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Teachers' professional development in a community:

A study of the central actors, their networks and web-based learning

Essi Ryymin[1], Jiri Lallimo[2], and Kai Hakkarainen[2]

Author for correspondence, e-mail: *essi.ryymin@edu.hel.fi*

[1] University of Tampere, Faculty of Education, Research Centre for Vocational Education

[2] University of Helsinki, Department of Psychology, Centre for Research on Networked Learning and Knowledge Building

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Contributions by authors:

Essi Ryymin has collected and analysed the data, interpreted the results and wrote the manuscript. Jiri Lallimo and Dr. Kai Hakkarainen have provided theoretical and methodological guidance during the research process.

Abstract

The goal of this article was to study teachers' professional development related to web-based learning in the context of the teacher community. The object was to learn in what kind of networks teachers share the knowledge of web-based learning and what are the factors in the community that support or challenge teachers professional development of web-based learning. The findings of the study revealed that there are teachers who are especially active, called the central actors in this study, in the teacher community who collaborate and share knowledge of web-based learning. These central actors share both technical and pedagogical knowledge of web-based learning in networks that include both internal and external relations in the community and involve people, artefacts and a variety of media. Furthermore, the central actors appear to bridge different fields of teaching expertise in their community.

According to the central actors' experiences the important factors that support teachers' professional development of web-based learning in the community are; the possibility to learn from colleagues and from everyday working practices, an emotionally safe atmosphere, the leader's personal support and community-level commitment. Also, the flexibility in work planning, challenging pupils, shared lessons with colleagues, training events in an authentic work environment and colleagues' professionalism are considered meaningful for professional development. As challenges, the knowledge sharing of web-based learning in the community needs mutual interests, transactive memory, time and facilities, peer support, a safe atmosphere and meaningful pedagogical practices.

On the basis of the findings of the study it is suggested that by intensive collaboration related to web-based learning it may be possible to break the boundaries of individual teachership and create such sociocultural activities which support collaborative professional development in the teacher community. Teachers' in-service training programs should be more sensitive to the culture of teacher communities and teachers' reciprocal relations. Further, teacher trainers should design teachers' in-service training of web-based learning in co-evolution with supporting networks which include the media and artefacts as well as people.

Keywords: professional development, web-based learning, social network analysis, phenomenography, central actors, teacher community, teachers' in-service training

1. Introduction

In-service training of web-based learning has been widely offered to teachers by a variety of development projects, interventions and training programs. New teaching and working practices have been created and technology-supported pedagogical models implemented and further developed within schools (e.g., Ryymin, Veermans & Lakkala, 2005)(43). It has been understood that new knowledge as regards the development of new skills and perspectives is strongly related to the working environment and organizational culture of communities of practices, where, for instance, the roles and relationships of workers have an impact on professional development and knowledge creation. (Senge, 1990; Ruohotie, 1996; Wenger, 1998)(47)(40)(62).

At its best, new knowledge related to the development of new working practices flows freely among members of a working community. Also, when promoting technology-supported educational change in schools, the traditional way of disseminating knowledge from authors to teachers or from trainers to trainees has been unsuccessful. It has been realized that when establishing new technology-related innovations it is important to strengthen teacher communities and networks (Granger, Morbey, Lotherington, Owston & Wideman, 2002; Ilomäki, Lakkala & Lehtinen, 2004; Supovitz, 2002)(14)(29)(51). Instead of linearity, new knowledge develops in networks of development participants; ideas and practices extend upwards, downwards, across and around and factors like trust and emotional support have significant influence on the process. (Hargreaves & Fullan, 1998; Triggs & John, 2004)(23)(53).

The goal of this study

The main aim of this study is to answer the question, “How do teachers contribute to each others' professional development in their working environment when implementing web-based learning?”

According to earlier experiences in teacher in-service training it seems that there are usually active adopters among teachers in development projects, who promote new pedagogical ideas as well as offer formal and informal peer support to their colleagues (e.g., Ilomäki, 2002)(28). From these presumptions the following research questions have been designed: Are there exceptionally active, central actors in the teacher community who collaborate in the field of web-based learning as well as share and mediate the knowledge related to web-based learning more than their colleagues? In what kinds of networks do

these central actors act and what kind of knowledge they mediate? What are the factors in a teacher community which support teachers to learn the skills of web-based learning? On the other hand, what are the challenges related in knowledge sharing of web-based learning in the community? By answering these questions the goal in this article is to open new perspectives on teachers' professional development related to implementing web-based learning in schools. This new knowledge may be of particular benefit to teacher trainers, as well as other adult educators, to see the wider context where teachers act and interact today instead of, as traditionally seen, only classrooms and staff meetings. The new aspects offered by this study may encourage the teacher trainers to realize that teachers are not only “participants” or “learning partners” in educational interventions, but creators of constantly renewing knowledge. The teachers' role as knowledge mediators is even more significant in technology-promoted educational change than it may have been considered before.

The key concepts of the research

The key concepts of this research are *professional development*, *web-based learning*, *teacher community* and *central actors*. In the following sections these concepts are described briefly to introduce readers to the research context and the starting points of this study.

Professional development

According to Beairsto (1996) the concept “intellectual development” involves an extension into the unfamiliar and the emergence of new concepts, skills and behaviours. Thus “professional development” might be used to describe the process of extending into qualitatively new areas of knowledge or ability. In this article, teachers' professional development is reflected in the context, where teachers develop new skills and practices of web-based learning. In this process they are considered to learn new working practices and acquire qualitatively new areas of knowledge.

Web-based learning

Web-based learning refers in this study to the implementation of new, web-based learning practices in teaching. The teachers in this study implement a web-based learning environment (http://www.opit.wsoy.fi) which is software designed for supporting problem-based and collaborative pedagogical practices in schools. It includes several tools for the purpose, for instance, a discussion forum, personal and shared (group) portfolio files, project management tools and learning materials related to the subjects and content areas of the Finnish comprehensive and secondary school (www.oph.fi) curriculum.

The teachers of this study planned and implemented so-called blended courses in their teaching: the web-based learning environment was used in supporting face-to-face studying. For instance, pupils had problem-solving discussions on their learning tasks in the discussion forum, created groupwork in the shared files or made learning material rehearsals with peers (or independently) in the web-based learning environment. The open distance courses or only virtual teaching were not organised in this intervention.

Problem-based and collaborative learning refers in this study especially to *progressive inquiry learning* (Hakkarainen, 2003)(17). Progressive inquiry means a sustained process of advancing and building knowledge characteristic of scientific inquiry. It entails that new knowledge is not simply assimilated but constructed through solving problems of

understanding. An essential aspect of this kind of inquiry is to engage collaboratively in improving shared knowledge objects; hypotheses, theories, explanations, or interpretations. Through intensive collaboration and knowledge building, resources of the whole learning community may be used to facilitate advancement of inquiry. Facilitation of progressive inquiry at school appears to require changing in the traditional division of cognitive labour between the teachers and students and to encourage students to take responsibility for their cognitive (e.g., questioning, explaining) and metacognitive (e.g., goal-setting, monitoring, evaluating) aspects of inquiry (Bereiter & Scardamalia, 1987A)(6). However, it is important to realize, that progressive inquiry is an abstract model, which can be applied in various ways in an actual educational setting, and the differences in the pedagogical arrangements have substantial effect on the realisation of the process.

Further, it is important to emphasize here, that the focus of this study is not on the pedagogical models or practices, but on the teachers' experiences on knowledge sharing and professional development. The pedagogical models and practises of technology-supported inquiry learning are further presented and discussed in other articles (e.g., Ryymin et al., 2005; Ryymin, in press)(43)(44).

Central actors

Central actors are teachers, who, according to the results of this study, play a central role in their community related to web-based learning. They are situated in the centre of the communication structure of the community; they have more interaction about web-based learning with their colleagues than other members of the community on average.

Teacher community

In this study*, teacher community* means a school's personnel, which is in practise in charge of teaching. It includes the all teachers of the school and the principal, the two school assistants, the school secretary and the two teacher deputy heads, who assist the principal in addition to their regular teaching work. The terms “school” or “school organization”, instead of “teacher community”, wasn't found relevant to this study, because in an educational context it refers to the formal school system which also includes students and local educational authorities. In this study, the focus is on the teachers in one certain school.

2. Innovative perspectives for rethinking teacher development in schools

In the following sections an overview of the latest findings from educational research related to the teachers’ professional development, collaboration and promotion of new technologies is presented. In addition, some basic principals about learning in social interactions and intelligent actions are reflected on. Criteria for choosing and presenting this particular literature are that it opens new perspectives on teachers' professional development in a collective context.

Relational perspective to teachers’ professional development

Ruohotie (1999) introduces a colleague-related insight to professional development: *relationship-based learning*. It underlines horizontal growth and interactive relations in working life. The professional development of a person includes constantly increasing competence, which results from both developing expertise and expanding personal networks. The relationship-based learning is closely related to the concept of *protean career* (Hall, 1976)(20), which involves the idea that the main source of professional development in working life is the peers and other relationships at work (Hall & Mirvis, 1996; Hall, 2004)(21)(22). According to Ball and Cohen (1999) as well as Leithwood (1999) it is important to pay closer attention how teachers learn from and in practice and from their colleagues too. Wenger (1998) introduces the concept of *communities of practice* and emphasises the meaning of practices in the process of knowledge creation. Knowledge creation and learning take place through complementary processes of participation, which means the daily, situated interactions and shared experiences of members of the community working towards common goals.

The debate on learning and knowledge creation in organizations has been empowered by many contributors in the last decade (e.g., Senge, 1990; Nonaka & Takeuchi, 1995; Starkey, 1996, Beairsto & Ruohotie, 2003)(47)(37)(50)(4). The idea of learning in an organizational context has its basics in the principles of learning through joint activities and interaction with others; the central importance of *sociocultural theorists.* For instance for Vygotsky (1981), the source of knowledge, and the “higher psychological processes that are involved in the construction of knowledge, is to be found in the cultural activities in which the learner engages with others, and in the interaction that accompanies, directs and reflects their shared endeavours” (see in Wells, 1994)(60).

Bereiter (2002) writes about *knowledge-building community*. Knowledge building can be described as collaborative working for developing conceptual creations, for example practices and theories. One of the benefits of knowledge building is that it makes the thinking of the participants with different expertise open and perceptible. For this purpose new technologies, such as web-based learning environments can offer valuable support for the process. (Scardamalia, Bereiter, McLean, Swallow & Woodruff, 1989)(45).

Creating learning communities for teachers

The professional development of teachers' aims for better quality of learning and the development of these two proceeds generally hand in hand in learning communities. Wells (1994) wrote already over a decade ago, that teachers should be encouraged to model those same qualities as they work together to improve the climate and opportunities for learning that they provide for pupils. “If the climate for learning in the classroom could be transformed through the creation of a community of collaborative inquiry and conversation why not in the staffroom as well? Since the same principles apply to all learners, teachers, too, might welcome the opportunity to become inquirers into their own practice in collaboration with other members of the community of their peers and colleagues. And if this were true for teachers why not administrators too? And finally, might these various communities of inquiry not benefit from collaborative links between, as well as within, them?” (Wells, 1994, 10)(60).

According to Wells (1999) an opportunity for learning with and from others, “the zone of proximal development” (Vygotsky, 1962; 1978)(54)(55), applies potentially to all participants, and not simply to the less skilful or knowledgeable. From that it follows that it is not only children who can learn in the zone of proximal development; learning continues

over the life-span, and can at all ages and stages be assisted by others. In further, the sources of guidance and assistance for learning are not limited to human participants who are physically present in the situation; absent participants, whose contributions are recalled from memory or encountered from semiotic artefacts, such as books, maps, diagrams, and works of art, can also function as significant others in the zone of proximal development.

A fresh point of view on the development of new technologies at school is offered by Triggs and John (2004); they found that teachers' professionalism develops in various communities, where new knowledge, ideas and practices extend upwards, downwards, across and around. One of the central features that underpin teachers' professional development is interaction that involves knowledge exchange as the basis for knowledge transformation.

Building on different theories generated from the basis of sociocultural tradition a paradigm for investigating human intelligent activity is also emerging. Characteristic of these approaches is an emphasis on the role of cultural-historically developed tools and artefacts in human intelligent activity (Cole, 1996)(10). Latour (1993; 1999) examined heterogeneous networks that consist of human and non-human actors in the frame of actor-network theory. These actors form clusters, associations of humans and nonhumans that can be called collectives. Scardamalia's and her colleagues' (1989) innovation of using computers to support collaborative knowledge building is one practical example. According to Bereiter and Scardamalia (1987B) intellectual performance develops only through sustained intellectual efforts and a commitment to break one's boundaries.

Basing on the same theoretical principles, Hakkarainen and his colleagues (2004B) have represented the concept of *networked intelligence*, which means that intelligence cannot be located inside the participating agents but is embedded in their mutual relations and relation to supporting artefacts and the task-environment. Networked intelligence refers also to those individual and collective knowledge structures, practices and reasoning processes that allow the individual or community to function intelligently in its environment. This kind of collective intelligence can arise from three sources: the structure of the social systems, its formal and informal relationships (Blanning & King, 1995)(8). However, the notion of networked intelligence should not be understood to mean that intelligence embedded in artefacts or environment somehow automatically produces significant gains in individual cognitive competence.

Some researchers suggest that the information and communication technologies substantially transform human's intelligent activity by providing more powerful and flexible tools for individual and collaborative creation, elaboration, and sharing of digitalized and dynamic representations. Computers provide tools for mastering, organizing and sharing cognitive tools and, thereby amplify individual and collective learning, thinking and problem solving (Hakkarainen et al., 2004B; Perkins, 1993)(19)(38).

When promoting new, technology-supported pedagogical practices in schools, it has been understood that *teacher collaboration* and *teacher communities* have a crucial role to play (e.g., Granger et al., 2002; Ilomäki et al., 2004; Sleegers, Van Den Berg & Geijsel, 2000; Spillane, 1999)(14)(29)(48)(49). Yet, transforming social practices is difficult. There are tensions between new and traditional pedagogical practices within the development projects, which must be respected (Grossman, Wineburg and Woolworth, 2001)(15). According to some studies, it takes several years of effort before teachers start using

information and communication technology intensively in preparing and conducting their instructional activities (Hakkarainen, Muukkonen, Lipponen, Ilomäki, Rahikainen, & Lehtinen, 2001)(16).

3. The context of the study

The study was carried out in an upper secondary comprehensive school in the Helsinki area. There were 300 students and 29 teachers, a principal, two school assistants and a school secretary working in the school. Students of the school are from 13 to 16 years old and they study in seventh, eight and ninth stages of compulsory education. In addition, there were two preparatory classes for immigrants and two supplementary classes (so called 10th classes) with emphasis on Finnish language teaching. In 2004, the school had a second pilot year for a web-based learning environment, although they had had emphasis of ICT (information and communication technology) in the curriculum since 1995. In this two-year pilot project, the school implemented the Opit web-based learning environment (www.opit.wsoy.fi), which is the software of the main Finnish commercial learning material producer.

The empirical data for this study was collected in the second year of piloting. There had been afternoon workshops for the whole teacher community about the use of the learning environment at the school. The training has been offered by the software producer's teacher trainers. In this training all teachers of the community had been encouraged to implement web-based learning in their teaching as blended courses, including both face-to-face learning and learning by support of the web-based learning environment. Teachers were also offered to use their official planning time to plan new courses and exchange experiences on their trials. Three (3) of the teachers had also been participating in the three-month intensive training program outside of school. This support was offered by the local educational authority. The pedagogical goal of this program was to introduce teachers to how they could support especially inquiry learning (Hakkarainen, 2003)(17) by web-based learning environment. The purpose of this study is not to and this is why is not introduced here.

It is good to remind here, that the original initiative to pilot the web-based learning environment in teaching had been offered by the local educational authority of Helsinki. However, in the interviews of this study, the principal and the teachers described that the community had made a decision to participate after joint reflection in a staff meeting. The web-based learning environment that we describe in this article was piloted altogether in ten (10) schools from elementary to secondary stages in the region. Besides this project, there were several other web-based learning environments under piloting in Helsinki schools. In the city of Helsinki, these projects were situated in both the local as well as the wider national frame of reference and also as part of the policy of promoting web-based learning in schools. The latest national curriculum reform (in 2003) in Finland includes progressive inquiry learning and web-based learning (learning in networks, technology-supported learning) in the national curriculum of nine years comprehensive school (http://www.oph.fi). In Helsinki there was also a special emphasis on the development of web-based learning at all educational levels (http://www.hel.fi). The goals of this process were

to develop innovative pedagogical practices supported by web-based learning environments, and finally, to find one pedagogically and technically sustainable web-based learning environment for the permanent use in schools in the future (http://www.edu.hel.fi).

4. Data collection and research methods

Social network analysis (SNA) of school community

The empirical data of this research includes the analysis of the social network (Scott, 1991; Wasserman & Faust, 1994)(46)(58) of 33 members of a teacher community: 29 teachers and a principal, a school secretary and two school assistants. In this study the principal, the school secretary and the school assistant are included to the teacher community, because they are in charge of planning and assisting the teaching and further, according to the principal, they closely participate in the pedagogical development together with teachers.

The data was gathered through a networking questionnaire that consisted of a list of names in which the respective rows represented contained names of the each of the 33 members of the community, and the columns indicated for five types of networking relations. In the case of each colleague, the member was guided to think about the following questions: 1) to whom they go with technical questions related to information and communication technology, 2) to whom they go with pedagogical questions related to information and communication technology, 3) with whom they collaborate on web-based learning, 4) from whom they receive new knowledge or ideas about web-based learning and 5) with whom they interact informally. In addition, the members were guided to specify what media they use in each of their relations in the following six categories: 1) e-mail, 2) Internet: web sites, 3) Web-based learning environment, 4) Phone, 5) Face-to-face and 6) Something else, what?.

In this study, it has been chosen to analyse the answers to the questions 3 and 4 in more detail: they are considered as the most relevant when studying the interaction related especially to web-based learning. The social network analysis (SNA) was used to find individual actors, who are in a central position of communication, who have more connections to other teachers than their colleagues on average. This kind of centrality value can be measured in a number of ways, but we chose the method to count the number of relations to others with whom a teacher maintains relations. This was done by calculating the centrality value of each teacher by using Freeman's degree-function (Scott, 1991)(46), which means the amount of information and knowledge the participant provides for or receives from the other participants. Since Freeman's degree has been chosen for centrality analysis, the centralization measure is based on indegree (number of incoming networking linkages) and outdegree (number of outgoing network linkages). The centralization of a whole network thus accounts for the variation in outdegrees or indegrees of the actors in a network. For instance, the indegree value of the teacher related to question 4 (“From whom do you receive new knowledge or ideas related to web-based learning?”) means: the colleagues get new knowledge and ideas from the teacher, and, in turn, outdegree value means: the teacher gets new knowledge and ideas from his colleagues.

When using SNA, relations were marked as a non-existing tie (coded zero), and an existing tie (coded one). For example, when teachers were asked to tell: “From whom do you receive new knowledge or ideas about web-based learning? “, respondents coded a person from list either zero or one. The results of the SNA formula were codified to a data matrix used in SNA and analysed by Freeman's degree-function implementing the UCINET-program (Borgatti, Everett & Freeman, 1996)(9). There are some difficulties in using degree measure for searching central actors. For example, degree doesn't show the reciprocal relationship between actors. However, in this study, the measure of Freeman's degree was chosen to guide in picking up the central actors, because both directions of information flow were considered meaningful from the point of view sharing and mediating knowledge.

Analysing mediative tools and other artefacts in teacher networks

One of the problems in analysing social networks is that only people and their communities are understood to be actors. The role of mediating communication and information artefacts is neglected. The framework of this study emphasizes such a perspective that the networks in working life are heterogenous and include not only people but also artefacts (Hakkarainen et al., 2004B)(19). For instance, when teachers are searching for answers to problems they may not consult only their colleagues, but also different sources of information and when they are consulting colleagues, they do not always communicate face-to-face, but use alternative media. For finding out in what kind of networks the central actors are involved in, the teachers wrote in the SNA questionnaire also what media they used in their relations (as described earlier). They also answered an open question on what other information sources they consulted beside their colleagues.

Schools' networks do not only include the relationships and communication inside a school community. As schools try to be interconnected over school boundaries, we found it also meaningful to explore teachers' relations which cross the school community borders. In addition to reporting intra-school connections, the teachers reported their inter-school relations in the questionnaire, and again, which media they used in these relations. It is good to notice here, that the respondents didn't report how often they use each medium they mentioned, so the frequency of media is not analysed in this study in detail.

Interviews of the central actors

In the second phase of collecting data, the central actors chosen by SNA were interviewed. The interview was carried out on the hypothesis that the qualities and working practices of central actors may reveal essential aspects about learning and developing web-based learning in the teacher community. The semi-structured, in-depth interviews focused on teachers' genuine experiences and the meanings they gave to their actions (Fontana & Frey, 2000)(12). The open-ended questions included elements concerning teachers' background, networks, working practices, and use of different mediating artefacts or information tools. Special attention was paid to the questions associated with the content of knowledge exchanged and the factors, which according to teachers' experiences, promote and challenge web-based learning in the community.

Phenomenographical approach in analysing central actors' descriptions

This study aims to understand the meaning of intelligent action in the teacher community and teachers' networks; this is why also the qualitative methods were needed in analysis. The central actors' answers to the three open-ended interview questions were chosen for deeper content analysis by implementing phenomenographical approach (Marton, 1988) (35). These essential questions were

1) What kind of challenges are there in sharing knowledge of web-based learning in a teacher community?, 2) Has your working community had an effect on the development of your skills of web-based learning?, and 3) Are there some specific factors in your working community which support and enhance the professional development of teachers in general? The analysis unit consists of the following: each of the central actors answered to the same question and these answers were put into one or several of the categories of descriptions. The researcher defined and labelled the categories of descriptions on the basis of the qualitatively different ways how teachers' expressed and described different factors and challenges in their answers. When categorizing the answers, the different aspects of expressions were identified and grouped on the basis of similarities, differences and complementarities. In other words, the categories of description are characterised and presented for the grouped conceptions.

Marton, Dall' Alba and Beaty (1993, 282-283) found that expressions often represent different fragments of the same conception. In addition, the conception refers to actual experiences, understandings and conceptualizations that people have of phenomena. Categories of description are abstract tools used to characterise these conceptions. In order to see expressions as representing different fragments of the same whole, the researcher has to have an idea what the whole is like. To be able to decide whether or not two expressions reflect the same conception, a researcher must also have an idea of what the conception is. The conception is abstracted from the expressions that are considered to reflect it. The categories of description, which emerged from the data of this study, are abstractions, which are interpreted to be meaningful in understanding the process of developing web-based learning and teachers' professional development within the community.

The phenomenographic approach was found to be purposeful in this study, because it supported finding out teachers' genuine experiences and the personal meanings they gave to them. This method offered teachers also the possibility to emphasise those aspects they found most important.

When assessing research, one has to pay special attention to the relationship the researcher has to the research object as well as to the research context. In this study, the researcher was involved with the research process by defining study context, methods and interpreting the results and this means that researchers' presumptions and concrete actions have had an effect on the research process. However, for the phenomenographic approach it is typical that the research is strongly related to the researcher's presumptions and interpretations. According to Laine (2001) the researcher's awareness of his/her presumptions supports him/her to assess their impacts on interpretation. In this research process, the researcher has discussed her presumptions with the teachers participating in the study and with the theoretical and methodological guides of this article. On this basis the categories of descriptions that emerged from the data, have been analysed several times critically taking into account the researchers' impact on the process.

5. Results

Central actors related to web-based learning were found by social network analysis

When analysing results of the question 3 (”With whom do you carry out collaboration on web-based learning?”) Freeman's degree-function revealed eight (8) teachers, who's in- and outdegree values were above the average of the community (Table 1). Seven (7) of them with the highest values were chosen to more in-depth interviews: Teachers 24, 21, 7, 18, 29, 19 and 12. The interviews were ended in seven cases, because it was noticed that the new teachers' descriptions didn't bring any new information. According to Eisenhardt (1989) the ideal number of cases in research cannot be defined in advance, and acquisition of the cases can be finished when theoretical saturation is reached. However, Teacher 28 had exceptionally high indegree value in this question, which means that her colleagues seemed to consider her as a meaningful partner in web-based learning collaboration. She was included in the central actors of the community and interviewed as well. The actors, who acquired the highest in- and outdegree values in question 3, were interpreted to be in the centre of the communication structure of the community related to web-based learning. They collaborated most actively on web-based learning in their community and were considered to play an important intermediary role among their colleagues.

Teachers	Freeman’s Degree (Outde-gree)	Freeman’s Degree (Outde-gree)
Teacher 1	0	1
Teacher 2	1	1
Teacher 3	3	1
Teacher 4	0	3
Teacher 5	2	4
Principal 6	4	2
Teacher 7	9	3
Teacher 8	0	0
Teacher 9	1	1
Teacher 10	0	0
Teacher 11	3	2
Teacher 12	3	6
Teacher 13	0	5
Teacher 14	1	3
Teacher 15	0	1
Teacher 16	2	0
Teacher 17	5	2
Teacher 18	6	4
Teacher 19	5	3
Teacher 20	3	4
Teacher 21	10	6
Teacher 22	0	2
Teacher 23	0	1

Teacher 24	11	10
Teacher 25	2	2
Teacher 26	3	0
Teacher 27	1	2
Teacher 28	1	11
Teacher 29	6	3
School assistant 30	3	0
School assistant 31	0	2
School secretary 32	2	0
Teacher 33	0	0

Table 1 - The centrality of the members of the teacher community (individual teachers) related to the question of collaboration on web-based learning. Teachers, who were chosen to interviews, are in bold. (The numbers refer to teachers' names in alphabetical order.)

The results of question 3 (”With whom do you carry out collaboration on web-based learning?”) were compared to question 4 (“From whom do you receive new knowledge or ideas of web-based learning?”) in the process of searching the central actors of the community. The results revealed that the all seven teachers, who collaborated most, had also above average outdegree values in question 4 (Table 2). This result strengthens the perception, that these teachers had also mediative role related to the knowledge of web-based learning in their community. They were not only collaborating with their colleagues but also seeking new information from them. In line with this interpretation, also teachers' interviews revealed that these teachers were interested in developing themselves in the web-based learning. Specific attention must be paid to the two teachers. Teacher 24 had the highest in- and outdegree values in collaboration of web-based learning (question 3) and the remarkably high indegree value in acquiring new knowledge or ideas of web-based learning (question 4). The other high indegree value in question 4 belongs to Teacher 28, who also received high indegree value in question 3. These teachers are significant sources of new knowledge and ideas related to web-based learning for their colleagues.

The principal was one of the central actors

Also, the values of the school's principal (number 6 in Tables 1 and 2, the numbers refer to the alphabetical order) were analysed. In question 3 (“With whom do you carry out collaboration on web-based learning?”) his outdegree value was above the average of the

community: he experienced that he is actively collaborating with the members of the community in web-based learning. The indegree value was, instead, under the average of the community. This means that other members in the community didn't consider him as a concrete partner in web-based learning collaboration. In question 4, acquiring new knowledge or ideas on web-based learning, the principal had, again, both in- and outdegree values that were above average. The interviews revealed that teachers perceived the collaboration of web-based learning as concrete, joint practices, but the principal understood idea exchanging and future planning as also being concrete collaboration. This difference in perspectives may explain the contradiction in principal's values in questions 3 and 4.

Teachers	Freeman's Degree (Outdegree)	Freeman's Degree (Outdegree)
Teacher 1	0	0
Teacher 2	1	0
Teacher 3	5	2
Teacher 4	0	4
Teacher 5	0	9
Principal 6	5	8
Teacher 7	9	1
Teacher 8	1	0
Teacher 9	3	0
Teacher 10	3	3
Teacher 11	3	5
Teacher 12	8	3
Teacher 13	0	6
Teacher 14	0	4
Teacher 15	1	1
Teacher 16	2	1
Teacher 17	4	2
Teacher 18	7	2
Teacher 19	9	3
Teacher 20	1	3
Teacher 21	5	6
Teacher 22	3	2
Teacher 23	3	2

Teacher 24	4	16
Teacher 25	9	2
Teacher 26	5	0
Teacher 27	1	0
Teacher 28	3	15
Teacher 29	7	2
School assistant 30	2	0
31 School assist-ant	1	1
School secretary 32	0	0
Teacher 33	0	2

Table 2 - The centrality of the members of the teacher community (individual teachers) related to the question of receiving new knowledge or ideas of web-based learning.

Central actors bridged different expert fields of teaching in their community

The nine (9) central actors represented different subject domains and expert fields of teaching. They participated in a variety of different teams, e.g., Curriculum Development Team, Immigrant Teaching Team, Information and communication technology (ICT) team, Special Educational Needs Team and Language Teaching Team. Central actors' serving years varied from 1,5 to 24 years: they represented also different time periods of working experience in their community. Three of the central actors had participated in in-service training program of web-based learning, which was organised by the local educational authorities (This training was described in chapter 2, “Context of the study”). Teachers 24 and 28 had specific roles in ICT team, which explains their exceptional centrality values: they both acted as peer support for their colleagues besides their regular teaching work. Peer support was originally local educational authorities' initiative and agreed yearly between teachers and the principal. These teachers' high centrality values (see in Table 1 and 2) reveal that peer support is an effective way to strengthen the use of information and communication technology among teachers.

The interviews revealed that all eight teacher central actors implemented actively web-based learning in their teaching. They carried out blended courses, which means that their teaching included both face-to-face occasions and studying supported by web-based learning environment. None of them implemented virtual teaching only. The functions of the web-based learning environment they used most actively were the discussion forum,

personal and group portfolios, e-mail embedded in learning environment and the learning tasks and materials in different subjects. The central actors collaborated with their colleagues in planning and sharing lessons, teaching and by participating in joint afternoon training and idea exchange occasions. In addition, the collaboration (for instance course planning) took also spontaneously place in their informal meetings.

The eight teacher central actors were transferring general knowledge of web-based learning to their own field of expertise. For instance, they planned peer and teacher guided learning discussions for students with lingual disorders with the purpose of encouraging them to be more active in expressing themselves, created specific groups for immigrant and other students for fostering the positive cultural change and or planned working life-oriented contents to the group portfolios of supplementary class students. They also presented their projects and ideas to other teachers in formal staff meetings or in specific afternoon workshops. In this way they also brought their own domain of expertise to the knowledge of their community. Five (5) teachers had even demonstrated their projects from web-based learning environment to others. However, only four (4) of them wrote reports or memos of their pedagogical innovations or trials for the use of colleagues.

Central actors had collaborative links over community borders

Four of the central actors (4/9) told that they carry out concrete collaboration on web-based learning with their contacts outside of school. These four teachers had each about 1-4 contacts. Half of these contacts were teachers from other schools and other half teacher trainers from different in-service organizations. Teachers detailed that they collaborated mainly in face-to-face but also by using different media, for instance, e-mail and the web-based learning environment they were implementing in their teaching.

All central actors (9/9) reported that their cross-school collegial relations they benefit when acquiring new knowledge or ideas of web-based learning.

There were 1-5 collegial contacts per central actor in the knowledge acquiring pursuit. Every central actor (9) had at least one important colleague outside of the school, from which he/ she received knowledge. In addition to colleagues, new knowledge or ideas were acquired also from trainers of different teacher in-service training organizations (5 mentions), coordinators from inter-school development projects (3 mentions) and from family members (2 mentions).

Central actors used several media and artefacts in their networks

When searching for new knowledge or ideas from their contacts *outside school* all nine central actors preferred face-to-face contacts (9 mentions) and six (6) of them used also telephone and e-mail. In addition, three (3) of them used the web-based learning environment and two (2) central actors used websites. When acquiring new knowledge or ideas from colleagues *inside school*, the central actors preferred face-to-face-occasions (9 mentions) again. Further, three (3) central actors also used e-mail, web sites, web-based learning environment and telephone. When carrying out collaboration of web-based learning *inside the school* the learning environment was in more active use: six (6) central actors reported that they use it as a medium in collegial collaboration. The central actors detailed, that they use it in collaborative lesson planning, idea sharing and lesson demonstrations for other teachers. However, the most general way to collaborate related to web-based learning inside the community were face-to-face occasions, all nine (9) central

actors reported this choice. The central actors used also e-mail (4), web sites (3) and telephone (4) when collaborating with their inter-school colleagues. None of the central actors suggested other media for this purpose.

It is good to remember, that the results don't reveal how often teachers used the media they mentioned. Teachers and the principal, anyhow, experienced these media meaningful in their relations, and the results offer general overview on networks of teachers, which doesn't seem to consist of only people but also mediative tools. The central actors were also asked what other information sources they use when acquiring new knowledge or ideas related to web-based learning in general. The most popular source of information was the Internet (8 mentions). Seven (7) actors also used professional magazines and newspapers and seven (7) actors read books on the subject. In addition, seven (7) central actors considered different teacher in-service training organizations as sources of information. Four (4) central actors reported that they received new knowledge or ideas from television, one teacher mentioned also videos, one the library and one a teachers' trade union as information sources.

Central actors mediated pedagogical and technical knowledge in their networks

The central actors were asked in interviews, what kind of advice their colleagues ask them most often and, in turn, what they ask from their colleagues about web-based learning? Four (4) of them reported that colleagues ask mainly pedagogical support, for instance:

“One asked me, could I help him to implement this web-based project with a pupil with lingual disorders.” Teacher 7

Four (4) central actors described that their colleagues usually ask the practical user for web-based learning environment support. One teacher reported that she's supporting her colleagues in information search and another teacher told that she's giving general advice in the use of office programs.

When turning to their colleagues, five (5) central actors reported that they are looking for new pedagogical ideas and tips to their teaching, for instance:

“I ask for advice on how they motivate their pupils in web-based learning projects. And in general, if I have failed in something, I ask how others have succeeded.” Teacher 28

They also asked for user support for the web-based learning environment (2 teachers), support for technical problems (2 teachers) and ideas for the practical use of new devices and equipment from their peers (2 teachers). In their inquiries, the central actors seemed to have meta-knowledge about who knows what in their community. For instance, they mentioned same persons they turn to with technical worries. In their pedagogical advice, they were bridging different fields of teaching and translating knowledge of web-based learning to their colleagues' subject domains. For instance, they supported other teachers to innovate and benefit from web-based collaborative writing in language teaching, or, how to organize students' evaluation by personal or group portfolios.

The community can support learning of web-based learning in multiple ways

The phenomenographical (Marton, 1988)(35) analysis of the central actors' answers to the question “Has your working community had an effect on the development of your skills in web-based learning?” revealed five different categories of descriptions. The categories are:

1) Learning from advanced colleagues, 2) Learning from colleagues' inquiries, 3) Learning from everyday working practices, 4) Safe and supportive atmosphere empowers learning and 5) Commitment on the community-level supports learning.

It is relevant to emphasise here, that the categories of descriptions are not hierarchical in regard to the quantity or quality of teachers' expressions. For instance, every category involves several expressions of teachers but none of the categories contains an exceptional amount of expressions compared with others. In the following section the contents of the categories are explained briefly and one example of teachers' expressions from each category is presented.

The central actors described, how useful it is to ask for guidance from a colleague, who's advanced in her / his subject (*"knows more than me"*), and on the other hand, how the questions of other colleagues support them to search for answers. They also said that the use of the web-based learning environment is more and more embedded in the daily working practices of the school community, so that it's even "difficult to avoid learning" new things regarding web-based learning at school. The central actors underlined that the safe working atmosphere encourages them to share their knowledge gaps and ask advice from colleagues without being embarrassed. They made it also very clear, that the community-level commitment fosters development of web-based learning. For instance, the school's web-based learning environment project was agreed to be part of the teachers' annual working plan and in the school curriculum.

Category 1, "Learning from advanced colleagues", reveals that the expertise of colleagues is important for teachers. They find it meaningful for their personal development and respect it openly. Teachers also seemed to have knowledge of who has experience and knowledge in certain subjects in their community. This refers possibly to the transactive memory (Wegner, 1986)(59) of the community and it seems that individual teachers make benefit of it in their professional development. Transactive memory is a shared system for encoding, storing and retrieving information; knowledge of one another's memory areas, who knows what in other words. Here is one example from this category, "Learning from advanced colleagues":

"If we didn't have people here who know about it [web-based learning], I probably wouldn't have learnt about it." Teacher 12

The central actors also answered the question "Are there some specific factors in your working community which support and enhance the professional development of teachers in general?" In addition to the categories reported above, the following new categories emerged: 1) Encouragement to participate in in-service training, 2) Flexibility in planning work, 3) Demanding pupils, 4) Supportive principal, 5) Shared lessons, 6) Training occasions at school and 7) Professional teachers.

The central actors told that teachers are personally encouraged to participate in in-service training in their school. The teachers had also possibility to plan their work quite flexibly. They, for instance, could use the time for staff meetings to study web-based learning, plan new courses and share experiences with colleagues. Teachers emphasised that these quite simple practices were very meaningful for them and made it concretely possible to develop themselves professionally in their working context. All the central actors who were teachers stressed the importance of a supportive principal for their professional development. They described, that a supportive principal is personally interested in

teachers' work and its' development. Also, pupils were mentioned several times as generators for professional development. Teachers told that they need multiple professional skills in supporting, for instance, immigrant pupils or pupils with special educational learning needs. Pupils inspire them to learn and try new strategies in teaching. Also the principal emphasised this factor.

Central actors considered shared lessons important for their professional development. This means lessons, which are planned and guided by, at least, two teachers in collaboration. Further, the central actors preferred the training occasions at school instead of outside-school training. They expressed, that it is more efficient to learn from peers in every-day working environment and with their every-day technology than visit simulation classrooms in training organizations. They also highlighted the meaning of professionalism among teachers in general. Educated teachers, who are experts in their subject domains and in pedagogical use of information and communication technology, share relevant knowledge with others too.

The category 1, “Encouragement to participate in in-service training”, shows that personal guidance plays a crucial role for teachers' professional development in a teacher community. Teachers told that the principal didn't only inform teachers about the available training occasions, but personally suggested individual teachers or teacher teams to certain courses. Teachers felt that their principal was positively interested in their professional competence, and its development, and this feeling was encouraging and motivating them. Here is one example from the category 1, “Encouragement to participate in in-service training”:

“I have found it really positive, that teachers' willingness to develop themselves is supported here. The training occasions are even actively introduced and personally proposed to you here.” Teacher 21

Knowledge sharing demands structure, safety and transactive memory

The analysis of teachers' descriptions on the challenges related to the knowledge sharing of web-based learning in their community revealed six categories of description: 1) Mutual interest in dialogue relations, 2) Transactive memory, 3) Need for time, facilities and structure, 4) Need for community-based peer support, 5) Emotionally supportive and empowering atmosphere and 6) Use of web-based learning environment in a pedagogically meaningful way.

Teachers emphasised the importance of mutual interest and respect in reciprocal relationships between colleagues when introducing new pedagogical practices of web-based learning. They described how important it is also to have knowledge who in the teacher community knows what, to whom to turn with questions. If there are a lot of personnel changes, or many substitute teachers in charge, this knowledge doesn't appear so easily. These descriptions refer, again, to Wegner's (1986) transactive memory, which means, that people in social communities spontaneously develop accurate meta-knowledge concerning distribution of knowledge and competencies. The central actors reported also that for successful collaboration, there should be special time, structures and facilities offered in school. In the middle of every day teaching hurries it is difficult to concentrate on meaningful knowledge sharing with colleagues. Teachers wished to have, for instance, more shared lessons and regular afternoon workshops.

The central actors found it important that knowledge sharing happens at school and in close relation to their every day work. They found peer support better than traditional teacher training, where a teacher or a group of teachers participate in training outside school. Also, the emotionally supportive atmosphere was found to be very meaningful for knowledge sharing. It is important to feel that one is accepted in the community. These descriptions were in line with Mahn and John-Steiner's (2002) idea of emotional Zone of Proximal Development that allows one to work at the edge of his or her competence without being afraid of unavoidable failures and mistakes. The central actors underlined that development of better pedagogical practices in general, encouraged teachers to share knowledge; to tell about their trials, challenges and successes to colleagues. And open knowledge sharing, in turn, supported and inspired teachers to develop further their pedagogical practices.

The category 5, “Emotionally supportive and empowering atmosphere”, refers also to Ruohotie's (1996) idea of emotional security in organizations and to the Engeström's (1999) suggestion that if the inevitable conflicts are debated openly they progress to creating new forms of knowledge and practice. Teachers detailed that the emotionally supportive and empowering atmosphere allowed them to talk about new challenges and difficulties and this was seen as a valuable asset for the community to maintain. Teachers reflected that it is important to feel accepted among their colleagues although one doesn't know something, but also in the case that one knows more than others. This feeling of acceptance encourages teachers to positively seek the opportunities for professional development. Here is one example of the Category 5, “Emotionally supportive and empowering atmosphere”:

“This open atmosphere, that people are ready to share their knowledge. That no one is hiding…the opportunity for collaboration is always there.” Teacher 18

6. Conclusions and discussion

In this section, a summary of the research results is made and then some new perspectives for designing more innovative teacher in-service training of web-based learning in future are offered.

The results of the research revealed, that there were nine (9) central actors, eight teachers and the principal in the community, who carried out collaboration and shared knowledge of web-based learning more than their colleagues on average. The central actors had internal and external relations in the community, for instance, collaborative colleagues in- and outside of the school, and their networks involved people, artefacts and variety of mediative tools. They shared knowledge of web-based learning not only in face-to-face occasions but also, for instance, by phone, e-mail and web-based learning environment. Further, they acquired new knowledge or ideas about web-based learning besides from people also from different sources of information, such as the Internet, books and magazines.

The central actors shared both pedagogical and technical knowledge of web-based learning, often very practical advice and tips for teaching practices and use of web-based learning environment. They seemed to have meta-knowledge about the locus and availability of community members' knowledge capital: they knew “who knows what” and they made benefit from that knowledge in their professional development. This research

result might indicate, that there was *transactive memory* (Wegner, 1986)(59) developed within the community. The transactive memory is developed by experience and in a long time period within working communities and it means knowledge of one another's memory areas. It is not traceable to any one of individual, nor can it be found between individuals: it is a property of the group.

The central actors bridged different expert fields of teaching in the community, for instance, they made innovative use of web-based learning in different subjects and learning tasks. They also translated knowledge from one field of expertise to others, for instance by bringing new ideas on web-based learning to immigrant teaching and by further developing the practices of web-based learning to the needs of special educational pupils. This finding is in line with research results of Robinson, Anning and Frost (2005), who revealed, that teachers in multi-agency teams brokered connections, introduced practices, and passed knowledge related to work across boundaries. Barabasi (2003) calls these linking agents in networks “information hubs”, which bridge different small-worlds, which can be groups, teams, or even whole organizations. The central actors can be also called as “gatekeepers” (Gould & Fernandez, 1989)(13), because they have connections to outside parties, and they may control information flow to their own groups.

According to the central actors' experiences the important factors that support teachers' professional development related to web-based learning in the community are; the possibility to learn from colleagues and from everyday working practices, an emotionally safe atmosphere, leader's personal support and community-level commitment. The research result of safe atmosphere and leader’s personal support are in line with Ruohotie’s (1996) findings that supportive culture and participative management are important factors in organizational learning. When organizational culture offers security and safety to workers, they can work also in their *emotional* zone of proximal development (Vygotsky, 1962; 1978)(54)(55), at the edge of their competence without being afraid of unavoidable failures and mistakes (Mahn & John-Stainer, 2002)(34). Also Thompson, Gregg and Niska (2004) have revealed that trust among community members is vitally important in the professional development.

Also, the flexibility in work planning, challenging pupils, shared lessons with colleagues, training occasions in an authentic working environment and colleagues' professionalism are considered meaningful for professional development. As challenges, the knowledge sharing of web-based learning in the community needs mutual interests, transactive memory, time and facilities, peer support, safe atmosphere and meaningful pedagogical practices. Also Ruohotie (1999) and Ruohotie & Nokelainen (2000) remind that learning takes place only when an individual gives a meaning to her/his experiences.

In this study, the size of the present teacher community (N=33) may be a limitation; it was chosen to be manageable. It is difficult to judge the effects in the present case, but it is possible that some of the teachers’ descriptions would appear differently for a larger sample and in different teacher communities.

However, from the basis of study findings it is suggested, that by intensive collaboration related to web-based learning it is possible to break the boundaries of individual teachership and create such sociocultural activities, which support collaborative professional development in the teacher community. Teachers' in-service training programs should be more sensitive to the culture of teacher communities and teachers' reciprocal

relations. Further, teacher trainers should design teachers' in-service training of web-based learning in co-evolution with supporting networks including not only people, but also the media and artefacts.

The challenge of developing web-based learning in a school community is often geared to the problem of embedding new innovations to every day practices of the school. In this study, the central actors were, already in the second year of the piloting project, implementing actively web-based learning in their teaching, but how about the other teachers in the community? It is important to notice, that all teachers in the community had received the same training and had same possibilities to apply web-based learning in their teaching as the central actors. Will the new pedagogical practices of web-based learning be disseminated on a wider scale in the community later? How could the networks of collaboration and knowledge sharing of the central actors be expanded to involve the whole teacher community?

It would be interesting in future to research what it is that has made central actors the central informants in their communities? For instance, what are the personal triggers, prerequisites or attributes which explain that these teachers are best placed to take advantage of development of web-based learning? If development activities concentrate only on a few actors in a community, what may later follow is that tasks within a community are divided unequally, so that challenging development projects are directed to the same actors, who already have received in-service training and whose knowledge and skills are constantly cumulating compared with less active colleagues. In the field of education, this leads to problems in pupils' democracy. All pupils should have equal rights to enjoy such teaching, which benefits from modern, technology-supported and high-qualitative pedagogical practices. It is not a privilege of those pupils only who are lucky enough to get an interested, development-oriented “central actor” teacher.

There is a need for such genuine collaborative culture of different agencies, where the knowledge of networking, adult education and new technologies are united with political and administrative will. The realization that teachers can very concretely contribute to each other's professional development in their daily circumstances could be better used in the teaching training programs. Today, schools are already acting, more or less consciously, in networks, which consist of not only people, but mediating tools, different information sources and interactive media. How this networked intelligence and widened pedagogical communities could be better utilized when planning educational interventions with teachers?

In future research, it would be interesting to study collaborative knowledge creation in pedagogical communities in more detail, for instance the different groups and their coherences, the reciprocity of knowledge change and the gaps and blocks in knowledge flow. Also the leadership of modern, networked pedagogical communities should be examined deeper. In addition, it is always interesting to hear teachers' voices in the processes of educational change: what are the meanings that they give to new technologies in teaching and learning? Do these meanings change in time? In near future, a variety of new media and technological tools will be innovated and offered for teachers' professional development. For instance, immersion of television, Internet and mobile opens new possibilities for networking and widening the learning communities. This continuous development challenges teacher trainers to constantly redefine and redesign the innovative and meaningful teacher in-service training.

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