e-Learning, Social Networks Analysis and the Diffusion of Innovation

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Abstract

The present paper is an attempt to analyze the dynamics of the diffusion of an innovative model of learning within a classroom of medical students. The role of structure in the direct and indirect ties among the students, their personal characteristics, and their participation to the e-learning activities in the spreading of innovation have been modeled like the diffusion of a contagion within a social network. The students' social network spontaneously self-organized in several "factions" of like minded students, and the diffusion of the adoption of an innovation have been conditioned by indirect influences and by the general cultural level. The role of web based interactions in the adoption of an innovation has also been analyzed.

1 Introduction

According to the model of participation, learning is the process of becoming a member of a community by the participation to cultural events and social activities (Lave & Wenger, 1991). Direct and indirect interactions among the members of a given society affect the diffusion of beliefs, opinions, knowledge that in turn affect the dynamics of the interactions (Giani, 2005). From this point of view, the learner is an entire social system that can be described at several levels of details: i.e. from dyads of individuals to the humankind (Giani, 2008). By using a metaphor, one can hypothesize that a social learning network behaves like a sort of diffuse brain where the connectivity of the "neurons" (individuals or agents) causes the emergence of the macroscopic properties of the system. It is reasonable to suppose that web based learning can provide further information about the typologies of significant interactions among the members of a learning community.

Thus, the problem is to grasp the associations between the relational structure of the agents and the diffusion of culture and knowledge. In particular, it is crucial to understand the balance between personal and social factors and the role of e-learning in the development of creative learning. According to the social network analysis each actor influences many significant "others" and, in turn, is influenced by other actors. Thus, the structural properties of the network cannot be deduced from the behavior of the single actors.

The similarity of knowledge and beliefs among the actors of the learning process is probably at the same time the main factor that induces people to form groups and the result of the interactions within the groups. These interactions reinforce the similarity intra-group behaviors and knowledge. In fact, according to the social learning theory (Omrod, 2999) and the social interdependence theory of cooperative learning (Skon *et al.*, 1981), people learn through the observation, imitation and the adoption of behaviors of "significant others" by means of the joint participation to events and meetings that create links among agents who create in turn links among events. From this point of view, the participation to the network activities is composed of a set of events that allow the connections between people and of people that create those events.

In this framework, interesting is the analysis of the role of the web in the dynamics of the diffusion of the adoption of an innovation within a learning community.

The present paper describes an application of a modification of the contagion theory (Ropoport, 1953) to the adoption of innovative models of learning with the aim of evaluating whether and in what extent the proneness of the members of the classroom to adopt innovations depends on the diffusion of the knowledge through the relational network.

2 Materials e methods

The students of the course of Medical Statistics of the University of Naples were invited to register on DVLN[1], an e-learning system based upon a socio-constructive and Problem Based Learning (PBL) approach (Giani, 1997; Giani, 2000). The course is based upon weekly vis-a-vis modules. At the beginning of the module the students are given the task of structuring an ill-structured problem that is open to different possible "interpretations". Then two lessons on specific statistical concepts that can help in structuring the problem are delivered. Finally, a plenary discussion is carried out. Between the start and the end of the week the students are enabled to interact through DVLN which allows to track the interactions of the users.

In the present work the following activities were monitored:

- Forum discussions
- Registration of interesting web sites
- Registration of glossary terms
- Citations of masterpieces, and philosophical or historical essays

In order to analyze the cultural attitudes of each student, the entrance scores to the Faculty of medicine were taken into account:

- General culture
- Biology
- Chemistry
- Mathematics

Each factor was dichotomized at the median value. Thus, each student was described with a set of eight binary personal attributes plus the gender.

In order to evaluate the proneness towards the adoption of a creative way of learning, the students were offered the choice between two different types of final examination:

- A written pass-fail multiple choice test (Traditionalist student, T_students)
- A written pass-fail multiple choice test plus an innovative group work (Innovators, I_students).

Each group of I_students was composed of four-five students who had to freely choose a health problem. Then, each student of the group had to audiotape the narrative of a patient suffering from the chosen health problem. Each narrative was transcribed by means of explicit typographic rules and was uplo-

[1] http://elearning.medicina.unina.it/DVLN

aded onto MEANINGS[2], a web based application which allows to analyze the narratives according to a multi-methodological approach (Giani, 2009).

In the present paper, the MEANINGS-based online version of content analysis (Bauer, 2007) was carried out. Thus, each student had to suggest a personal segmentation of the narrative into meaning units, and to discuss it with the other members of the group until a shared codification of the meaning units was negotiated. The result was discussed in a written document that was registered as a project on DVLN. This way all the projects were accessible to the classroom through the Project Gallery. Teachers and students were allowed to interact online in order to integrate, modify, criticize the projects until they assumed a final shared form.

At the end of the course the students were invited to mention other students with whom they had been in significant contact during the course. The I_students had to exclude the students of their group.

Two different socio-matrices of social influence were defined: direct contacts, ω_1, and indirect contacts, ω_2.

Two different multiple logistic analyses were carried out in order to evaluate the effect of the two different socio-matrices upon the adoption of the innovation.

3 Results

61.2% of the students adopted the innovation. Figure 1 shows the network of the direct significant contacts.

73% of the I_students mentioned other I_students, whereas 60% of T_Students mentioned other T_Students.

The relational structure was decomposed into seventeen different components formed by nodes connected to each other by different paths, but without connections with the nodes of other components.

[2] http://elearning.medicina.unina.it/associazioni

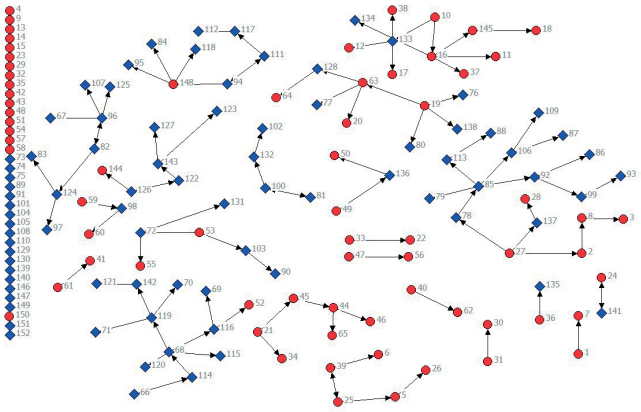

Fig. 1: Graph of the direct contacts: diamonds = I_students; circles = T_students. On the left the isolated students

The direct influence was not associated with the adoption of the innovation, whereas there was a statistically significant association with the indirect influence, gender, masterpieces citations, and general culture. (Table 1).

TABLE 1
Multiple logistic regression. OR and 95% C.I. *: $p < 0.05$, **:$p < 0.01$.

	Factor			
		OR	Lower 95%	Upper 95%
	Direct social influence	2.74**	1.59	4.74
	Geder (M vs F)	5.85**	2.32	14.79
Web based activities	Forum (High vs Low)	0.88	0.25	3.14
	Glossary (High vs Low)	1.00	0.27	3.72
	Web sites (High vs Low)	2.08	0.51	8.56
	Masterpieces(High vs Low)	5.55*	1.02	30.24
Cultural preferences	Culture (High vs Low)	5.37*	1.57	18.32
	Biology (High vs Low)	1.14	0.39	3.33
	Chemistry (High vs Low)	0.67	0.13	3.43
	Mathematics (High vs Low)	2.04	0.68	6.11

4 Discussion

The objective of the present paper was to understand the relative weights

of the personal attitudes and social influences on the adoption of an innovative and creative e-learning model.

Even though each student had been in a significant contact with one or two other students, one can observe some relational chains which allow the diffusion of knowledge and information among students not directly connected. This is the phenomenon known as the "power of weak ties" (Granovetter, 1983). Moreover, the students' social network was characterized by several components, i.e. sub-networks without significant connections with students belonging to other components. Thus, the classroom self-organized in factions, each faction being composed of individuals that were in contact more than with the students belonging to different factions. This agrees with the observation that human beings tend to self-organize in clan, factions, tribes, parties, scientific societies, on the basis of similar opinions, cultural interests, cognitive and learning styles, and so on (like-minded persons).

The I_students mentioned preferentially significant contacts with other I_ Students, whereas the T_students mentioned preferentially other T_students. Thus, one can hypothesize that the students can be split into two different categories of students with similar cognitive and learning styles, attitude towards culture and knowledge, and so on.

The participation to the online activities can be considered as the space where like-minded people can meet and reinforce their common opinions and behaviors.

The indirect contagion was significantly associated to the adoption of the innovation. This means that the social influence manifests through more or less long chains of contacts of friends of friends through which the information flow is iterated several times so generating stable relational structures.

Among the personal factors, gender was associated to the adoption of the innovation: i.e. male showed a higher propensity to the innovation. This result can be explained by assuming that males have a higher proneness to explore new and potentially risky situations.

The general cultural level was statistically associated to the adoption of the innovation.

Regarding the participation to the web based e-learning activities, only the citations of historical and philosophical masterpieces was statistically associated to the adoption of the innovation. This result is somewhat surprising because the discussion forum is usually considered the crucial point of the e-learning activities. Our data showed that the participation to discussion forum, and the suggestion of interesting web sites are not statistically associated to the adoption of the innovation, and represent a sort of interactive background that is common to the entire classroom.

Thus, one can hypothesize that individuals with a wide culture are more

prone to be involved in complex, innovative educational activities requiring a certain dose of creativity and risk.

In conclusion, in order to understand whether and how the social network affects individual learning and whether and how the interactions among the members of the network generate a network dynamics which facilitates or inhibits individual learning, the e-learning platforms should allow the elicitation of the structure of the relations among the students at the beginning of the course, and follow their temporal evolution in order to allow the teachers to develop educational interventions directly on the social network conceived as a whole. These platforms should contain procedures for eliciting the personal attitudes of the students, and in particular stimulating the development of general culture attitudes. Finally, it is necessary to develop reticular models of learning where the emphasis is posed upon the structure and dynamics of the network.

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