchanges between squad members in the course of working with particular emphasis on the exchanges highlighting relationships (c) tangible shared and collaborative artefacts such as guidelines, manuals, models, prototypes, and other forms of electronic materials (d) practice rules, work processes and technologies and (e) products or services offered (Cross & Baird, 2000).

In terms of organizational learning roles, eKoNEΣ offers two distinct role classes, namely the role of the eKoNEΣ administrator (or broker) and the role undertaken by members of an eKoNEΣ squad. It should be noted that a less active role of the end user is also assumed but the scale of its involvement in the collaborative activities is limited to expressing the demand and personalizing packages. The eKoNEΣ administrator resembles the role of a mentor or the teacher in conventional learning communities, but this role is not about 'teaching' people how to achieve their vision. It is about exploiting the capabilities of squad members to foster learning for everyone through incentives creation, guided instruction and task-oriented support. In other words, an eKoNEΣ administrator seeks to help squad members develop systemic understandings of the tasks agreed, apply common rules to achieve intermediate and final goals and in doing so to comply with the community's set norms. The eKoNEΣ administrator stands neutral as to the specific work practices adopted by members, the tools used to execute work or the intrinsic aspects of work. On the other hand, the role of the squad members is to capitalize upon the administrator's advice, revisit and adapt own practices and frequently reconstruct

experience (thereby learning), so as to appropriate the benefits of participation for own and the squad's well being.

DISCUSSION

The eKoNEΣ scenarios as currently implemented provide insights which extend beyond the prevailing view on adaptive learning – which is about coping – contributing to generative learning or 'double-loop learning' (Argyris 1977) in virtual organizations. This is evidenced from the fact that progressively eKoNEΣ squads translate an abstract request into a new construction (i.e. new package), not previously available and owned by the squad. Moreover, such a construction is not only persistent and therefore can be reused, but also it can be analyzed in terms of underlying rationale and critical decisions leading to the final outcome. Thus, eKoNEΣ supports Senge's (1990) view that generative learning is about creating and as such it requires 'systemic thinking', 'shared vision', 'personal mastery', 'team learning' and 'creative tension' between the vision and the current reality. On the other hand, eKoNEΣ also encompasses adaptive learning. Adaptive or single-loop learning focuses on solving problems in the present without examining the appropriateness of current learning behaviours. Adaptive organizations focus on incremental improvements, often based upon the past track record of success. Essentially, they don't question the fundamental assumptions underlying the existing ways of doing work. This adaptive learning is obvious in the operation of an eKoNEΣ squad, but it need not be the only or the prevailing type of learning. In other words, the essential difference is between being adaptive and having adaptability. It is claimed that the challenge for eKoNEΣ is to establish mechanisms for maintaining adaptability throughout a squad's lifecycle. The essence of this is that eKoNEΣ squads need to maintain themselves in a state of frequent, nearly continuous change in structures, processes, and goals. It is precisely this mode of operation that enables organizations to learn about a variety of design features and remain flexible.

As eKoNEΣ is still in its early stage of development, in this paper we cannot present evidence of whether or not this challenge is achieved. However, we are able to reflect upon the computational support required to facilitate organizational learning in networked communities. Our current thinking is that advanced learning communities, which break away from the traditional teacher-learner-course model, are still in an infant stage. Despite recent progress, it will take much more of mere technology integration to provide effective, efficient and enjoyable means for computer-mediated, community-oriented learning. The challenge has a theoretical and an engineering component, both of which amount to the ultimate objective of designing the new virtualities, which will promote, encourage and facilitate the learning endeavour. At the theoretical level, the prime challenge to be addressed is that community-oriented organization learning is a social contract involving more than networked resources. It assumes stabilized partnerships, trust, active and continuous engagement, willingness to participate, and commitment to change and adapt. To this effect, it may be viewed as a process of knowledge construction, tuned to the situation in which it takes place (Suchman, 1987), and affected as much by motivational issues (Csikszentmihalyi, 1990), as by cognitive issues of the learning community.

The engineering challenge entails the use of information technology for two primary purposes. The first is to provide a non-contemporary medium for forming the learning community in which knowledge and effort required to solve a problem are distributed among various participants. For this purpose, existing internet/intranet/Web technologies suffice, as they are conductive to learning - training sessions, seminars, and group meetings can all be conducted and documented. In this manner, not only is individual performance improved, but also learning materials and the learner's perceptions can all be accessed and stored for later use. The second and perhaps more important role of information technology is providing the tools (software infrastructure) which will promote, encourage and facilitate situated and action-oriented learning. Our claim is that modern organisations will increasingly need knowledge management tools to attain integration of diverse problem solving perspectives, tools used in problem solving situations, and tool outcomes. Such integration is needed to facilitate three knowledge attributes, which are critical in a learning community, namely, sharing, flow and the generation of new knowledge, which is in effect, a measure of learning. Such environments should

exhibit several characteristics, which are briefly described below. They should be integrated systems of inter-operable components to provide a greater scope for learning. In this context, an integrated system implies a computational tool that bridges across alternative problem solving and / or regimes, the tools that serve them, and the humans that employ them. On the other hand, the notion of inter-operable components means that different tools facilitating alternative learning perspectives, can expose data to, and receive data from, one another, so as to support the broad variety of learning experiences through an evolutionary and persistent computational protocol. Moreover, the scope of such computational environments should not be limited to mere propagation of a particular type of knowledge, but should also facilitate knowledge construction as related to the new virtual spaces likely to emerge and the new range of end user experiences likely to be encountered. To facilitate this task, design environments should allow for knowledge to flow and be articulated in generative manners.

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