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Rosa Maria Bottino

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ON-LINE LEARNING NETWORKS: FRAMEWORKS AND SCENARIOS

Rosa Maria Bottino

Consiglio Nazionale Ricerche – Istituto Tecnologie Didattiche
Via De Marini 6, Genova, Italy. E-mail: bottino@itd.cnr.it

ABSTRACT

Progressively the idea of using the internet as a platform to mediate social interactions and learning at different levels has affirmed itself, and this has given rise to a huge number of spontaneous and planned collectives, which are often described as on-line learning networks. On-line learning networks create value from a combination of content and people knowledge. They can vary widely in the strength and permanence of their connections and resources necessary to maintain them. Aspects both pragmatic and social in nature have to be carefully considered in the process of initiation of on-line learning communities. This paper considers learning networks from the perspective they offer to the straitening of relationships among institutions, groups, and people sharing a common interest in computer enhanced learning. Some case-studies are analysed and an analytical framework is sketched to guide observations and to provide a lens through which case-studies can be interpreted. The final goal is to delineate a reference to individuate strong and weak elements in virtual networks and to examine under which conditions they are succeeding. Moreover some possible scenarios for on-line networks are delineated according to two main lines: the organisation and structure of the network and its level of establishment.

1. INTRODUCTION

The economic requirements of the modern world have pushed institutions and organisation to look more and more at knowledge as a strategic resource that can give them sustainable competitive advantage. For organisations (it does not matter if academic or commercial) it is vital to become “learning organisation”, since they have to prepare people for an environment where learning is dynamic, where they have the responsibility for their own learning, and participate, at least to some extent, in the process of defining knowledge (Senge, 1990).

In business context, many organisations apply knowledge management to improve their efficiency and effectiveness, and to encourage the creation and sharing of knowledge among people. Education today is subject to the same pressures of the marketplace. Traditional universities are now rethinking their role having to face the global competition among each other made possible by new technologies. Also the traditional value of qualifications is taking in a different meaning under the pressure of international markets and associated needs. The relevance of traditional practices is under question, considering also new challenges put forward by the increasing need for lifelong learning.

The main focus of innovation often has been in the application of new technologies and restructuring of content to make use of it. Pedagogical and organizational aspects have been given less emphasis, and the potential of ICT for improved pedagogy and new organizational models of learning has been less considered (Griffiths, 2001). Initially the effort was largely focused on reproducing traditional distance learning approaches and, more generally, the “knowledge delivery” model of education. The next stage was an attempt to reproduce the traditional face-to-face environment, but with a focus on the formal learning environment. The technology reproduced this formal structure in the client server approach to virtual learning environments. This presented the university or the training organization as a repository of knowledge that could be distributed to learners. The following step has been in the direction of including communication, conversation and collaboration, all things that happen in traditional educational communities around the formalist classroom setting. Progressively the idea of using the internet as a platform to mediate social interactions at different levels has affirmed itself, and this has given rise to a huge number of spontaneous and planned collectives, which are often described as on-line networks. On-line networks can vary widely in the strength and permanence of their connections and resources necessary to maintain them. Some can have very informal structures and almost no independent assets. Others can do nearly the same work as formal organisations but operate without a heavy organisational structure. The concept of on-line networks has captured popular, as well as scholarly, interest. This is particularly true in the sector of technology enhanced learning which has been highly challenged by concepts and methods derived from exploring the educational value of employing a “community” model for supporting learning.

The idea of online learning networks is affirming itself also at the political and institutional level as a new form of organisation that can foster cohesion and integration among Institutions and that can promote new and better forms of training and life long learning. For example, in Europe, as pointed out by European Commission documents (see, for

example, the Report on the EC Open Consultation on new research challenges for technology supported learning, 2001) it appears more and more important to provide a nexus for the wide variety of programmes, initiatives and organisations active in the field of education supported by new technologies. The idea of establishing and sustaining on-line networks connecting academic, training and public research institutions as well as private, local reality, and professional associations has been seen as an answer to some of the posed problems.

This paper considers learning networks from the perspective they offer to the straitening of relationships among institutions, groups, and people sharing a common interest in studying the potential benefits and drawbacks of computer mediated learning. Since network approach to professional development has great potential both in terms of theoretical and practical opportunities, it is useful that some real cases be studied empirically in order to point out their strong and weak elements and to examine under which conditions they are successful.

A framework is sketched to guide observations and to provide a lens through which the case-studies can be interpreted. Such framework does not want to provide a static tool to identify elements in a network but a mean to describe the inherent interplay of different variables and how this interplay drives network activity. The main goal is to look at the interaction of variables that impact the dynamics of building social networks aimed to improve and share participants' knowledge and experience in the field of technology enhanced education.

2. SOME EXAMPLES OF LEARNING NETWORKS

In the following three examples of networks are briefly analysed. They have been chosen as representatives of different realities and modalities of initiation and running. The examples considered are cases of networks in which the author has been directly involved in or had the opportunity to examine closely. They are examined against some areas that are assumed as crucial in the networking process (see figure 1). The considerations reported, which, for space constraints, are necessarily synthetic and brief, are based on the analysis of data such as design documents, on-line interactions, informal talks with networks members, produced outputs, etc. Some ideas are based on personal interpretations of events to which the author directly participated.

Case Study 1: PROMETEUS ¹

PROMETEUS (PROMoting Multimedia access to Education and Training in EUropean Society) was an open initiative launched in 1999 by the European Commission to encourage effective use, research and development in the field of Technology Enhanced Learning (TEL). Prometheus initiative was bound to a Memorandum of Understanding (MoU) that had to be signed to become a member of Prometheus. At the end of September 2002 (when the financial support from EC terminated), 162 organisations and 92 individuals had signed such MoU. Prometheus can be defined as a "virtual" association of enterprises, universities, research institutions, and individuals sharing a common interest in employing technologies for education and training. As a virtual community it worked through the Prometheus web service: www.prometeus.org.

Aims and Goals

At the basis of the Prometheus initiative was the pressing need in Europe to strike a balance between research and the actual use of learning technologies, and between the rapid development and the wide spreading of ICT and the necessity to address pedagogical and educational needs taking into consideration different cultural requirements. Prometheus was established with the aim to address such topics, to build consensus, and to identify elements that needed further research or stronger support. Given this general framework, the concrete objectives to be pursued within the community were often unclear, especially at the beginning. One of the main problems encountered was to identify, within the virtual community, concrete goals and a road map for work. Even if many difficulties were encountered, some valuable results were reached when the community concentrated on viable objectives, such as, for example, the answer to the EC Open Consultation process (see the Prometheus Position Paper, 2001), the organisation of the general conference in Paris, the editing of reports on topics of interest following on-line discussions and face-to-face workshops.

Organisation and management

Prometheus operated through an elected Steering Committee, and through Special Interest Groups (SIGs). At the beginning, Prometheus did not receive a financial support from EC and relied on voluntary contributions. Even if a large amount of networking took place in the initial period (mainly concerning the setting up of the foundations of the PROMETUS community, its rules and ways of working), it appeared evident that the production of tangible outcomes required a more substantial support. Hence a support service was funded by an EC contract for 2 years for performing specific tasks (e.g. set up and maintenance of the Prometheus web site, organisation of meetings, secretary functions, on-line newsletter, brand and publicity, etc.). All members continued to participate to the activities on a voluntary basis and only travel expenses for SC members were reimbursed by the support service. When the support finished Prometheus was requested to be completely self-sustainable. This management structure created some difficulties within the community. Firstly, it can be observed that the aims of the support service group sometime differed from that of the Prometheus actors since the support

¹ The author of this article was elected member of the Prometheus Steering Committee from its establishment and chair from March 2001 to March 2002.

group had to directly respond to EC as far as deliverables, milestones, timetables, etc. Secondly, the push towards self-sustainability was considered by many members as a braking factor, taking also into account the main objective of Prometheus, that is, to convey needs and suggestions to EC and other public bodies and to stimulate awareness on TEL in the community at large. Many discussions rose as far as how to pursue sustainability. Visions, objectives and modalities were quite different. After considerable discussion, a not-for-profit Association was established, but its activity and impact reduced highly and the interaction among members seems now confined to a very restricted group if not at all ended.

Technology infrastructure

The PROMETEUS website supported on-line interaction among members and provided opportunities to publish and retrieve information and documents and to comment on them. Nevertheless, e-mail was the mean most widely used for interaction. The computer conference made available was used at a very limited extent and never became a shared mean of communication and collaboration among members. SC members used periodically audio-conferences for on-line meetings. The web site was used mostly for finding information, for managing the delivery of documents and newsletters, and for performing vote procedures.

Community issues

Prometheus attracted a variety of subscribers with different expertise, and interests within the general field of TEL. The composition was a mix of academic (or other public Institutions) subscribers, and subscribers from SMEs, corporate, or other private organisations. All the processes related to the launch of the initiative, the signing of the MOU, and the election of the Steering Committee, were handled via the web through the EC IST web site. This subscription strategy, from one hand, did not assured a balanced and effective participation but, on the other hand, gave the opportunity to relatively new and un-known persons and Institutions, working in the field of technology and education, to become more visible in the European community. The different fields of expertise, and cultural backgrounds, often resulted in a difficulty to build a common language and sharable meanings among participants. These effects reduced in face-to-face meetings and when participants worked together towards concrete goals, while were emphasized in general discussions.

Individual issues

Members had very different motivations for participating ranging from the wish “to hear what is happening” to the wish to add participation to personal CV (mainly for steering committee members). The desire to establish new relations for European projects and the wish to use Prometheus as a channel to convey the offer of services and products were other motivations for participation. Differences of backgrounds, motivations and objectives resulted in an un-balanced involvement and personal commitments of members both at steering level and SIGs participation. This on occasion produced negative effects on the virtual community, such as a cut off of interactions, reciprocal accusations, frustration, and a reduced sense of belongings.

Case Study 2: Networks of Excellence

Networks of Excellence (NoE) are funded by EC through the Sixth Framework Programme, after a process of selection of proposals. NoE aim is to promote integration at European level of a critical mass of resources and expertise on specific research fields with the aim of strengthening scientific and technological excellence (see, http://europa.eu.int/comm/research/pf6/instruments_en.html).

Aims and Goals

NoE are focused on integration. This integration is pursued through specific projects and activities that allow the community to work in groups of interest while maintaining a vision of the whole process through specific instruments such as, for example, newsletter, general meetings, and transversal activities.

Organisation and management

The composition and the number of partners of funded NoE is variable as well as the modalities that each network is putting in action to pursue integration.

For example, Kaleidoscope, a NoE in technology enhanced learning, has clustered 76 European research units, mainly from University and public Institutions, involving more than 800 researchers² (see <http://www-kaleidoscope.imag.fr/index.html>). NoE are autonomous as far as the organisation of their activities and the managing of the funds received by the EC. They are medium-long term initiatives funded for a period of 48 months. The structure of a NoE is shaped by its scientific coordinator who is often supported by a core group of members. Kaleidoscope, for example, has organised itself according to a variety of activities (Special Interest Groups, jointly executed integrating research projects, research teams, transversal “backbone” activities, such as, a shared virtual laboratory and a virtual doctoral school), each of which is funded and managed in a relatively autonomous way. Support and evaluation structures have been established to maintain the various activities focused to integration.

Technology infrastructure

Partners are supposed to give a contribution to the evolution of the technological tools made available to the community, both in terms of requirements and implementation. This procedure is thought to better fit evolving needs derived from the activities put in action within the network. Moreover, each activity within a network can set up specific tools to support collaboration among participants and dissemination of results.

² The author of this article is currently participating to Kaleidoscope and she is member of the Steering Committee of TELMA (Technology Enhanced Learning in Mathematics) one of the research teams of Kaleidoscope.

Community issues

Composition and objectives of NoE are, in general, less heterogeneous than those of open initiatives like Prometheus. Consequently, it is relatively easier to establish some viable aims around which to organise collaborative activities. This helps to outline concrete goals and to maintain the interaction among groups of members targeted to specific aims. The problem is that the general aim of NoE, integration, is sometime perceived by members more like an “external” obligation than as an actual need of participants.

Individual issues

Motivations and involvement of individuals in NoE are directly supported through mechanisms such as, for example, mobility programs for young researchers, funds for travel costs and meetings, periodical calls for targeted projects within the network.

Case Study 3: Networks of Teachers

Networks to support teachers’ professional growth have been established both at national and international level. Some of them are structured and supported by government institutions or by specific funded projects, while others have a less structured nature and are set up on the basis of common interests and maintained on a voluntary basis, often relating to a very simple technological infrastructure.

Aims and Goals

Supported networks usually involve teachers in on-line training activities. The aim of such activities is often to improve teachers’ practice on the innovation induced by ICT in classroom. As an example of an EC funded project U-Learn³ can be cited. The main goal of the U-Learn project was to develop prototypes of ICT “pioneer teachers” learning communities that resulted as spin-off of courses offered by the project. Such courses were focused on discussion of a syllabus on ICT for pioneer teachers and on the collaborative design of ICT based activities for students.

Less organised networks of teachers develops on the basis of the individual interest of groups of teachers on a specific topic or subject. For example, the “Cabrines”⁴ network in Italy links together mathematics teachers interested in the use of software (not only Cabri⁵) for mathematics learning. The aim is to exchange ideas, experiences, and information on this topic and to launch, also, some common initiatives involving students.

Organisation and management

Usually supported networks have a quite structured management model and are focused on the production of some concrete outputs. For example, U-Learn involved a distributed model which was encompassed a coordination unit and several local centres. Local centres delivered teacher training courses organised by the coordination unit. The learning strategy adopted for courses was a blended one: virtual learning communities (20-25 participants) coordinated by an online tutor, and periodically face-to-face meetings.

Spontaneous networks of teachers have usually a more free way of working (e.g. e-mail messages and a web site for inscription, finding information, etc.) or can have some “light” management structure such as, for example, moderated discussions on selected topics.

Technological infrastructure

The technology used can be very different according to the different types of teachers’ networks. Structured networks can rely on computer conferencing systems and web services while other, less organised (and funded) networks can refer only to the use of e-mail or bulletin boards.

Community issues

The composition of teachers’ networks is usually quite homogeneous. This aspect contributes to establish a sense of belonging and a common ground of needs, competencies, and shared meanings. These are key aspects for nurturing trust in the network even if the participation of individual members can be very variable.

Individual issues

In networks oriented to the exchange of information, and experience, the active involvement is often limited to a subset of members and lurking is widespread. This is due to the fact that there is no concrete mean to encourage the participation of all members. Participation in supported networks, oriented to training activities, is considered as a necessary condition and is both maintained (e.g. by tutors) and often encouraged with periodical face to face meetings.

3. A FRAME FOR ANALYSING LEARNING NETWORKS

The above briefly sketched analysis has been carried out trying to outline some elements of the examples considered that can be considered of general interest. The goal is to delineate a framework to individuate strong and weak elements in a network and to examine under which conditions it is succeeding.

³ U-Learn is a two years project funded by EC through the “e-learning” program (<http://ulearn.itd.cnr.it>).

⁴ <http://www.scuolan.it/mailman/listinfo/cabrinews>

⁵ Cabri i san educational software for Euclidean geometry:

The successful development of a learning network can be related to three main traits: effectiveness, efficiency, appeal (or satisfaction). Effectiveness can be defined as the extent to which the learning network attained the goal for which it was initiated. Efficiency can be seen as the measure of the resources, such as human time, effort, and cost employed to run the community, whereas appeal can stand for the measure of affective reactions (trust, personal involvement, identity, etc.) for the involved people (see, for example, Nielsen, 1993; and Reigeluth & Frick, 1999, for an introduction to these concepts within the context of instructional design models). The success of a learning network depends on how well these traits are developed and balanced. They can be analysed considering the interplay of factors pertaining to different areas that can be assumed as crucial in the networking process (see figure. 1).

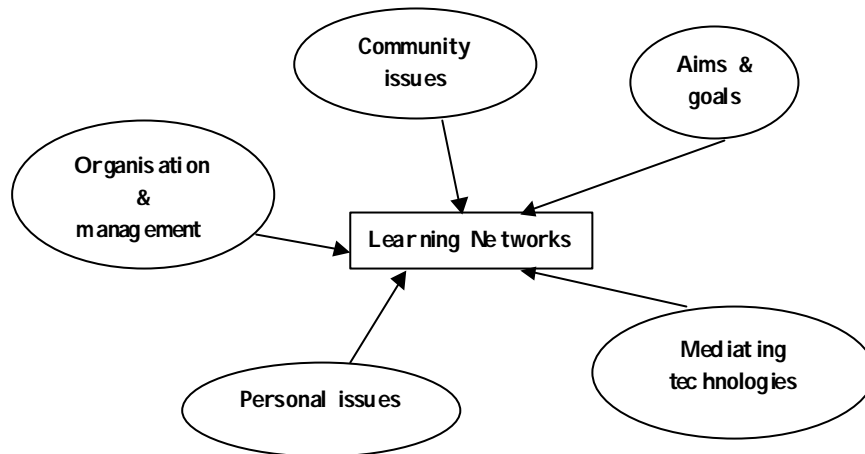


Fig. 1 Crucial areas in networking process

A first critical area has to do with **aims and goals**. Some networks can grow spontaneously around common interests while others may require careful planning with clearly stated goals. In general, it is worth noting that the community should develop around understandable, concrete, and viable goals and objectives. The production of tangible outputs is often perceived as a positive goal of the network, even if, different members can be interested at different outputs. For example, academic people are usually more interested and tend to assign value to outputs such as written reports, papers, etc., while people from other sectors can be more interested in other types of outputs, such as, for example, prototypes, contacts, showcases, etc. This can produce a tension within the network, as it happened in Prometheus. This tension can be a braking factor but can also results as a stimulus for widening participants' objectives and perspectives.

Learning networks should become an integral part of organisations that can do a lot to create a context in which they can develop. Creating such contexts, among other things, entails integrating their purpose in the organisation life, so that such networks can be legitimated as far as decisions, and importance given to the value they create (Wenger et Al., 2002). This can help, for example, to transform teachers' networks oriented to training, to truly life-long learning experiences that have a recognised role in the institutions (e.g. schools, regional and national centres) to which the teachers refer to (see, also, Bottino, 2003).

Organisation and management is a second area to be considered in the development of learning networks. Network management is about facilitating, and administrating to ensure the smooth functionality of the community. It includes factors such as design issues, and issues related to sustainability, support offered, and maintenance. Large networks, such as Prometheus or NoE, have usually a quite structured organisation and they are managed through a combination of both on-line and face-to-face meetings. Even if the management of a network is often performed by a restricted group of people, its objectives and functioning should be clear to all participants and possibly negotiated among members. As the experience with Prometheus support service has taught, managers' aims have not to be perceived as different from that of the entire community.

In general, some resources have to be invested while initiating a virtual network. Such resources should support the setting up of the organisational and technological infrastructures as well as their maintenance. For structured networks, self-sustainability is a process which requires time to be pursued and that depends also on the objectives at the basis of the constituency of the network. For example, for Prometheus a two years support resulted a too short period of time to establish a truly operative and self motivated network able to sustain itself completely. NoE are supported for a longer period of time and their development is linked to a number of different activities and specific projects. The sustainability of networks of teachers that grow spontaneously around some common topic of interest is easier to be accomplished since they are usually managed in a "light" way by a restricted group of volunteers, relying to a very simple technological infrastructure.

As the matter of fact, the **technology** adopted is a third crucial area to be considered that is strictly linked with networks aims and organisation. A number of technologies are available. They can be both synchronous (audio & video

conferencing, web conferencing, chat, instant messaging, etc.), and asynchronous (e-mail, threaded conferences/discussions, content management systems, etc.). Blended solutions are possible from the structural point of view (e.g. to combine face-to-face and online activities) as well as for timing (e.g. to combine asynchronous and synchronous interactions). This is often the model adopted in networks of teachers oriented to training activities. Tools for interactions should not be necessarily very sophisticated. People tend to use tools that are more familiar with and of daily usage for them (e.g. e-mail is the technology most widely used not only in networks limited in number and scope but also in large networks such as Prometheus and NoE). A clear advantage should be seen to use other more specialised tools. Technology infrastructure can evolve during the life of the community. For example, in NoE, clusters of people oriented to specific activities are supposed to contribute to the evolution of the general infrastructure of the network both in terms of requirements and of development. This procedure is thought to better fit evolving needs and objectives.

It is important to observe that, even if the technology adopted is not neutral with respect to the purpose of the network and its management model, a learning network cannot be identified only with the technology adopted. It is not the tool that increases the quality of the interactions but clear goals to be pursued together.

Community issues such as composition, diversity, grouping, and social interaction, forms an area of concern which is crucial as far as the success of online learning communities. For example, the heterogeneous composition of participants can imply a variety of objectives, cultural backgrounds, and motivations that, if not carefully considered and orchestrated, can have a negative impact on the virtual community. Trust is another important factor in communities that want to generate long-lasting interaction. Trust is in the community and in other members. Trust in the community derives from valuable results and rewards for participants and from a reliable environment. Trust in other members is generated by clear (even if different) motivations, a balanced work and involvement among members, and possibly, the opportunity to meet face to face on occasions. As pointed out in NoE, grouping together according to some aim (a common theme to be discussed, a joint project, etc.) creates subsets in a community, increasing its efficiency. Virtual common areas for groups are important as well as the possibility of meeting sometimes face to face.

Complementary to the community area, there is the area of **individual issues**. Identity, personal commitments, rewards, motivations and frustrations are all issues related to this area. For example, the chance for initiating contacts between unknown members increases based on the quality and quantity of information on members' identity and motivations. Usually a virtual learning community strongly depends on the personal commitment and work of its members (often of a limited subset of them). Such work and involvement should be acknowledged and rewarded through forms and mechanisms that are to be negotiated within the community. In large networks, differences of backgrounds, motivations, and objectives can result in an un-balanced involvement and personal commitment of members, thus creating negative effects on the virtual community, such as a cut of interactions, reciprocal accusations, a reduced sense of belongings, etc. This was evident in Prometheus but can be a risk for NoE too. What appears clear is that on-line interactions should be carefully scaffold and directed towards concrete objectives. When goals are clear valuable results can be obtained. A key aspect in individual relationships is members' reputation. Reputation derives from general information on each member, but, more important, is built on the basis of the interaction and content developed within the network.

As the above briefly sketched framework points out, the analysis of a learning network is a complex activity which requires taking into consideration issues from different but interrelated areas. The balance between such different areas and issues is the key for the success of the network. Finding a balance does not mean necessarily that inherent conflicts and tensions are to be solved but that they should be used to drive the dynamics of the networks (Barab, Makingster & Moore, 2003). For example, in Prometheus the heterogeneous composition of the network as well as the difficulty to point out clear aims and goals to be pursued together determined an unbalanced involvement of participants that, on occasion, caused a sense of frustration and a reduced sense of belongings. These factors had a great impact on the initial phases of the network life and reduced when a reputation for active participants began to be built and shared concrete goals were shaped. Such processes in large networks usually require time to be developed and require adequate sustain and management. This sustain should be assured for a period whose length depends also on issues as objectives, and chosen organisational model.

NoE can rely to a longer support time from the EC, and this support is specifically finalized to foster integration and joint activities among participating institutions and organisations. The risk is in the fact that integrating activities can be perceived as objectives "external" to the organisation life and that a context cannot not be really created within the institutions to promote their development. Networks with a limited number of participants and with more concrete and clearer goals, such as, for example, networks of teachers oriented to training, are, in principle, easier to be established and run. Nevertheless, too narrow perspectives could be an insufficient stimulus for participants that in the long run could result as a braking factor for the network life.

The previous considerations and the examples briefly analysed point out that computer-mediated communication can be the basis for people with shared interests to form and sustain relationships and communities. This is particularly true for networks oriented to straitening relationships among institutions, groups, and individuals sharing an interest in computer enhanced learning. On-line learning networks can create value from a combination of content and people knowledge. They can vary widely in the strength and permanence of their connections and resources necessary to maintain them. Aspects both pragmatic and social in nature have to be carefully considered in the process of initiation of on-line networks. Such process entails taking into account overlapping issues and tensions which can be analysed trying to delineate different scenarios that can be seen as possible trends in on line learning networking.

4. SOME POSSIBLE SCENARIOS

The delineation of possible scenarios can be done considering two main interlinked lines: networks organisation and structure and their level of establishment.

The interplay between these lines gives rise to some possible scenarios that can be considered as examples of different trends and prevailing characteristics. Previously discussed issues can help to define such interplay and to outline the main features of these scenarios. Of course, these scenarios do not refer to any specific concrete case and are not to be intended as polarities along a continuum but as a reference to understand tendencies in networks development and running that can inform both design and research.

This attempt wants to offer researchers/designers with some elements from which they can build their own generalisations so that they can confront and potentially overcome the challenges they face when analysing and designing online based communities.

Figure 2 offers a synthetic description of possible scenarios that have been delineated according to the two main lines considered. Issues evidenced for each scenarios have been selected trying to sketch some prevailing trends and do not want to be exhaustive of the different tendencies (see also Mikkela, 2002).

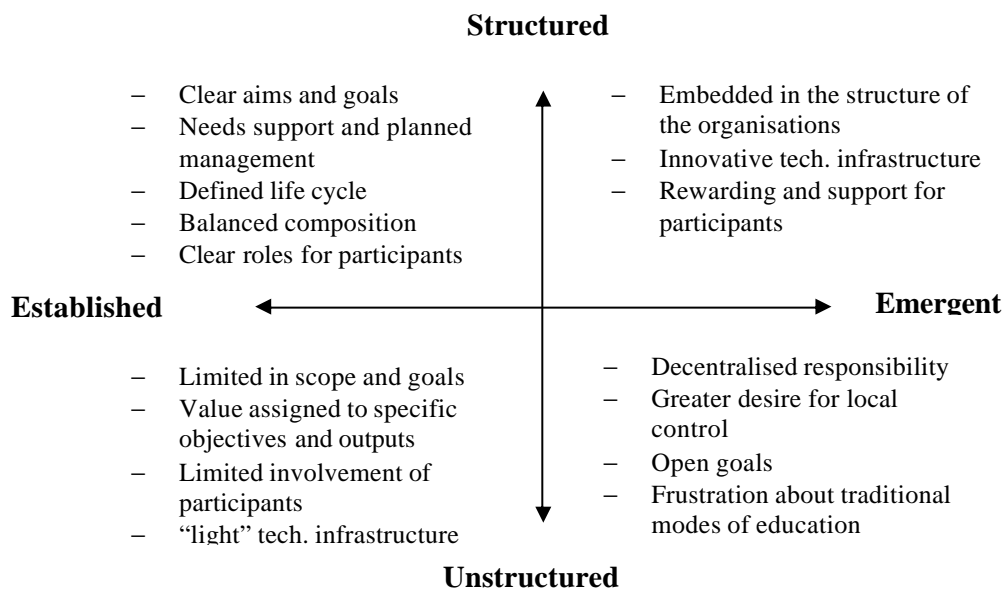


Figure 2: a sketch for possible on-line network scenarios according to main lines: networks organisation and structure and their level of establishment

5. CONCLUSIONS

Progressively the idea of using the internet as a platform to mediate social interactions and learning at different levels has affirmed itself, and this has given rise to a huge number of spontaneous and planned collectives, which are often described as on-line learning networks.

Computer-mediated communication can be the basis for people with shared interests to form and sustain relationships and communities (Hiltz & Wellman, 1997). Compared to communities "offline," computer-supported communities tend to be larger, more dispersed in space and time, more densely knit, and have members with more heterogeneous social characteristics. Despite earlier fears to the contrary, online communities can provide sociability as well as information and instrumental aid. However, for this to occur takes both the right software to support group communication, but also an emphasis upon collaborative learning approaches rather than individual learning. Important aspects both pragmatic and social in nature have to be carefully considered in the process of initiation and running of on-line learning networks. Such process is not easy and may be problematic.

This paper, through the exploration of some aspects involved in the existence, emergence, and management of examples of networks, wants to give a contribution to the general debate around organisational, motivational and technical constraints that affect the generation and the successful maintenance of on-line networks. It discusses some crucial areas and issues in networking process and briefly delineates possible scenarios making a specific reference to the straitening of relationships among institutions, groups, and people sharing a common interest in studying the potential benefits and drawbacks of computer mediated learning.

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