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Learning Networks and *Moodle* Use in Online Courses:

A Social Network Analysis Study

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Learning Networks in Online Courses: A Social Network Analysis

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I wish to dedicate this work to the most important people to me. Without any particular order, just that they came into my life. To Antónia, Jorge, Argiro, Mixalis, Maria, Gabriel, Lara and Iris.

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Abstract

This research presents a case study on the interactions between the participants of the forums of four online undergraduate courses from the perspective of social network analysis (SNA).

Due to lack of studies on social networks in online learning environments in higher education in Portugal we have choose a qualitative structural analysis to address this phenomenon.

The context of this work was given by the new experiences in distance education (DE) that many institutions have been making. Those experiences are a function of the changes in educational paradigms and due to a wider adoption of Information and Communication Technologies (ICT) from schools as well as to the competitive market.

Among the technologies adopted by universities are the Learning Management Systems (LMSs) that allow recording, storing and using large amounts of relational data about their users and that can be accessed through *Webtracking*. We have used this information to construct matrices that allowed the SNA.

In order to deepen knowledge about the four online courses we were studying we have also collect data with questionnaires and interviews and we did a content analysis to the participations in the forums. The three main sources of data collection led us to three types of analysis: SNA, statistical analysis and content analysis. These types of analysis allowed, in turn, a three-dimensional study on the use of the LMS: 1) the relational dimension through the study of forums networks and patterns of interaction among participants in those networks, 2) the dimension relative to the process of teaching and learning through content analysis of the interviews; 3) and finally the dimension related to the participants' perceptions about the use of LMS for educational purposes and as a platform for creating social networks through the analysis of questionnaires.

With the results obtained we carried out a comparative study between the four courses and tried to present a reflection on the *Online Project* of the University as well as possible causes that led to what was observed.

We have finished with a proposal of a framework for studying the relational aspects of online learning networks aimed at possible future research in this area.

Keywords: Learning Networks, Moodle, Online Courses, Online Interaction, Social Network Analysis.

Resumo

Esta investigação apresenta um estudo de caso sobre as interacções entre os participantes dos fóruns de quatro disciplinas de cursos universitários, leccionadas *online,* sob a perspectiva da análise de redes sociais (ARS).

Devido à falta de estudos sobre redes sociais de aprendizagem no ensino superior *online* em Portugal escolhemos uma análise estrutural qualitativa para abordar este fenómeno.

O contexto deste trabalhado foi dado pelas novas experiências de ensino a distância (EAD) que muitas instituições têm vindo a fazer. Essas experiências resultam das mudanças dos paradigmas educacionais, de uma maior adopção das TIC assim como devido ao mercado concorrencial.

Entre as tecnologias adoptadas pelas universidades estão os LMSs que possibilitam registar, guardar e utilizar grandes quantidades de dados relacionais sobre os seus utilizadores e que podem ser acedidas através de *Webtracking*. Essa informação foi usada por nós para a construção de matrizes que permitissem a ARS.

No sentido de aprofundar o conhecimento sobre a realidade que estávamos a estudar recolhemos dados através de questionários e entrevistas assim como realizámos uma análise de conteúdo às participações nos fóruns. As três fontes principais de recolha de dados conduziram-nos a três tipos de análises: ARS, análise estatística e análise de conteúdo. Este tipo de análises permitiu, por sua vez, estudar três dimensões relativas ao uso dos LMSs: 1) a dimensão relacional através do estudo das redes sociais e dos padrões de interacção dos participantes nessas redes; 2) a dimensão relativa ao processo de ensino e aprendizagem através da análise do conteúdo das entrevistas realizadas; 3) e por fim a dimensão relacionada com a percepção dos participantes sobre a utilização do LMS para fins educativos e como plataforma para a criação de redes sociais, através da análise dos questionários.

Com os resultados obtidos fez-se um estudo comparativo entre as quatro disciplinas e procurou-se apresentar uma reflexão aprofundada sobre o *Projecto Online* da Universidade assim como sobre as causas possíveis que estiveram na origem do que foi observado.

Terminámos com a proposta de um modelo operacional de uma estrutura de pesquisa dos aspectos relacionais das redes *online* de aprendizagem com vista a possíveis futuros trabalhos nesta área.

Termos chave: Análise de Redes Sociais, Cursos Online, Interacção Online, Moodle, Redes de Aprendizagem.

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Glossary

ADSL – Asymmetric Digital Subscriber Line

B-Learning – Blended Learning

CMC - Computer Mediated Communication

CMCL - Computer-Mediated Collaborative Learning

CSCL - Computer Supported Collaborative Learning

CMS – Course Management System

DE – Distance Education

DEL – Distance E-learning

DL – Distance Learning

DT – Distance Teaching

EADTU - European Association of Distance Teaching Universities

EHEA - European Higher Education Area

E-learning – Electronic Learning

GNU – GNU's Not Unix

HTTP - Hypertext Transfer Protocol

ICT – Information and Communication Technologies

IMM – Interactive multimedia

ISP – Internet Service Provider

KDDB – Knowledge Discovery in Data Bases

LAMP - Linux, Apache HTTP Server, MySQL e PHP

LCMS – Learning Content Management System

LMS – Learning Management System

Moodle – Modular Object-Oriented Dynamic Learning Environment

PHP - Hypertext Pre-processor

PLE - Personal Learning Environment

RIA - Rich Internet Application

RSS - Really Simple Syndication

SNA – Social Network Analysis

SNAPP – Social Networks Adapting Pedagogical Practice

SQL - Structured Query Language

TEL - Technology-enhanced Learning

UNED – Universidad Nacional de Educación a Distancia

URL - Uniform Resource Locator

VLE – Virtual Learning Environment

WBT – Web Based Training

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1. Introduction

1.1 Motivation and relevance of the theme

The changes witnessed in education in recent years raise the question whether we are dealing with a new educational paradigm. Not unrelated to this fact is undoubtedly the creation, in Europe and with the Bologna Process, of the European Higher Education Area (EHEA), which is conducting a synchronization of university degrees between most European countries and a change in education systems. According to Mazzoni & Gaffuri (2010) EHEA could imply a new educational paradigm for many European countries because of the shift from a passive learning system (instructor centred with the use of non-interactive learning methods like lectures and conferences) to a new learning system centred on students and that uses several interactive learning methods.

Simultaneously and according to Allen and Seaman, between 1998 and 2009, the development of tools for group interaction on the Internet involved a 'Copernican' revolution in the field of Higher education leading to an increasing availability of online courses (Juan, Daradoumis, Xhafa, Caballe, & Faulin, 2010).

As a result of all these changes, the traditional methods for evaluating and monitoring the process of teaching and learning have become insufficient to meet the challenges posed by this new type of distance learning mediated by computer. It thus became necessary to develop new models of analysis that allows a better understanding of the activity and provision of teachers, students and groups in online environments. According to Garton, Haythornthwaite, & Wellman (1997) human-computer interaction, online person-to-person interaction, and computer-supported communication within small groups has received more attention than computer-supported social networks. Only recently, have we witnessed a growing phenomenon to study the social networks created in online environments.

If the study of social networks aroused the attention of researchers (particularly with the creation of social networking sites like MySpace, Facebook and YouTube) to the importance of this phenomenon we believe there is still much to investigate in the field of Education Sciences, especially regarding the learning networks created with the use of LMSs.

The use of SNA to study LMSs, in Portugal, is minimal and deserves further research. This would not only determine the characteristics of the LMS, the characteristics of its users and the type of relationships that they establish, but allow a better planning, organization and efficient use of those systems.

Moreover, it is important for the research area of online learning environments, to analyse and understand the type of social networks that are created in the context of distance learning through the use of an LMS (e.g. *Moodle*[1]). According to Scott (2000) the structure of a social network helps determine the usefulness of it for its users. Smaller networks may be less useful to the users than networks with many connections with other individuals / groups outside the main network. Open networks with many ties and social connections are more likely to introduce new ideas and opportunities for its members as opposed to closed networks that have many redundant ties since its members already share the same knowledge and opportunities. Connections with other social worlds also help individuals to have success by having access to a wider range of information (Center of Innovation Management, 2007). Likewise, individuals can exercise influence or act as intermediaries in their social networks to build a bridge between two networks that are not directly linked. Thus it is important to understand what type(s) of network(s) are created online, by LMSs users in an educational context. It is a single closed network of teaching and learning? Or it is a kind of network consisting of other smaller networks that establish connections not only among themselves but with other external networks? And when established what kind of relationships are those and what are their features, benefits and / or challenges? In the online environment the process of teaching and learning is also a process that depends on the networks created and shared. We intend, with our research, to investigate to what extent a LMS allows and encourages the creation of learning networks.

This research proposes an analysis of computer-mediated communication (CMC) in online forums from a SNA point of view. SNA deals with the description of relationships patterns and examines how the involvement in social networks helps explain the behaviour and attitudes of network members (Wasserman & Faust, 1994). This approach facilitates the study of the information flow through direct and indirect connections made on social networks and provides both visual and mathematical analysis of complex human systems (such as relations between

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[1] Acronym for *Modular Object-Oriented Dynamic Learning Environment*. *Moodle*, according to its official site (http://moodle.org), is considered a *Course Management System* (CMS) but is also known as *Learning Management System* (LMS) or *Virtual Learning Environment* (VLE).

people or other agents of information processing) (Garton et al., 1997). But while relations are measurable to the extent that they exist between members, understanding the effect and significance of a relationship between two members requires taking into account the broader patterns of connections within the network.

SNA is based on the intuitive notion that patterns are important features of the life of the individuals who exhibit them (Freeman, 2004). Researchers believe that the way an individual lives depends largely on how he is connected to a large network of social relations. Many believe that the success or failure of societies and organizations often depend on how they organize their internal patterns structures (Garton et al., 1997).

Social networks have become an area of interdisciplinary research. The concept of social networking provides a model for social structure and a large number of formal methods of SNA can be understood through it (Scott, 2000). These methods, rather than treating individuals (persons, organizations, and countries) as discrete units of analysis, focus on how the structure of ties affects individuals and their relationships. This type of analysis contrasts with analyses that assume that socialization through rules determines the behaviour:

Behavior is interpreted in terms of structural constraints on activity, rather than in terms of inner forces within units (e.g., "socialization to norms") that impel behavior in a voluntaristic, sometimes teleological, push toward a desired goal. (Wellman, 1988: 20)

The network analysis looks to see to what extent the structure and composition of relations between individuals can affect patterns. Although this type of analysis leave less room for individual action, for the ability of individuals to influence their success (because of the importance attached to the network structure), it has proved useful for explaining many real-world phenomena. SNA produces an alternate view, where the attributes of individuals are less important than their relationships and ties with other actors within and outside networks (Wasserman & Faust, 1994).

SNA can, according to Müller-Prothmann (2006), help in knowledge sharing focusing on specific applications of knowledge management, as exemplified in table 1:

Table 1 Specific applications of knowledge management (adapted from Müller-Prothmann, 2006)

Identification of personal skills and knowledge
Research on the transfer and sustained conservation of tacit knowledge
Discovery of opportunities to improve the communication process and its efficiency

Regarding the knowledge management goals, SNA can help assess the availability and distribution of critical knowledge and facilitate a strategy for developing organizational knowledge. It can also provide support in developing core competencies, create opportunities to improve communication processes (as mentioned above), identify and support communities of practice, harmonize and manage knowledge networks and, in a sustainable way, also the external relationships (Müller-Prothmann, 2007). Still according to this author in service organizations, relationships (existing ones and development of new ones) are among the prerequisites to create synergetic effects and co-operations.

In a report written by Bielschowsky, Laaser, Mason, Sangra, & Hasan (2009) for the Ministry of Science and Technology of Portugal, on the reform of higher DE in our country, the authors claim that some progress was made in the area of Distance Learning (DL) but yet our country is far from the level of other European countries. This report also says that DL and e-learning areas are not considered 'appropriate' and that there is no fund for this specific research topic. It is also mentioned that most of the studies that were conducted in our country were made in the context of European funding programs. Technology-enhanced higher education is not an area where it was invested much in terms of research in contrast with other European countries.

Additionally Arneberg et al. (2007) said that there is no national policy for e-learning and it cannot yet be considered a viable alternative to traditional educational structures. Despite what Arneberg et al. said, we have witnessed, in recent years, some changes that

(…) have shaped the development of DL in Portugal include demographic changes (massive migration towards the coastal belt), growth of higher education in general; increased accessibility to HEIs through improved roads and transport networks; changes in DL pedagogy and on-site education methodologies and technologies. (Bielschowsky, Laaser, Mason, Sangra, & Hasan, 2009: 5)

Nevertheless, Portugal is still far behind from European countries like Germany, England, Sweden and France who have thousands of students enrolled in online courses. (Arneberg et al., 2007)

Our research tries to explore an area that we believe will be of particular interest in/ for the future. That area is about different contexts of use and implementation of e-learning systems in our country. In this framework we believe that our research will help to increase the knowledge in an area that we consider crucial for the future of the Portuguese educational system.

As part of the personal motivations for conducting this research is the professional context of the candidate. She is a teacher in a private higher education institution, and has been using, for five years, *Moodle* as a platform to support classroom courses and since 2009/2010 for teaching online courses. This context aroused her attention to the use of LMS, DL, e-learning methodologies and analysis of these phenomena in our country.

Before the technological development, increasing use of LMSs in the Portuguese universities, adaptation and flexibility in the face of new forms of training and what is, potentially, a new paradigm of education, the relevance of our study rests on the need to increase the available knowledge in this area in Portugal with a view to better use and implement such systems. The promotion of online courses that have been possible thanks to LMSs (Drázdilová, Obadi, Martinovic, & Snásel, 2010) and the need to understand the distance education predominantly made through it, is the thread of our inquiry. We propose to address this issue from the perspective of SNA to demonstrate that such methods should be part of the organizational design of higher education institutions to support the process of communication, sharing, building and knowledge management.

1.2 Dissertation structure

This dissertation is presented in six main chapters. The first chapter introduces the general theme and goals of the study, explains its relevance and also the personal interest of the candidate in this research area.

The second chapter has the literature review and is composed by five subchapters. Each one tries to describe and deepen themes which in turn correspond to the dominant areas of this research: DE, E-learning, Online Interaction, LMSs and Academic Analytics.

In the third chapter we describe the research paradigms and methodological options as well as the research questions and objectives. Data collection and analysis are also described.

The fourth chapter presents, in different subchapters, the findings for the three types of analysis performed in this study: statistical analysis, SNA and content analysis.

In the fifth chapter we discuss the findings in view with what was explored in the literature review. This chapter also tries to answer the research questions as well as the general and specific objectives.

The sixth chapter has a conclusive character and tries point to some future directions for research in this area.

Following the bibliography are the appendices where the material used for data collection (e.g. questionnaires, interview guides) are presented as well as the schedule for completion of the doctoral program and dissertation.

Finally the attachments consist of documents which are not authored by the responsible of this study, but which served to complement and support the research (e.g. print screens of *Moodle*).

2

2. Literature Review

2.1 Distance Education

2.1.1 Distance Education Progress

Throughout this chapter and the next subchapters, the expressions *Distance Learning* (DL) and *Distance Teaching* (DT) will be used several times in accordance with the option of the authors referenced. This option has to do with the greater or lesser emphasis given to the teaching or learning processes by the different authors. However, in this research we opted to use the term *Distance Education* (DE) for agreeing with Hills & Keegan (1994) who state that both halves of the larger educational process (teaching and learning) are represented in it.

DE in Europe developed primarily from the 1960s and 70s. Some examples were the creation of the British Open University in the UK, the Universidad Nacional de Educación a Distancia (UNED) in Spain, the Dutch Open Universiteit and FernUniversity in Germany and the Portuguese Institute of Distance Education in Portugal. But if these two decades have witnessed the emergence and development of institutions specialized in this type of education, we can find traces of DL experiences dating back to the early nineteenth century, such as the Lieber Hermondes Institute in Sweden or the Sir Isaac Pitman School in the UK (L. Alves, 2011). DL, from its beginning up to today, has come a long way both in supporting technologies and in teaching and learning methodologies. Bielschowsky, Laaser, Mason, & Sangra (2009) describe the evolutionary process since printed courses (with some face to face tutorials) to the enlargement of media role with radio, video and television and computer aided learning.

Anderson & Dron (2011) speak of three generations[2] of DE pedagogy associated with the technologies used by each of those generations. To each generation there is an educational pedagogy related to a cluster of technology as shown in table 2. According to these authors the first generation used postal correspondence technology, while the second was defined by the technology used by mass media. Finally the third generation it is characterized by using interactive technologies. Still according to Anderson & Dron the three generations coexist and none has been elimated which provides DE designers and learners with more available options.

Table 2 Summary of Distance Education Pedagogies (T. Anderson & Dron, 2011)

Generation of distance education pedagogy	Technology	Learning activities	Learner granularity	Content granularity	Evaluation	Teacher role	Scalability
Cognitive – behaviourism	Mass media: Print, TV, radio, one-to-one communication	Read and watch	Individual	Fine: scripted and designed from ground up	Recall	Content creator, sage on the stage	High
Constructivism	Conferencing (audio, video and web), many-to-many communication	Discuss, create, construct	Group	Medium: scaffolded and arranged, teacher-guided	Synthesize: essays	Discussion leader, guide on the side	Low
Connectivism	Web 2.0: social networks, aggregation & recommender systems	Explore, connect, create and evaluate	Network	Coarse: mainly at object and person level, self-created	Artifact creation	Critical friend, co-traveler	Medium

Authors like D. R. Garrison (1985) and J. C. Taylor (1995) also talk about DE generations but describe it in in a perspective more connected with the delivery technologies. In the first generation there was a Correspondence Model based on print technology while in the second, there was a Multi-media Model based on print, audio and video technologies. In the third generation there was a Telelearning Model, based on applications of telecommunications

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[2] According to Anderson & Dron who referred Taylor (2002), with the exception of the use of intelligent data bases it not clear what defines the fourth and fifth generations of distance technologies.

technologies to provide opportunities for synchronous communication. Taylor describes the fourth generation of DE as one with a flexible learning model with Interactive Multimedia (IMM) and CMC and states that new technologies are likely to improve the efficacy of the teaching and learning processes in higher education. Regarding the fifth generation Taylor (1999) says that it derives of the fourth generation and tries to take advantage of the features of the Internet and the Web and calls it *Intelligent Flexible Learning Model*. The fifth generation of DE technology incorporates the use of automated response systems and intelligent object databases in the context of Internet-based delivery and is more cost-effective. According to Taylor the fifth generation of DE technology is likely to transform DE and students experience on campus.

DE is the predominant mode of delivery in the so-called *Open Universities*. The *Open Universities* have also revolutionized long life learning in many countries. "These institutions were inspired by democratization, growing demands for tertiary education, technological developments well suited to mass education, and the human resource needs of modernizing societies." (Savukinas, Jackson, & Caiwei, 2002:165)

According to these authors, the *Open Universities* are distinguished from traditional universities in at least three characteristics:1) are open to a large segment of the population, mostly consisting of people from social groups who do not usually have access to higher education and often admit students regardless of their previous academic record, 2) are opened in the courses they offer which include both the traditional college courses or professional and personal development courses, and 3) are open to different 'times' and 'spaces' of study that in many circumstances are fully determined by the students.

The importance of DE can be seen, over the past decades, in references from the European Union such the Maastricht Treaty and the President Delors White Paper. (Trindade, 1996)

The *White Paper on Education and Training* stated, in 1995, that *Open Universities* have contribute to the development of DL and that information technology will permit a substantial growth in all forms of DT (European Union, 1995). The *Maastricht Treaty* says that one of the Community goals should be the encouragement of DE (Council Of European Union, 1992).

2.1.2 Development of Distance Education in Portugal

In Portuguese universities, the process of DE has existed since 1979 with the establishment of the Portuguese Institute of Distance Education succeeded, in 1988, by the Open University. Our country was even a founding member of the European Association of Distance Education Universities (EADTU)[3] in 1987.

Although there are several contextual changes suggested for the development of DE in Portugal in recent years one first major step was taken, in 1985, with *Minerva*[4] *Project*. According to Freitas (2004) it was an inter-university project for introduction of computers in education. It was created by the Ministry of Education and its goals were to renew the educational system through the introduction of new information technologies in non-tertiary education, including teacher training. The *Minerva Project* was developed in two phases (pilot and operational) and its goals were reformulated more than once.

After the *Minerva Project* (which lasted until 1994) other governmental initiatives[5] with different titles and goals were funded contributing to a slow but steady integration of ICT in the Portuguese educational system which led to the approval, in 2007, of the *Plano Tecnológico da Educação* (*Technological Plan for Education*). One of the main purposes of this plan was to consolidate the role of information and communication technology (ICT) as a basic tool for learning and teaching. That would be possible through the creation of physical conditions that would contribute to the achievement of students and the modernization of schools (Conselho de Ministros, 2007).

Other contextual changes for the development of DE in Portugal are the demographics, the growth of higher education and the changes both in teaching methodologies and in technologies for education. The growing demand for DE in Portugal happens when there is a massive increase access to basic education, when the labour market demands increasing specialized skills and qualifications and when the personal development is specifically triggered by the Information Society (Bielschowsky et al., 2009). Still, compared with the more advanced European countries, the number of students in the DL system in Portugal is very small with only 3% of students enrolled at the university level. These authors suggest several reasons to explain this low level of participation in our country. Among these are a small population, the low rate of

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[3] "(…) EADTU is Europe's institutional network for open and flexible higher education. EADTU is a membership organization." (European Association of Distance Education Universities, 2012)

[4] Acronym for *Meios Informáticos no Ensino: Racionalização, Valorização, Actualização* (*Computer Methods in Education: Rationalization, Valuation and Update*).

[5] Such as *Programa Ciência Viva* (*Live Science Program*) and *Programa Internet na Escola* (*Internet in School Program*).

use of ICT and short course supply in some areas. Also according to these authors only recently has the transition to e-learning pedagogy been made. In addiction the low opinion about this type of education may have contributed to the weak implementation of DE in Portugal. Also traditional universities generally have a low perception of the quality of DL, which still offers only a low number of courses, in a few disciplines. Finally, according to Bielschowsky et al. there is still a large reliance on classical pedagogy.

Currently the only DE institute of higher education in Portugal is the Open University[6]. Pereira, Quintas Mendes, Morgado, Amante, & Bidarra (2007) describe the new pedagogical model of the Open University for undergraduate courses as being student-centred based on the flexible access to learning, and based on the possibility of interaction among the students, teachers and learning resources. However others (Dron, 2007; Harris, 1987) have argued that the use of canned courses with little opportunity for student control is a very narrow description of 'learner centred'.

2.1.3 Distance Education Characteristics

Traditionally, DL was defined as a method of instruction through print or electronic communications in which learners could be in a place or time different from that of the instructors (Gunawardena & McIsaac, 2004).

Borje Holmberg (1985) defined DE as a convergence of various forms of study at all levels, and that is not under immediate and continuous supervision of a tutor but that benefit from planning, guidance and training organized by an institution. This author says that DE has two constitutive elements: pre-produced learning materials and mediated communication between students and a supporting organization.

According to M. G. Moore (1972) DT is a family of instructional methods in which communication between teacher and learner must be facilitated by different kinds of devices like print, electronic, and mechanical ones.

But older DE also has had a dimension of scalability with the possibility of reaching a large number of people at the same time. Perraton (2008) says that DE is a technique of mass

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[6] However many universities have already courses using the DE model.

education that constitutes an attraction to planners because of its capacity to reach large numbers and as a way of raising education quality.

The several definitions of DE are coloured, according to Hills & Keegan (1994) by each authors' image of DE and their own experience and philosophy of education.

Despite all the definitions, Hills & Keegan found some common ground, in several publications, when dealing with the DE concept:

• The rapid evolution of applications in distance education has created a certain amount of terminological confusion.

• Despite the divergent views there are some constants: communication, distance (in terms of time and/or space), the use of media or technologies, planning and organization.

• At present, distance education stands as an umbrella concept covering correspondence courses, televised teaching, radio-broadcast teaching, open learning, computer-assisted instruction, telematic, individualized learning and self-learning.

• Distance education is viewed differently by many authors depending on their personal vision of education, of teaching and of learning.

• For the last ten years, distance education has distanced itself from broadcast- type media and has embraced technologies that offer interactive and individualized communication opportunities.

• Finally, the authors cannot agree upon a common definition. (p. 91)

Wedemeyer (1981) also talks about several terms used to refer to non-classroom-based programs: distance education, independent learning, open learning, and external studies. One of Wedemeyer's[7] most important contributes to DE theory was to focus on independent study or learning. That way it shifted from the correspondence study to the independent study pedagogy by giving emphasis to educational issues concerning learning at a distance (Garrison, 2000).

Wedemeyer (1981) has also reflected about the impact that traditional institutions, methods, and practices had, for many time, on non-traditional learning. To this author the non-traditional learning is a reflection of a schooling and credential-oriented society that although can be fulfilling for the learners it also can leave them frustrated because of its incomplete and distorted image of the actual social needs. Nevertheless the landscape is changing and Wedemeyer believes that profissional and political links with the needs of the learners are being forged by non-traditional learning leaders and community college.

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[7] Wedemeyer also contributed to the establishment of the *British Open University* (*BOU*).

Pyari (2011) states that various forms of DE have existed but a theory has been unfulfilled until recently, despite all the attempts at theoretical explanations made by leading scholars.

According to Amundsen (2001) authors like Otto Peters, Michael Moore, Borje Holmberg, Desmond Keegan, D. R. Garrison (and Myra Baynton and Doug Shale), John Verduin, and Thomas Clark have proposed over the last two decades several theoretical frameworks which have seek to cover all activity in DE.

Otto Peters argues that DE it is a product of the industrial society and compares it to the industrial process in some of its characteristics such as mechanization, standardization, labour division, centralization and mass production. He interprets the distance study phenomenon in light of the structural elements, concepts and principals derived the theories of industrial production (Peters, 1967). Peters also says that DE must change to meet the needs that our society is facing now that is entering a post-industrial or postmodern era.

Michael Moore developed a theory of independent learning and teaching composed by two dimensions: transactional distance and learner autonomy. According to Moore (1991) DE is a transaction that occurs in an environment where students are physically separated from teachers and because of that has a set of special teaching and learning behaviours. The transactional distance is a psychological and communications gap that can lead to misunderstandings between instructors and learners exactly because they are spatially separated.

Moore claims that although much of the theory and practice in conventional education can be applied in DE, the extent of transactional distance is what will determine the design and the practice and it is a function of two variables: dialogue and structure. According to Moore (1991) dialogue happens when the teacher gives an instruction and the learner responds. The extent and nature of that dialogue is influenced by several factors such as the personality of the teacher and learner, the subject matter of the course, the educational philosophy of the responsible for the course design, and the environment. To Moore the most important of the environment factors was the medium of communication.

The structure variable is related to the program educational objectives, teaching strategies, and evaluation methods. The rigidity or flexibility of that structure can be responsible or accommodate, to some extent, the learners individual needs (Moore, 1991). Moore argues there is an inverse relationship between structure and dialogue. High levels of one can produce high quality even with low levels of the other.

The second dimension of Moore's theory concerns learner's autonomy. An autonomous learner controls the learning process and only surrenders temporarily some of his autonomy to the teacher when he needs, for instance, help in formulating his problems, gathering information or judging his progress (Moore, 1972). This author says that what is different is the degree to which instructional programs can accommodate the autonomous learner.

Amundsen (2001) argues that Moore's work has contributed to further theory development in DE by serving as the basis for Garrison, Verduin and Clark frameworks.

Holmberg's teaching theory of guided didactic conversation in DE has evolved over the years and concentrates on the inter personalization of the teaching process at a distance (Amundsen, 2001). Holmberg makes reference to the non-contiguous communication as a process that takes place when the learner and the instructor are separated in time and place. Non-contiguous communication allows, in DE, establishing personal relationship with the learner and it is a prerequisite to learner's motivation. To Holmberg (1985) a constant conversation-like interaction takes place between the student and the tutor and/or counsellor of the supporting organization administering the study through the distance-study course and the non-contiguous communication. That conversation can be on one hand simulated by the interaction with the pre-produced courses and on the other hand real through the written and/or telephone interaction between students and their tutors.

On the other hand Desmond Keegan (1993) believes that DE is not primarily characterized by interpersonal communication because teaching and learning acts are separated by time and place. Also according to this author in DE the strengths of distance are the possibility of the quality materials being developed some time before they are used and the fact that students can be spread over many different locations.

Keegan believes that a satisfactory way to overcome this distance is with the concept of reintegration of the teaching acts. The distance can be reconstructed between learners and teacher by linking learning to learning materials. This author focuses on teaching and he believes that the reintegration of the teaching acts may help compensate for the (distant) location of the students and the lack of eye-to-eye contact. Keegan also argues that the reintegration of the teaching acts is a way to achieve quality education and overcome some of the constraints of DE.

D.R. Garrison proposed a theory of DE that is more congruent with campus based education. This theory is based on the concept of educational transaction that occurs when leaners and teachers seek understanding through dialogue and debate. Since learners and teachers are separated, technology supports the two-way communication needed to ensure the educational transaction. Garrison argues for need to understand the impact that new technologies

have had on DE and its delivery methods (D. R. Garrison, 1985). According to this author we are at a stage where a post-industrial model of DE is emerging and "(…) incorporates highly interactive communications technology along with the ideal of both personalised and collaborative learning." (Garrison, 2006:3)

Another important concept in Garrison's theory is learner control and the importance of collaborative approaches as a way to build knowledge. Control is based in the relation between several factors: independence, proficiency, and support (Amundsen 2001). On the other hand and according to Garrison & Anderson (2009) this independence and control can led to a decrease in interaction and an increase on learner's isolation. For Garrison (2006) control and responsibility for learning can be gained through collaboration between learners. In this collaborative constructivist approach to education meaning results from interaction in communities and networks of engaged learners with conferencing applications.

Verduin and Clark three-dimensional theoretical model attempts to reflect a broader scope of DE while retaining the adult education focus of both Moore and Garrison. Their work is also influenced by Keegan's concept of two-way communication and his notions of the separation of teacher and learner (Amundsen, 2001). The first dimension of the framework is dialogue/support and reflects a primary need of dialogue to support learners. The second dimension, structure/specialized, is related to different degrees of structure needed by the different fields of DE. A high level structure is only needed when many years of study are necessary before a learner is competent enough to set objectives and study methods or to take part in evaluation (Amundsen, 2001).

This second dimension cannot be separated from the concept of specialized competence which is a situational attribute that is usually a function of the structure of the subject matter.

The third dimension is general competence/self-directedness. According to Verduin and Clark (1991), again quoted by Amundsen (2001) student's general and specific competences must be determined before deciding appropriate levels of self-directedness or autonomy. That way it can also be assessed if the appropriate structure and dialogue have been afforded.

Various combinations of the three dimensions are proposed by these authors that consider that it is useful to think of more than one of the categories to be applied to an entire course (Amundsen, 2001).

The synthesis of all these authors' works is shown in table 3. For each author central concepts are presented as well as the major impact their work had and their influences. This table from Lopes (2001) compares the six theoretical perspectives from the six authors.

Table 3 Comparative table of six theoretical perspectives of Distance Education theories (Lopes, 2001). Translated

Author	Central concepts	Major impact	Influence
Peters	Industrial Society Post-Industrial Society	Principles and Social Values	Cultural Sociology
Moore	Transactional Distance	Learner needs	Independent Study
Holmberg	Apprentice's Autonomy Distant Communication Guided Didactic Conversation	Promotion of Learning through Personal and Conventional methods	Humanist Current of Education
Keegan	Reintegration of Teaching and Learning Acts	Recreation of inter-personal components present in face-to-face teaching	Traditional Pedagogy
Garrison	Educational trading Apprentice's control Communication	Facilitation of Educational Trading	Communication Theory Principles of Adult Education
Verduin & Clark	Dialogue / Support Structure / Specialization Competence / Autonomy	Tasks and Learners Requirements	Principles of Adult Education Structures of Knowledge

Despite all these contributions to the theoretical framework of DE theory, Garrison (2000) states that we still need coherent, articulated and flexible theoretical constructs that reflect the practical and evolving approaches to DE. The critical and creative thought in this type of educational experience has a purposeful and a spontaneous nature that should not be constrained.

Hills & Keegan (1994) argue that no global theory of distance education exists yet but theoretical models can be grouped into two large fields of study. The first field is based on the notions of student autonomy and independence and their respective models and some of the authors of reference are Charles Wedemeyer (1981) and Michael Moore (2006). The second field is based on notions of interaction and communication in DE and some of the most prominent authors are Baath (1982) and Sewart (1989).

Despite the theoretical models, the challenges educators are facing with technological developments, led to a change of the traditional definition of DE through the rethinking of concepts such as schooling and lifelong learning. For Gunawardena & McIsaac (2004) distance educators are in the limelight because of the interest of the public about the rapid development of computer

related technologies. Nevertheless these authors think that the systematic design of instruction should drive the development of DL.

Researchers from online DE as well as designers, organizers and instructors have been deigning ways to build online environments that satisfy a wide range of cognitive, educational, motivational and social objectives, while trying to overcome constraints like geographical, technological, financial and organizational constraints (Schlager, 2004).

DL combines a number of characteristics that address the needs and desires of those accustomed to face-to-face classes and the affordances of learning technologies. It is true that in a first instance, these technologies were designed to recreate in the online environment, strategies that have traditionally been developed by classroom teaching such as distribution and sharing of resources, discussions, assignments, evaluation, among others. Some examples of these activities are carried out in DL through the uploading of files to a platform (e.g. a LMS), webcasting, wikis, chat rooms and forums. However, the biggest challenge seems to lie in the enhancement of the quality of learning experiences through the development of new sociotechnical structures and pedagogical strategies (Schlager, 2004).

Due to the differences between more pedagogical or technological approaches to DE, Anderson (2009) and Anderson & Dron (2011) propose a middle ground by referring that not only some technologies incorporate pedagogies but we can also look, to some extent, at our pedagogical processes as technologies. According to Schlager (2004) technologies and pedagogical strategies should come together with the main objective of maximizing the cognitive, social and motivational benefits of the participants. However the transition to this new type of learning cannot occur instantaneously and users need time to adjust (Smith, 1999). Because of this whole context, higher education institutions have a new challenge in their hands. For Mcloughlin & Lee (2008) this new challenge is related to the discovery of new models of teaching and learning to meet the needs and opportunities of a more autonomous and connected generation of learners who seek chances for experimental learning through social relationships.

Due to these challenges, demands, and new opportunities it has not been easy to construct of effective DE environments. The heterogeneity of students and teachers in areas of knowledge, technical and pedagogical preferences are, along with technological development, some of the most pertinent issues in the development and support of systems and distance educational models. According to Thormann & Zimmerman (2012) those guidelines and boundaries can be found when the instructors' knowledge and experiences are applied in a consistent an explicit way. On the other hand Perraton (2008) claim that "[i]f the right model could

be found, the techniques of open and distance learning might be adapted to the needs of some of the millions who drop out of school, or who dropped out in a previous generation." (p. 6)

2.2 E-learning

Even if they are different concepts, DE and e-learning are often associated because of the fact that most of the courses offered by distance use any or several e-learning tools. New fields and technologies make the definition of e-learning even more complex and complicate the differentiation between self-contained e-learning and virtual, leader-led e-learning (Rosenberg, 2006).

Moreover the fact that DE is currently developing especially in online environments leads to the frequent use of the term e-learning to refer to any situation of education in a network which can be confusing, for example, with self-learning situations (Dias & Dias, 2003). The literature on this subject has several definitions, more or less comprehensive for e-learning [8] (J. L. Moore, Dickson-Deane, & Galyen, 2011) while the origins of the term are not certain. Belchior and Freitas (2005) define e-learning as a way of online teaching and learning but refer the existence of a broader conception which includes any and all use of computers[9]. Durah, Alraddadi, Alzubi, & Alzubi (2011) also refer Kheder Durah that in Tashkent-Uzbekistan experts meeting in May 2003 defined e-learning as "(…) the art of converting the brainware of the teacher into a courseware to be shared and disseminated via electronic media" (p. 49)

Rosen (2009) claims there are two main delivery modes for e-learning:

• Synchronous training where instructors meet students for a session at a predetermined time;

• Asynchronous training where students access and use material made available through the Web at any time they needed.it.

Tables 4 and 5 summarize this author view of the synchronous and asynchronous features:

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[8] J. L. Moore, Dickson-Deane, & Galyen (2011) claim that the term "most likely originated during the 1980's within the similar time frame of another delivery mode online learning." (p. 2)

[9] In accordance with the *eLearning Initiative* of the European Union which seeks "(…) to mobilize the educational and cultural communities, as well as the economic and social players in Europe, in order to speed up changes in the education and training systems for Europe's move to a knowledge-based society." (European Comission, 2012)

Table 4 Synchronous Versus Asynchronous Features (Rosen, 2009:61)

Synchronous Courses	Asynchronous Courses
Time-sensitive	Shift workers
On-line seminar series	Training provided on a standard interval (e.g., once every six months)
No budget or time to create asynchronous courses	Workers located around the globe
Personality-focused courses	Workers with unpredictable schedules
Easy assembly of the learners	Trainers with only limited availability
	Continuing need for just-in-time training

Regarding asynchronous e-learning relatively to the content Rosen says it can be categorized into two different modes: rapid e-learning[10] and traditional e-learning[11]. These two modes have fundamental differences as shown in table 5:

Table 5 Differences between Traditional and Rapid e-Learning Courses (Rosen, 2009:67)

Rapid e-Learning	Traditional e-Learning
Content rapidly changes or is updated frequently.	Content is fixed or rarely changes
Content may or may not be generic or have a short shelf life.	Content is generic or has a long shelf life.
Budget is limited or non-existent.	Budget is large.
Information is of a just-in-time nature— a hot topic.	
Time for delivery is short.	Lead time to delivery is relatively long.
Existing content is being repurposed.	The content is original.
Subject can be explained in words.	Subject needs simulations or 3D models.

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[10] "(…) 'rapid' usually refers to the time it takes to create the course, typically a day to two weeks." (Rosen, 2009: 68) The 'rapid' may also refer to: "The amount of time that the user spends reading the material or revisiting it; the quick delivery from concept to the employee; the short cycle before the content needs to be updated; the rapid review cycle." (p. 68)
[11] "Traditional e-learning can be viewed as a Web-enabled version of computer-based training, focusing on providing a multimedia experience including elaborate animations and simulations." (p. 68)

Regardless the mode, e-learning is now facing new challenges with new communication technologies that have been developed to facilitate interactivity through Web 2.0[12]. In Web 2.0 users assume leadership in content creation and some of the sites that stood out were those that gave this new form of experience for cybernauts (see table 6). As an example we can mention YouTube that was ranked by TIME magazine, in 2006, as *Invention of the Year*.

Table 6 Formulation of Web 2.0 (Lencastre, Vieira, & Ribeiro, 2007: 461)

Web 1.0	Web 2.0
DoubleClick	Google AdSense
Ofoto	Flickr
Akamai	BitTorrent
mp3.com	Napster
Britannica Online	Wikipedia
Personal websites	Blogging
Evite	Upcoming.org and EVDB
Domain name speculation	Search engine optimization
Page views	Cost per click
Screen scraping	Web services
Publishing	Participation
Content management systems	Wikis
Directories (taxonomy)	Tagging ("folksonomy")
Stickiness	Syndication

In this context, the development of Web 2.0 enabled an increase in quality using the Internet allowing for greater creativity, participation and socialization. According to Blees & Rittberger (2009) one of the most important trends is related to software especially in the social learning communities.

Also students' needs and their learning processes are taking centre stage (Tomei, 2010; Harry, 2003; Bach, Haynes, & Smith, 2007; Commission of the European Communities, 2008;

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[12] "The concept of 'Web 2.0' began with a conference brainstorming session between O'Reilly and MediaLive International." (O'Reilly, 2010) According to O'Reilly core competencies, combined with Web 2.0 tools and the diversity of platforms are central components in the evolution of Web 2.0. It is also referred to as the "Read-Write Web'.

Prensky, 2005). Students-centred learning[13] can be considered a learning approach characterized by innovative methods of teaching that assume students as active participants in their own learning. They are expected to foster transferable skills such as critical and reflective thinking, and problem solving (Attard, Di Iorio, Geven, & Santa, 2010).

In Encyclopaedia of Distance Learning (Rogers et al., 2009), Lesley Blicker defines a student-centred learning environment as one where active learning strategies and students experience is incorporated by instructors. This view also sees collaboration among students as a way to achieve learning and construct knowledge.

But some other developments are contributing to new definitions of e-learning. The Internet evolution is one of them and surely backed the emergence of the term *e-learning 2.0*. Stephen Downes coined this expression in 2005 as a way to present a new way of e-learning different from traditional one where a set of open-source applications is used by educational institutions instead of enterprise LMSs (Downes, 2005). According to Tomei (2010) e-learning 2.0 allows learners to access content in different ways like search, aggregation, and tagging instead of just having a more passive attitude of receivers, readers and responders. With e-learning 2.0 students collaborate with peers to create content and a learning network where it can be distributed.

Steinert (2010) has a different opinion and states that we cannot define e-learning 2.0 in a concise way because it does not describe anything really new (such as a paradigm, a technology, a model of learning or even a new variety of e-learning). To Steinert e-learning 2.0 requires a change from teaching to learning and it rather describes trends, points of view and several developments. This author also argues that e-learning 2.0 is a self-directed way of learning in social networks that questions (from a constructivist perspective) the 'possibility of indoctrination' because students can only be stimulated and provoked by the environment rather than determined by it.

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[13] Students-centered learning concept has been credit and associated, according to O'Neill & McMahon (Eds) (2005), to the work of authors such as Hayward, Dewey, Carl Rogers, Piaget, Malcolm Knowles and Froebel.

Ehlers (2006) discusses the great challenges posed to the planning, organization and provision of e-learning, by the shift from a distributive mode of e-learning to a collaborative mode of e-learning (table 7) and proposes the model of Computer Supported Collaborative Learning (CSCL).

Table 7 Characteristics of the Distributive and Collaborative E-Learning Model (Ehlers, 2006:165)

e-learning model / Characteristics	Distribution Model	Collaboration Model
Goal of teaching/ learning	Knowledge Qualification	Competence
Knowledge is	Stored, Processed	Constructed
Paradigm	Reproduction, Problem solving, Understanding Remember	Reflection to invent new experience Active social practice
Technology use	Presentation Distribution, Information	Collaboration Communication
Learners mode of involvement	Acquisition Metaphor	Participation Metaphor
Teacher is	Authority or Tutor	Coach Player
Teacher activity	Teaching Helping Demonstrating	Collaboration Interaction oriented practical experiences
Interaction type	Transfer Model	Communication Exchange (interaction) model
Assessment type	Knowledge Reproduction Test, Multiple Choice	Performance, Skill application, Evidence based assessment, e-portfolio

According to this author, one of the main goals of CSCL is the development of different competences based on the acquisition of objectives by individuals in a learning process where they learn together with others through mutual exchange of topics, tasks or by solving problems. The CSCL concept, which follows constructivist learning theories, sees learning as process of construction of an active knowledge which in turn leads to changes in at least three ways (Ehlers, 2006):

- By enabling not only the replication of traditional university classroom education but also the creation of new forms to access content and connect people and resources through the use of technology to form collaborative networks;

- By its individual dimension which discusses the development of competences as a way to empower learners to become self-organized and self-guided, intended for taking part in an emerging learning society;

- By its organizational dimension which argues that if educational organizations want to enter into a knowledge co-construction process with their learners they need to change and to open their rigid traditions towards time and knowledge transfer.

Also because of all of these exchanges concepts such as network learning, flexible learning and hybrid learning systems extended DE and changed the nature of the initial models of lifelong learning. Traditional programs are adopting web-based and web-enhanced courses to join the anytime, anyplace educational frenzy (Gunawardena & McIsaac, 2004).

The evolution of educational systems and their underlying contexts were involved not only in characterizing the concept of e-learning over time, but also in its evolution as can be seen in table 8:

Table 8 Evolution of educational systems and contexts (Kidd, 2010: 48)

Era	Focus	Educational Characteristics
1975-1985	Programming; Drill and practice Computer-assisted learning - CAL	Behaviourist approaches to learning and instruction; programming to build tools and solve problems; Local user-computer interaction.
1983-1990	Computer-Based Training	User of older CAL models with interactive multimedia courseware; Passive learner models dominant; Constructivist influences begin to appear in educational software design and use.
1990-1995	Web Based Training	Internet-based content delivery; Active learner models developed; Constructivist perspectives common; Limited end-user interactions.
1995-2005	e-learning	Internet-based flexible courseware deliver; increased interactivity; online multimedia courseware; Distributed constructivist and cognitivist models common; Social networking; Remote user-user interactions.

E-learning also placed on the agenda quality assurance and assessment procedures issues (PLS Ramboll Management, 2004; Anderson & Elloumi, 2004). Quality assurance standards are no longer just an individual and local concern of schools, but became a concern that crosses different levels of education throughout Europe. PLS Ramboll Management (2004) considers that EU could help developed the quality assurance standards by disseminating good practices from pre-existing models, and by compiling and disseminating checklists of issues that must be taken into account.

The lack of quality ICT-based learning material it is a challenge because its production may be, according to PLS Ramboll Management report, a very resource-hungry process. Therefore it is proposed that the EU take an active role in the process by advising on pedagogical issues and course development. This report considers being of key importance the development and application of common metadata standards for the future development and sharing of digital learning resources provided that there is clarification concerning if metadata should conform to industry standards or to pedagogical models that already exist in Europe.

The growing importance of e-learning led it to be considered, by some authors, as a new educational paradigm:

O e-learning é o novo paradigma educacional que marca a sociedade pós-moderna, assente no conhecimento e na formação ao longo da vida. (…) a necessidade de desenvolvimento de novas capacidades ou aquisição de novos conhecimentos por parte dos indivíduos ou por parte das sociedades, como a forma mais capaz de os vários países responderem ao fenómeno da globalização económica, implicou o aparecimento de um novo paradigma educacional que assenta na capacidade de cada um aprender a aprender (Tavares, 2005).[14]

Currently, the definitions of e-learning cover mainly three areas: the use of ICT in education and training, online education and training and the ability to transform education and training through the use of ICT (Botturi, Cantoni, Lepori, & Tardini, 2009). For our work we adopted the definition of e-learning which considers it as a method of distance learning that uses ICT, particularly the Internet, for the distribution of education, training or education through electronic means. E-learning is thus viewed in the context of an online system of education that is supported by computer systems. For operational reasons, we will designate it as Distance E-learning (DEL).

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[14] Translation: "E-learning is the new educational paradigm that marks the post-modern society based on knowledge and training throughout life. (...) The need to develop new skills or acquire new knowledge by individuals or by societies, as the most capable way of the various countries to respond to the phenomenon of economic globalization, led to the emergence of a new educational paradigm that relies on the ability of each to learn how to learn." (Tavares, 2005)

2.3 Online Interaction

According to Anderson (2003) education has always valued interaction and several authors have reflected on the meaning of interaction and online interaction for the educational process.

Wagner (1994) defines online effective instructional interaction as a reciprocal process that has the purpose of changing the learners' behaviour toward an educational goal through the interaction with his environment.

Rogers et al. (2009) claim that we are witnessing an increasing interactivity between learners, instructors, and contents via CMC.

According to Bowman (2001) each stage of CMC require specific skills and specific instruction given by experienced teachers that facilitate effective online communication among students through encouragement, support, and moderation. These stages include socialization, development/ application/ construction of knowledge, and exchange of information.

This study reflects the importance of understanding the mechanisms of online interaction as a crucial requirement fir the success of online interaction processes and dynamics (Rogers et al., 2009).

2.3.1 The community

The great development of technologies, online social networks as well as learning environments has led to a call for new definitions of community (Hrastinski, 2008).

Encyclopaedia of Distance Learning (Rogers et al., 2009) defines online community as a place where people share common interests and needs on the Internet. Some online communities are open to all and some to membership only. They may or may not be moderate. According to Du, Liu, & Brown (2010) in an online learning community individuals are united by communication media and through online interaction and collaboration develop a sense of trust and connectedness. This connectedness is facilitated by online technologies (computer networking) which removed any notions or constraints of locality (Dawson 2007). According to Rogers et al.

(2009) online learning communities can also be defined as virtual places on the Internet where through proactive and collaborative partnerships learning needs can be addressed. People work as a community by using CMC to achieve a shared learning objective that may have been proposed by an instructor or by the participants and that reflect their personal interests.

The majority of the literature state that meaningful learning can be increased by a sense of community (Du et al., 2010:62). A community depends on the contribution of its members and that is one of the reasons why online participation is important for DE (Rovai 2002; Mazzolini & Maddison 2003; Hew & Cheung 2008; and Hrastinski 2009). The sense of community is reflected on the collaboration established between the participants of communities in the online learning environments.

The use of CMC impacted the definition of community as well as the need for further studies in the area. D. Randy Garrison, Anderson, & Archer (1999) talk about community and its importance to the educational process. They have described the Community of Inquiry model which assumes that learning occurs from the interaction between cognitive presence, social presence, and teaching presence (figure 1). For these authors "(…) a worthwhile educational experience is embedded within a Community of Inquiry that is composed of teachers and students - the key participants in the educational process." (p. 89)
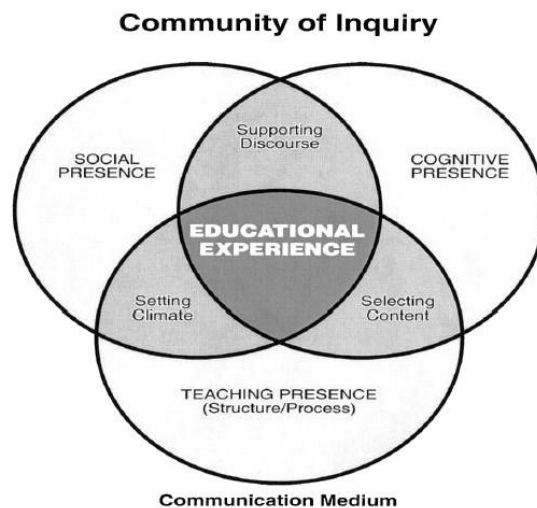
Figure 1 Elements of an Educational Experience (D. Randy Garrison et al., 1999:88)

This model describes cognitive presence as the construction of meaning from a *Community of Inquiry* through sustained communication (Garrison et al., 1999). Social presence allows students to present their personal characteristics to the other participants in the community. Social presence is considered a supporting element of cognitive presence,

(…) when there are affective goals for the educational process, as well as purely cognitive ones, (i.e., where it is important that participants find the interaction in the group enjoyable and personally fulfilling, so that they will remain in the cohort of learners for the duration of the program), then social presence is a direct contributor to the success of the educational experience. (p. 90)

The third element of the model is teaching presence. This element consists of two general functions: the design of educational experience and facilitation, and can be performed by any element of the *Community of Inquiry*[15]. The design of the educational experience consists in a set of activities such as selection, organization and presentation of course contents, design and development of learning activities and assessment. Facilitation is a synonym of shared responsibility between the teacher and the other participants.

While learning communities can be studied from different perspectives they all have one common goal: achieving and facilitating the learning process through the collaboration of its members.

2.3.2 Collaborative Learning

What is exactly collaborative learning? Dillenbourg (1999) proposes a broader definition and says that whenever two people attempt to learn something together we are in presence of collaborative learning. This definition, unsatisfactory to Dillenbourg, raises issues of interpretation such as the number of participants involved, what it means to learn something and the different forms of interaction associated to the expression 'together'. On the other hand, Hiltz & Goldman (2005), present a more descriptive definition of collaborative learning. For them it is a set of pedagogical methods which promotes an active exploration and/or social collaboration among small groups of students who are expected to work together on academic tasks such as simulations, field studies, laboratories and case studies. Collaborative learning is seen as an

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[15] "(…) however, in an educational environment, these functions are likely to be the primary responsibility of a teacher." (D. Randy Garrison et al., 1999: 91)

interpersonal process between participants that through academic problem solving tasks try to learn.

Among the academic benefits[16] of collaborative learning Roberts (2005) mentions the promotion of critical thinking, the involvement of students actively in the learning process, the improvement of classroom results and the appropriate modelling of student problem-solving techniques.

Hiltz & Goldman (2005) reinforce the importance of collaborative learning by saying that the professor goal is to help students learn fluency in the discourse of their knowledge community. Students and professors talk a different language because they belong to different communities and conditions must be created so students can negotiate the boundaries between their knowledge community and the one of the professor.

The use of computers for educational purposes in collaborative communities led to the creation of a study area designated by Computer-supported collaborative learning (CSCL)[17]. CSCL arose in the 1990s as a branch of the learning sciences and tries to bring learners together and offer creative activities of intellectual exploration and social interaction through the development of new software and applications (Stahl, Koschmann, & Suthers, 2006).

According to these authors it is useful to draw a distinction between cooperative and collaborative learning in order to separate CSCL from earlier investigations of group learning. Dillenbourg (1999) defines cooperation as a process where the work is split, sub–tasks are individually solved, and the final output results from the assembly of the partial results of each partner. In collaboration partners do the work together. Dillenbourg points out, however, that even when people work together some spontaneous division may occur.

In collaborative learning individuals negotiate and share meanings (including the construction and maintenance of shared conceptions of tasks) with other group members through interactive processes (Stahl et al., 2006).

The goal for design in CSCL is to create artifacts, activities and environments that enhance the practices of group meaning making. (…)To create the possibility of an enhanced form of practice requires more multifaceted forms of design (bringing in expertise, theories and practices from various disciplines): design that addresses curriculum (pedagogical and didactic design), resources (information sciences, communication sciences), participation structures (interaction design), tools (design studies), and surrounding space (architecture). (p. 10)

For collaboration to take place learners need to participate and the encouragement of that participation has been one of the main challenges of DE. Hrastinski (2008) says that although

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[16] Roberts (2005) also talks about social and psychological benefits.
[17] Also referred as *Computer-Mediated Collaborative Learning* (CMCL).

there are many different perceptions about how online participation should be, many researchers agree that participation is a key driver for learning.

2.3.3 Online Participation

Hrastinski (2008) defines online learner participation as a complex process that can occur both online and offline and in which learning results from taking part and maintaining relations with others. That process includes feeling, thinking, communicating, doing, and belonging.

According to Hrastinski, six levels iteratively emerg when studing researchers' perception of the complexity of online participation: 1st participation as accessing e-learning environments, 2nd participation as writing, 3rd participation as quality writing, 4th participation as writing and reading, 5th participation as actual and perceived writing and 6th participation as taking part and joining in a dialogue.

In the first level conceptions are characterized by participation as equal with the number of times a learner access an e-learning environment and it represents his degree of participation in the online discussion (Davies & Graff, 2005). The most common measure of online learner participation has been the quantity of messages or units. Most online participation studies are in this level.

In the second level, online participation is characterized by the messages or words written by a learner. Those who write more are seen as having participated more actively.

Regarding the third level, online participation is characterized by writing contributions of high quality. Those who write many high quality contributions are assumed to participate more actively (Hrastinski, 2008).

The fourth level equals participation to writing and reading. Those who participate more actively are those who write and read many messages. According to Lipponen et al. (2003) there are two forms of participation in CSCL: writing notes that are shared and can be discussed by the other participants; and reading (lurking) which means that participants do not make any contribution to the discourse.

Hrastinski (2008) states that in the fifth level of conceptions the online participation is equalled with actual and perceived writing. It is assumed that a learner participates more actively when his messages are perceived of importance. An example of this approach is provided by Mazzolini & Maddison (2003) whose research about online learners participation tried to establish a relation between the participation rate of students and the length of discussion threads.

The last level of conceptions of online participation is related with taking part and joining in a rewarding dialogue. Vonderwell & Zachariah (2005) define participation as a process in which students take part and join a dialogue for engaged and active learning.

2.3.4 Discussion Forums

This study focuses on participants' interactions in online discussion forums. Arulchelvan (2011) states that the online forums are located in three dimensions: group atmosphere, cohesiveness and participation. According to him this social space of online communication between multiple users allows them to share their experiences, information, and technical knowhow.

Still according to Arulchelvan online forums began as an off-shoot of the neighbourhood bulletin board and consist "(…) of a tree like directory structure containing at the lowest end topics commonly called threads[18] and inside them posts." (p. 59) Forums are organized into topics and governed by moderators. Arulchelvan considers posters[19] as the driving force behind the community. Posters can have diferent editing rights[20] while moderators have access to all posts and threads in their area of responsibility and answer users' concerns about the forum, general questions, as well as responding to specific complaints. Usually member's details (name and avatar) are in a column on the left side of the post and the post controls are located on the right at the bottom above the signature block.

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[18] "A thread is a collection of posts, usually displayed by default from oldest to latest; although the option for a threaded views a tree-like view applying logical reply structure before chronological order can be available." (Arulchelvan, 2011: 59)
[19] Posters are participants who post in a forum. According to Arulchelvan (2011) "A post is a user submitted message enclosed into a block containing the user's details and the date and time it was submitted." (p. 59)
[20] Usually they are allowed to edit or delete their own posts.

Discussion forums[21] are one of the most common tools used in online teaching in which the teachers give specific guidelines about the nature of discussion, the number and the length of the posts expected from each participant and what is supposed to happen in that thread (Dawley, 2007). Dawley also mentions the misuse that some new online teachers often make by grading the number of posts a student makes. This can place the emphasis on quantity (not quality) which can lead to posting wars between students and create an unnecessary competition.

The strengths and weaknesses of using discussion forums are illustrated by Dawley in table 9:

Table 9 Strengths and Weaknesses of Discussion Forums (Dawley, 2007:72)

Strengths	Weaknesses
• Provides discussion capability • Allows time for in-depth reflection • Peer learning by viewing and responding to work of others • Discussions can continue to build over time or over the length of the entire course • Simultaneous discussions can occur at once, yet they are organized by topic • Builds class community by promoting discussion on course topics • Students can choose post times by a certain deadline • More time to reflect, research, and compose their thoughts • Easy tool for group correspondence • Ability to attach presentations, papers, and so forth • Can post group or individual work • All students can participate in a discussion, thus equalizing student participation • Develops thinking and writing skills • Attachments can be downloaded for further review and processing of information • Instructor can post intermittent feedback • Forums can be created by students or teachers, offering empowerment • Forums create a historical record of the class's progress over the semester • Overcomes issues of race, class, and age discrimination due to lack of visual cues • Guest experts can participate in course by posting information and questions	• No ability to discuss in real-time, creating frustration for some students who want immediate feedback • Shy students can feel "exposed" • Can require multiple logins to participate in discussion during one module, thus negating self-pacing capability, if desired • If misused, it can promote competition instead of cooperation • Teacher must monitor all postings to prevent potential flaming between students • Students must be coached on norms for posting in discussion boards • Teachers may need to spend time creating rubrics to promote effective discussion • Responding to multiple postings can be time intensive for the instructor

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[21] Also known as 'threaded discussions'.

Dawley stresses the potential of discussion forums to create an individual historical portfolio of a student's work. According to this author discussion forums also offer a great opportunity to empower students by building a community, creating connections and engaging participants.

Asynchronous communication offers students the choice of where and when access learning althoug web-based instruction depends on having access to the Web (Fusco & Ketcham, 2002).

To Mazzolini & Maddison (2003) discussion forums can be used for social interaction, as a tool for collaborative work, for discussion (e.g. of assignments), for tutorial purposes or any other teaching strategy. They can be entirely voluntary and be used as a way to engage students (they may be compulsory but they carry no intrinsic assessment weight) or they can be used as a part of the assessment mix.

Despite the different uses that discussion forums may have one of the one of its most important characteristics is the participation. Bach, Haynes, & Lewis-Smith (2007) claim that online discussion need more direction from the instructor at the beginning because they take a little longer to start than classroom discussions. Nandi, Hamilton, & Harland (2012) reinforce this idea by saying that the students' engagement in online forums it is not always automatic and it is not clear yet what is the ideal role of the instructor in the management of the discussions.

These authors mention three levels of participation in discussion forums: 1) 'Lurkers' who simple read the messages and do not participate; 2) participants who use the forum as a notice board, posting and having limited interaction; and 3) participants who use the forum to its full potential.

Gerbic (2003) conducted a study where she found that the most influential factors for students' participation were assessment, genuinely discursive activities, preparation of students for learning through interaction and dialogue, nature of the discussion activities, and presence and feedback from the teacher.

Ho (2002) has defined participation and identified the principal attributes that typify effective participation in online discussions. Online discussions can help learners develop sharing and critical skills that promote a deep understanding of the material. It's a process in which all participants are actively engaged in a text-based communication and where connections are made within elements of learning material or with other independent sources of material.

Blignaut & Trollip (2003) state that learning successfully in an asynchronous online environment depend on the quality of faculty participation that promote the development of

improved skills associated to learner and instructor satisfaction while lowering attrition rates. These authors also refer that the nature of content addressed by the discussion topic, the type of discussion topics or questions, and the style of faculty participation are variables contribute to the quality of online discussions.

Pelz (2004) proposes some strategies for increasing teaching presence on the discussion forums:

1. By facilitating the discussion: a. Identifying areas of agreement and disagreement b. Seeking to reach consensus / understanding c. Encouraging, acknowledging and reinforcing student contributions d. Setting a climate for learning e. Drawing in participants / prompting discussion f. Assessing the efficacy of the process

2. By direct instruction: a. Presenting content and questions b. Focusing the discussion c. Summarizing the discussion d. Confirming understanding e. Diagnosing misperceptions f. Injecting knowledge from diverse sources g. Responding to technical concerns (p. 44)

Different researchers have suggested several instructors' behaviour for improving students' participation in online forums. According to Hew & Cheung (2008) the role of the instructor as a facilitator of online discussion is one important and typical strand of research. These authors suggest that an instructor facilitator should play the role of an encourager and their presence is perceived by students when some characteristics are displayed: a rapid response to the student's original contribution; rapid subsequent responses to student contributions; direct responses to students rather than groups; dispersion of facilitator answers along the thread instead of being clustered together; the instructor respond to at least half of the students' messages; and a pattern of individual student-addressed messages so he can feel that his contribution was acknowledge as an individual one.

Other authors as Cifuentes, Murphy, Segur, & Kodali (1997) believe instructors who help students overcame technical difficulties and set explicit expectations play an important contribution to quality participation in online discussions.

But not all researchers agree that an instructor should always facilitate the online discussion. For example Mazzolini & Maddison (2003) concluded in their study that instructors may have not stimulate discussions and may have even limited the amount and/or the length of discussion threads by being too active.

Online interactions are not just about interactions between the participants but also between participants and content. In this sense Anderson (2003) claims that in educational interaction the participation of a teacher cannot be a defining feature. This author developed an equivalency theorem resulting from his experience of distance teaching where he has concluded "(…) there is a wide range of need and preference for different combinations of paced and un-

paced, synchronous and asynchronous activity, and also a strong desire for variety and exposure to different modes and modularities of educational provision and activity." (p. 4) His theorem (figure 2) explains how the three forms of interaction (student–teacher; student-student; student-content) can support a deep and meaningful formal learning.[22]
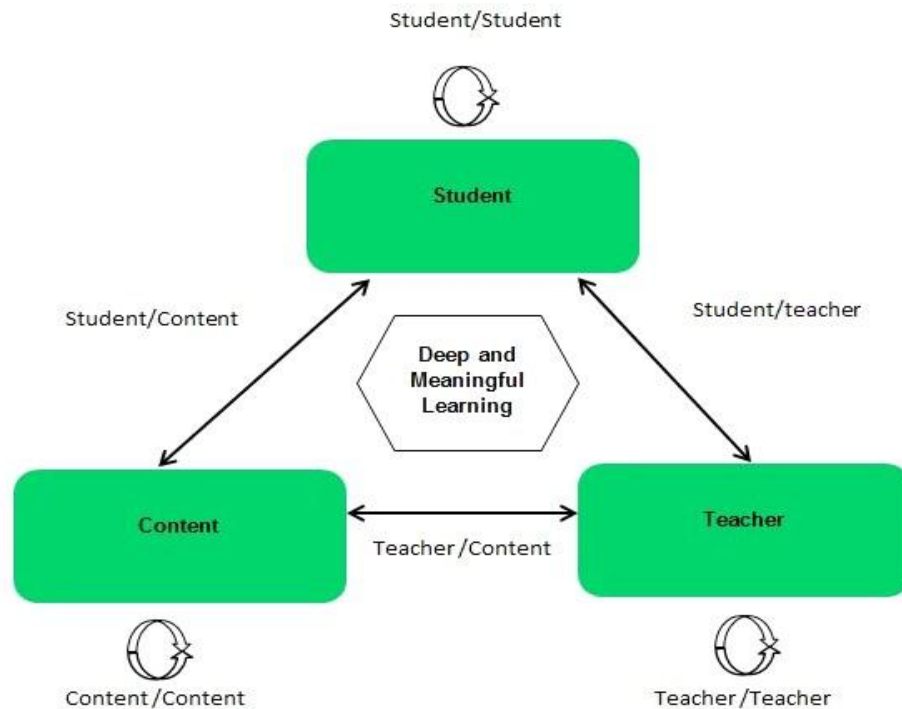
Figure 2 Modes of Interaction in Distance Education from T. D. Anderson & Garrison (1998) in T. Anderson (2003)

Because of the interactive component in communication for educational purposes, T. D. Anderson & Garrison (1998) talk about a shift in the balance of control in higher education because of the demand from learners and society in general for a meaningful and relevant learning to changing needs. In DE that shifts in balance control is also a result of learning networks.

Despite the different perspectives about online interactions we agree with Morris, Finnegan, & Wu (2005) who concluded with their research that successful online learning also depends on the participation in discussions and we believe in the need for research into this topic as "(…) it appears that little substantive research has been carried out (…)" (Gerbic, 2003:272).

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[22] See also Anderson, T. (2010). Theories for learning with emerging technologies. In G. Veletsianos (Ed.), *Emerging Technologies in Distance education* (pp. 23-40). Edmonton, AB: AU Press: Athabasca University.

We hope to contribute, with this research, to strengthening the knowledge available in an area that we consider very important for DE.

2.4 Learning Management Systems

Given the particular framework of student centred learning, the technological progress of support and management systems for this type of learning suffered a great development in recent years. Among these systems we have the LMSs which are one of the areas that characterize online educational systems. In a study on e-learning platforms in Portugal, Lencastre, Vieira, & Ribeiro (2007) have defined a LMS as a DE system specially prepared to facilitate interaction, communication, exchange of documents, and assessment tasks (such as tests). This term also refers to management systems for training processes by electronic means. These management systems can use training resources available in Intranet, Extranet or the Internet.[23]

LMSs are also systems that allow storage of information about the performance of its users as well as other functions such as authoring, personalization, discussion boards, competency management, classroom and knowledge management, certification or compliance training, mentoring, video conferencing, and chat (Learning Systems Architecture Lab, 2003).

Since learning management software has a multitude of functions, the choice of this instrument can be troublesome. Among some factors to consider in selecting this type of software are the instructional training design, the type of audience, the characteristics of the contents and the budget available (A. Oliveira et al., 2009). Although, according to these authors, e-learning is not hostage to a single technology it seems consensus that formal courses in DEL must be supported by more or less closed technologies (like LMSs and LCMS) that only allow access to users previously registered. According to Lencastre, Vieira, & Ribeiro (2007) technology issues should not chair the planning of DEL training systems, but the model and type of training activities to be developed. For these authors technology has certainly an intrinsic value but the development of technological tools for learning should be centred on users and learning processes.

Medien and Kompetenzforschung (Blees & Rittberger, 2009) argue that the educational potential of new technologies does not ensure, by itself, the need to acquire important skills

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[23] This type of training is also called *Network Training* or *Web Based Training* (*WBT*).

including media and methodological ones. Michael Wesch also quoted by Blees & Rittberger (2009) states that the creation of platforms for participation that allow students to deal with the new technological environment is main future challenge to learning.

The use of LMSs assumes that the process of teaching and online learning should be student-centred and that the student takes an unprecedented degree of autonomy as they tend to be self-directed learners. Initiative, independence, curiosity, strong desire to learn, self-discipline, organizations and persistence in learning are some of their main characteristics. These students accept responsibility for their learning and they see problems as challenges rather than obstacles. They can set goals, make plans and set an appropriate learning pace (Lewis et al., 2005).

In selecting an LMS there are many possible options, including the so-called open source systems and the commercial systems. In functional terms, there are no significant differences between these two types of systems (Inversini, Botturi, & Triacca, 2006). However, it must be taken into account the fact that open source systems cannot ensure the software requirements regarding consulting, structural configuration, administrators and users training, maintenance, upgrades, and daily management parameterizations. Despite these limitations, open source produces a cascade effect: each user create new applications, modules or devices (they too under the GNU[24]) 'on top' of what others have already developed (Lencastre et al., 2007).

All these issues will be decisive in choosing the deployment model to be applied. Among the possible models we have the integration, maintenance and hosting ones. In the first model, the software is stored on machines own by the company / institution that also ensure the equipment and software maintenance. In the maintenance model the software is housed in machines own by the company/ institution but the maintenance and management is made by the supplier. In the last model, the hosting one, the software is purchased and installed on ISP[25] servers or another data service provider that also ensures the maintenance of the global system. As an example of the best known open source systems we have the *Claroline*, *A tutor*, *Docebo*, *Dokeos*, *xFront*, *Interact* and *Moodle*. Meanwhile among the most popular commercial LMSs we have the *Apex Learning*, *Blackboard*, *FirstClass*, *Formare*/ *PT-Inovação*, *Learn.com*, *Saba Software*, *Sum Total* and *TWT*.

To make a course effective and efficient the instructor needs to know the different components of the LMS and how these components work in order to create pedagogically sound course content and learning objects. The LMS should have all the necessary e-learning tools to

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[24] Recursive acronym for 'GNU's Not Unix!'. "The GNU Project was launched in 1984 to develop a complete Unix-like operating system which is free software: the GNU operating system." (Free Software Foundation, Inc., 2012)
[25] Acronym for *Internet Service Provider.*

create and manage online learning courses such as tools for assessment, communication, collaboration, and community building (Lewis et al., 2005).

The new possibilities offered by Web 2.0 (in the field of multimedia, reading and writing) led to the emergence of service-oriented applications, such as feeds, and RSS[26] aggregators that allow the sharing of information in an integrated manner as well as the interconnection of content from different sources[27]. The pedagogical value of these applications has led to its adoption or integration in the latest versions of LMSs.

Um dos movimentos mais marcantes desta nova forma de experiência online, e também ele assume agora um certo protagonismo no campo do ensino e da aprendizagem, é o Social Bookmarking, já adoptado de alguma forma pelas LMS de maior relevo, seja com a disponibilização de ferramentas internas ou com a integração com outras já existentes para esse efeito, e que permitem estabelecer vários tipos de relações sociais, profissionais ou académicas de uma forma muito eficaz com indivíduos que partilham algo em comum, e que pretendem alargar o seu círculo de influências. (Lencastre et al., 2007:463) [28]

Academically bookmarking allows, for example, the exponential multiplication of fruitful relationships of exchange of knowledge and collaboration. Before these applications, learning-oriented applications broaden their field of action and it is possible to find in them collaborative learning tools such as forums, chats, and wikis, among others, whose contents can be adapted to users according to certain parameters.

According to Pedro, Soares, Matos, & Santos (2008) who have report results from a national study carried out under the Project "Educational application of learning management platforms", the use of LMSs to support learning activities and stimulate the creation of virtual spaces has been perceive as important. LMSs are especially useful to support cooperative practices, collaborative work, schools' councils activities, and partnerships between schools as well as communication and collaboration with local educational partners.

The new learning platforms allow a personalization of the learning environment and are no longer a mere repository of contents. These environments are called *Personal Learning Environments* (PLE) resulting from the use of new concepts such as informal learning (Jay Cross),

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[26] One of the most popular webfeed formats is *RSS* (*Really Simple Syndication*). The technology of *RSS* allows enrollment in sites that provide *RSS* feeds when carrying out their updates.

[27] Reference to 'semantic web' where the resources of similar nature can relate (to some degree automatically), after its cataloging through labels (tags).

[28] Translation: One of the most remarkable movements of this new form of online experience, and that also assumes now a certain role in teaching and learning, is Social Bookmarking, already adopted in some way by the LMSs of greater importance, either with the availability of internal tools or with integration with other existing for that purpose, and that allow establishing various types of social, academic or professional relationships, in a very effective way with individuals who share something in common, and who want to expand their circle of influence. (Lencastre et al., 2007: 463)

social learning and communities of practice (Ettiene Wegner), and a new learning theory called *Connectivism* (George Siemens) (Lencastre et al., 2007).

2.4.1 The LMS Moodle

This research was done in online classes taught using the LMS *Moodle*. *Moodle* was created by Martin Dougiamas in 2002 (date of release of version 1.0) and is guided by the principles of social constructivist pedagogy in which students are involved in building their own knowledge.[29]According to Fairchild (2010) the concepts behind this learning philosophy defend that students learn more by explaining to others and by adopting a more subjective posture towards the knowledge being created. These concepts run parallel to the way open-source is developed. Quite often developers are users and everyone is free to pick, use and modify the software and the code and refined it through peer-reviewed and open discussions.

Moodle has been developed through the participation of a large community of users around the world who are creating and deploying their changes and / or new software modules. According to its home page *Moodle* is provided freely as open source software which means is copyrighted but users have additional freedoms such as copy, use and modify[30]. This software package enables the production of Internet-based courses and web sites that support a social constructionist framework of education (Moodle Trust, 2012).

Also according to this website, *Moodle* can be used in different ways. Its features allow it to be used by both a large number of students (in the hundreds of thousands) or by a small school with few students. Many schools use this LMS to conduct fully online courses, while others use it as a complement to classroom courses (in a B-learning[31] system). Many users use the *Moodle* modules (forums, databases, wikis and others) to create collaborative learning communities on topics of their interest while others prefer to use it to deliver content to students and evaluate them through tasks and tests. Its flexible technical requirements make it possible to install *Moodle* on almost all computers and run it on shared web servers and managed it through the services of

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[29] You can also watch the video *Moodle explained with LEGO* of Tomaz Lasic here: http://human.edublogs.org/2008/09/30/moodle-explained-with-lego/ (Lazic, 2008).
[30] "(…) provided that they agree to: provide the source to others; not modify or remove the original license and copyrights, and apply this same license to any derivative work." (Moodle Trust, 2012)
[31] *Blended Learning.*

hosting providers[32]. According to Haguenauer & Bechara (2009) *Moodle*, unlike other LMSs, has a framework that combines features and activities that promote learning and that favours the development of environments focused on education, not giving too much focus on the computational tools available.

Paula Flores and António Flores (2007), conducted a study about the teaching and learning process using *Moodle*, and claim that it represents a milestone in changing attitudes in education that can lead to profound changes in the optimization of education because it changes the pedagogical model of information transmission for the knowledge construction. A key factor to the success of teaching is an active and responsible participation of the student in the process of acquiring knowledge through interactivity.

2.5 Academic analytics

According to Baepler & Murdoch (2010) although academic analytics broadly refer the decision making field (practices for operational purposes) it also can be applied to student, teaching and learning issues. It has emerged in higher education as a new field and result from the extensive use of data mining in business and marketing.

Campbell, DeBlois, & Oblinger (2007) claim that academic analytics can improve decision making with its predictive modelling, which combines large data sets with statistical techniques. The predictive nature of academic analytics allows faculty members to intervene by providing them with timely information about students. This can help improve the success of teaching and learning and may become a valuable tool in 'institutional improvement and accountability.

Both academic analytics and data mining describe methods for harvesting and analysing large volumes of institutional data for informing decision making and reporting processes. These methods also apply various statistical techniques in order to identify patterns and correlations (Campbell et al., 2007). Academic analytics is built on the concept of data mining surged in higher education around 1995 at the advent of Internet (Baepler & Murdoch, 2010).

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[32] *Moodle* is designed in the popular *LAMP* platform (an acronym formed by the initials of a set of open source software - *Linux, Apache HTTP Server, MySQL* and *PHP. Linux* is an operating system, *Apache* a Web server, *MySQL* a management system of relational databases and *PHP* a scripting language). One of its biggest appeals is the possibility of running on virtually any server that uses *PHP* (*Hypertext Preprocessor*). In addition it allows the *PostgreSQL* (*object-relational database management system*) to be used instead of *MySQL*.

However there is a distinction between academic analytics and data mining:

Academic analytics is often thought of as hypothesis-driven, using a particular dataset to solve a practical academic problem, such as increasing student retention levels. Data mining, to continue the mineralogical metaphor, is thought of more as a kind of speculative prospecting for riches. A large field of data might unearth all kinds of insensible information that, when manipulated with data mining techniques, might present some useful insights.[33]. Researchers use data mining techniques to sift through data for implicit affinities and hidden patterns without a preconceived hypothesis. They wait for patterns to emerge. (Baepler & Murdoch, 2010:2)

According to Ferguson (2012) learning analytics draws on substantial pre-existing areas of research such as SNA, latent semantic analysis and dispositions analysis. Technological, pedagogical and political/economic drivers have boosted its emergence and development.

This research falls in the categories into which has been made more work in higher education: clustering, classification, visualization, and association analysis. And while the works made in these categories remain largely exploratory the early findings show promise, and learning analytics is one of the fastest growing areas of technology-enhanced learning (TEL) research (Ferguson, 2012).

Although data mining may not provide causality, it may often provide correlations that still yield interesting and powerful results. When applied to higher education, this might mean noticing a particular meaningful behaviour in a CMS.

Regarding online discussions data mining techniques may provide instructors with a key tool for delivering group discussion through, for example, the creation of network maps of online discussions. By mapping the discussions' architecture it is easier to know how a dialogue developed and it is more efficient to see how new threads emerge and/or pinpoint discussion leaders (Baepler & Murdoch, 2010).

S. Dawson (2009) claims that online technologies allow capture and recording of student and staff interactions and bring "(…) an unprecedented opportunity for educators to analyse new data sets for informing and improving pedagogical practice." (p. 751) Still according to Dawson these evaluative opportunities have been beyond the reach of the everyday practitioner and can now be integrated into every teaching and learning plan.

And it is precisely here that comes in SNA.

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[33] "The fact that the latter method—data mining—typically lacks a hypothesis to drive an investigation can seem troubling, but it's a distinction that might be rendered immaterial when it produces insights." (Baepler & Murdoch, 2010: 2)

SNA assumes that social life is apparent from the relationships established between individuals and the patterns that these relationships create (Marin & Wellman, 2010). SNA includes theories, models and applications that are expressed in terms of concepts and relational processes. According to Wasserman & Faust (1994), SNA views network participants as interdependent units that establish links between them through which resources (material and immaterial) flow. The structural environment in which networks are embedded is seen as enhancer or inhibitor of the actions of individuals. The network models conceptualize the notion of social structure as enduring patterns of relationships between individuals.

To perform this type of specific analysis methods are needed. A first possible method is the expression of relational theoretical concepts providing formal definitions, measurements and descriptions to evaluate models and theories in which the central concepts are expressed as relational processes and structural results. This method also allows providing statistical analysis of multi relational systems. In alternative, social networks models can be used to test theories about the structures and relational processes. This type of specific structural theories presents results that can be evaluated from the data collected on the networks. Whatever the method used, SNA need concepts, definitions and processes in which social units are linked together by various types of relationships. SNA require concepts and analytic procedures different from traditional statistics and data analysis and its statistical and descriptive uses are distinct from more standard social science analysis (Wasserman & Faust, 1994).

This type of structural approach is not, however, exclusively of social sciences and is being used, for example, in astrophysics, chemistry, biology and electrical engineering (Freeman, 2004). Although SNA should deal primarily with the relationships established between individuals, other social relations of the animal world can also be the subject of its study because what the researcher is looking are relations patterns, the conditions that gave these patterns and the consequences that they may have.

Before the advent of modern SNA, scholars have used one, or some combination of four possible approaches, in structural research of social phenomena. Still according to Freeman (2004):

Some clarified and extended the basic structural intuition. Some collected the kind of actor-by-actor data that permits the systematic examination of social patterning. Some developed procedures for constructing visual images of patterns of ties. And others worked on computation or spelled out the mathematical properties of social patterns. (p. 3)

Freeman claims that recently, these four approaches were integrated into a paradigm of research and helped define the scope of SNA. This type of research focus on four key elements: 1) SNA is motivated by 'structural intuition' which is based on the ties linking social actors 2) is based on systematic empirical data 3) relies largely on graphics and 4) is based on the use of mathematics and / or computational models. SNA basics are shown in figure 3:

Actors
- Nodes in the network
- Examples: Students and instructors in a class, Informal learnings in an online forum; co-workers in an organization; organizations in an industry or region

Relations
- Lines in the network – Connect actors in **one** specific kind of interaction
- Directed (giving or receiving), **OR** undirected (sharing)
- Example: sharing information; giving social support; teaching and learning

Ties
- Also lines in the network: total connection between actors, comprised of **one or more relations**
- Strong ties (many, important, different, plus intimate relations) or weak ties (few relations)

Social Network Basics

Networks
- Configuration of sets of actors and their ties
- Reveals key actors (star), positions (broker), roles (technological guru) **AND** connectivity, centralization, cliques, isolates
- Can be robust, solid, enduring, based on many nodes, sustaining social capital **OR** sparse, fragile, temporary, dependent and critical nodes
- Co-located and distributed
- Center on work, social and/or learning relations

Configurations of discussion board conversations

Figure 3 Social Network Basics (Haythornthwaite & Laat, 2010:184)

The emergence and development of computers allowed a major breakthrough in SNA. Since the 50's of last century to the present, much software has been set up for this field of analysis: The wide variation of the early programs suggest that the social network community was diverse but the 1980s witnessed several attempts to tie all the separate approaches together and produce a general SNA program (Freeman, 2004).

Among these attempts was the development *UCINET*[34] software whose first version[35] was presented by Linton Freeman in 1983 at the University of California at Irvine. Freeman claims that *UCINET* as well as three other software developed at the same time (*STRUCTURE*[36], *GRADAP*[37] and *SONIS*[38]) played an important role in the progress of SNA community.

Otte & Rousseau (2002) state that only in the early 80s of the twentieth century SNA began his 'career'. The institutionalization[39] of social network analysis (late 1970s), and the availability of basic textbooks and computer software are the major reasons present by them for this beginning.

Among the first authors to write exclusively about SNA there are David Knoke and James Kuklinsky (*Network Analysis*, published in 1982), Barry Wellman e Scott Berkowitz (*Social Structures: a network approach*, published in 1988) , John Scott (*Social Network Analysis: A Handbook*, published in 1991) and Stanley Wasserman and Katherine Faust (*Social Network Analysis: Methods and Applications*, published in 1994).

2.5.2 Social Network Analysis historical references: the first decades

Wasserman & Faust (1994) claim that the pioneers from SNA came from sociology, social psychology and anthropology with authors like Moreno, Cartwright, Newcomb, Bavelas, Barne and Mitchell. The development of graph theory and sociometry were two of the factors with a large contribution to SNA. According to John Scott (2000) even though the term 'sociometry' is particularly associated with Jacob Levy Moreno[40], it represents a description of the research style that came up with the *Gestalt* tradition. Sociometry is a theory of group process that measures relationships and believes that by examining the choices group members make at any given moment we can best know the internal life of those groups. That information can then be used to institute a 'program for positive change' (Moreno, 1987).

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[34] *UCINET* was the software used in this research.
[35] Since its creation the *UCINET* has been improved in later versions, thanks mainly to the efforts of Bruce Macevoy (version 3.0), and Stephen P. Borgatti and Martin G. Everett (in later versions).
[36] Developed by Ronald S. Burt in 1976.
[37] Developed by Robert Mokken, Frans Stokman e Jac M. Anthonisse in 1981.
[38] Developed by Franz Urban Pappi e Peter Kappelhoff in 1983.
[39] According to these authors, the institutionalization of SNA began with the creation, by Barry Wellman, of the *International Network for Social Network Analysis (INSNA).*
[40] Freeman (2004) believes that Moreno early researches about sociometry had an immense contribution of Helen Hall Jennings.

Moreno also defines sociograms[41] as graphs of interactional relations and describes them as method of exploration of sociometric facts that present the placement of every individual and of all interrelations of individuals allowing structural analysis of a community.

Moreno's innovation was the creation of the 'sociogram' as a way of representing the formal properties of social configurations. For Moreno, social settings have identifiable and distinguishable structures and their mapping in sociograms allow the researcher to view the channels through which information flowed and through which individuals might influence each other. The sociogram also allows identifying the groups' leaders as well as isolated individuals to uncover asymmetry and reciprocity as well as the connection strings.

This idea of Moreno was pursued by Dorwin Cartwright and Frank Harary, in 1966, through the representation of groups as sets of points connected by lines. These sociograms or graphs can be analysed by using the mathematical ideas of graph theory (Scott, 2000). Harary, Norman, & Cartwright (1966) present graph theory as being concerned with patterns of relationship among pair of abstract elements making no reference to the empirical world. Nevertheless this theory can serve as a mathematical model with potential usefulness to the empirical scientist because it presents the structural properties of any empirical system. Digraphs[42] represent the communication structure of a group in which members (elements) communicate directly to others (relationship).

The *Graph Theory* was proposed by the Swiss mathematician Leonhard Euler[43] and consists of a body of axioms and mathematical formulas which describe the properties of patterns formed by the lines of a graph (Passerino, Montardo, & Benkenstein, 2007). The graphical representation of network elements and the relationships established between them and the description of the patterns of these relationships was critical to the further development of SNA (Scott, 2000).

Meanwhile SNA development also had the contribution of a research effort that began at Harvard in the late 1920s and that was focused on the study of social structure with researchers like William Lloyd Warner, George Elton Mayo, Fritz Roethlisberger, T. North Whitehead and Lawrence J. Henderson.

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[41] Moreno (1987) claims that although there are numerous types of sociograms "(…) [t]hey have in common that they portray the pattern of the social structure as a whole and the position of every individual within it." (p. 104)
[42] According to Harary, Norman, & Cartwright (1966) the term digraph was proposed by G. Pólya and stands for direct graph. The theory is known as 'Theory of direct graphs'.
[43] The problem 'Seven Bridges of Königsberg' (a famous historical problem in mathematics) from Leonhard Euler, published in 1736, was considered the first result of graph theory.

After the excitement generated in the 1930s by Moreno and Jennings things started to wane. The Harvard group broke up and the 1940s were a kind of 'dark ages' for SNA because of a lack of a general approach to social research and because SNA was not recognize either as a theoretical perspective or an approach to data collection and analysis (Freeman, 2004).

Nevertheless some social network research was done during this period by Kurt Lewin a German Jew psychologist who fled the Nazi regime and went the United States in 1933. Lewin who worked in several places like Cornell, the University of Iowa and MIT. He managed to attract many students to his research such as Alex Bavelas, Dorwin (Doc) Cartwright, Leon Festinger, John R. P. French, Jr., Ronald Lippett, Marian Radke and Alvin Zander.

Also Charles P. Loomis and Leo Katz (from Michigan State College) and Claude Lévi-Strauss (from University of Paris) contributed, during the 1940s, for SNA development by conducting studies about sociometry and structural approach to systems of rules respectively.

Swedish geographer, Torsten Hägerstrand started an effort early in the 1950s at Lund University to identify the process underlying the patterns of a time-dated sequence of maps about innovations spread.

Still in the 1950s we can find the works of Nicolas Rashevsky, Paul Lazarsfeld and Robert K. Merton with general social network conceptions. One of the major contributions of Lazarsfeld and Maerton was preparing students to develop projects of social network research. Among those students were Menzel, Katz and Coleman who have examined interpersonal factors in the diffusion of drug information among physicians; Peter Blau who developed the notion of homophily; Charles Kadushin (1966) who extended and specified Simmel's concept of "social circles." Many of these Columbia students helped in turn to produce another generation of students for the SNA field (Freeman, 2004).

Along with these researchers it is also important to mention Everett M. Rogers (who used some sociometric procedures in the study of the diffusion of innovations), Radcliffe-Brown (development of the concept of social structure), Max Gluckman (disciple of Radcliffe-Brown), Karl Wolfgang Deutsch (structural perspective in the study of nationalism and information flow), Ithiel de Sola Pool (structural phenomena), Morris H. Sunshine and Linton C. Freeman (new approach to the study of community decision-making).

Through 60s, 70s and 80s researchers like Claude Flament (graph theory), Edward O. Laumann (empirical test of the differentiation of social classes as interacting social circles or groups), Robert Mokken (study of interlocking directorates) and Harrison Colyer White (structural model of kinship) contributed to the growth of SNA. One of White's greatest strength was training

students and the list of his students is a virtual 'who is who' in SNA. He created an active network of analysts which included names such as Peter Bearman, Paul Bernard, Phillip Bonacich, Ronald L. Breiger, Kathleen M. Carley, Ivan Chase, Bonnie Erickson, Claude S. Fischer, Mark Granovetter, Joel Levine, Siegwart M. Lindenberg, Barry Wellman and Christopher Winship (Freeman, 2004).

Despite all different network analysis 'schools', the representatives of each have "(…) all joined together and organized themselves into a single coherent field." (p. 135) Freeman claims that one main reason for this may have been that, from the start, contributions to SNA were often couched in mathematical terms and its relative precision. Another reason resulted from the great deal of integrative work[44] by a number of individuals and institutions resulting in bridging among early practitioners of social network analysis.

2.5.3 Social Network Analysis developments

Since the 1980s new researchers have become increasingly interest in SNA. One example of that is Duncan J. Watts and his experiment, with Steven H. Strogatz, on the small world phenomenon (Watts, 1999). More than 150 papers were published on the small world alone and in 1998 there was a follow up done by Collins and Chow. Many of these papers were published in high-prestige journals, like Nature, Science, and Proceedings of the National Academy of Science, Reviews of Modern Physics and Physical Review, and have attracted a lot of attention making SNA become popular (Freeman, 2004).

Another example is provided by the physicists Albert-László Barabási and Réka Albert who reported their findings on tendency of nodes in a network to display gross inequalities in the numbers of others to which they are linked (Barabási & Albert, 1999). Barabási[45] and Albert also developed a model designed to explain that tendency.

Regarding more recent studies conducted within SNA they have been scattered in different areas ranging from the analysis of large social networking sites like YouTube, Orkut and Flickr (Mislove, Marcon, Gummadi, Druschel, & Bhattacharjee, 2007), the study of data analysis

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[44] One of the major examples of the integrative work was the foundation of INSNA, the *International Network for Social Network Analysis*, in 1977, by Barry Wellman.
[45] See also Albert-László Barabási, 2002, *Linked*: The new science of networks. American Journal of Physics (Vol.71). Cambridge, Massachusetts: Perseus Publishing.

methods (Cadima, Ferreira, Monguet, Ojeda, & Fernandez, 2010) to the construction of knowledge in online networks (Wang, 2010). SNA seems thus to have 'contaminated' many areas of research being increasingly applied to a wide range of subjects. The information collected by this type of analysis contributes no doubt to what the guidelines for e-learning, DE and the use of LMSs point: a comprehensive and quality education for an increasing number of people.

Conventionally, the data collected in SNA was inserted into rectangular tables consist of rows and columns. Cases, subjects or observations were placed in lines while the attributes, variables or measures were placed in the columns. The fundamental structure of such data led us to compare the subject of each line as a function of the attributes displayed in columns or to seek similarities or differences between the attributes of the subjects. According to these authors, SNA researcher goes further by looking at this data set in search for a holistic view on them. He will see how all the patterns of individual choices give rise to more holistic patterns. The major difference between the conventional data analysis and SNA is that the first focus on the players and their attributes and the second focuses on players and the relationship that they establish. Most tools used by SNA analysts are not different from those used by other social scientists. What are different are the purposes and emphases of network research when deciding on research design, sampling, measurement, and handling the resulting data (Hanneman & Riddle, 2005).

These authors state that SNA is more of branch of the 'mathematical sociology' rather than a quantitative or statistical analysis although researchers use the two types of approach. Still according to these authors the distinction between these two types of approach is not always clear. The mathematical approach tends to treat data as 'deterministic'. In other words it sees the extent and the power of relationships as reflecting the balance of the network status. This type of analysis also considers that the observations are not a sample from a larger population but the population of interest. In turn, the statistical analyses "tend to regard the particular scores on relationship strengths as stochastic or probabilistic realizations of an underlying true tendency or probability distribution of relationship strengths." (p. 14) In this type of approach the observations are samples from a wider population and the concern for the results lies in the possibility of future reproduction with similar samples. The methodology used by SNA has been discussed by different authors and their classification does not meet consensus although there is agreement on the methods of analysis used and their purpose. Carmean (2010) states that SNA uses a methodology that is neither qualitative nor quantitative, but numeric. For him a systematic determination, assessment, rework, strategic collaboration and knowledge identification within a learning community is done by designers and researchers.

SNA has called the attention of many researchers especially in Europe, North America and Australia. The process of formation of social networks is increasingly associated with the learning process.

According to Chatti & Jarke (2007) connectivism presents learning as a connection/network-forming process in contrast to the behaviourism, cognitivist, and constructivism views of learning.

George Siemens[46] describes connectivism as both a new learning theory and a reconceptualization of how learning takes place in today digital environments. The emphasis on the importance of social networks (especially those created in digital environments through the use of the Internet) to the learning process reinforces the relevance of this study. Siemens, however, goes even further in the importance it attaches to the role of networks.

A network model of learning (an attribute of connectivism) offloads some of the processing and interpreting functions of knowledge flow to nodes within a learning network. Instead of the learning having to evaluate and process every piece of information, she/he creates a personal network of trusted nodes (people and content). The learner aggregates relevant nodes…and relies on each individual node to provide needed knowledge. The act of learning is offloaded onto the network itself – i.e. the network is the learning. (Siemens, 2005)

According to Haythornthwaite & Laat (2010) networked learning goals are to understand the network processes and properties such as relations, roles, ties and network patterns. It is an emerging perspective that asks people how they develop and maintain their own social learning networks. Ferreday, Hodgson, & Jones (2006) claim that networked learning is a specific response to the pedagogical potential that ICT can offer to higher and continuing education. These authors also add that networked management learning assumes that learning emerges from relational dialogue (social constructionist view or theory). This relational dialogue occurs many times through attempts to promote collaboration and interaction supported by communications technology.

The development of technology design to support particular tasks or working relationships are a sign of the importance given to purposeful relationships. (Haythornthwaite & Laat, 2010)

We agree (and have adopted for this research) with Haythornthwaite & Laat about the benefics of a networked perspective on learning because "(…) encompasses more and different relations, looking at the diversity of social relationships people develop, the diversity of ties (weak to strong), and the diversity of relations (work, learning, social) – that make up communities and other forms of social structures." (p. 186)

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[46] One of the founders of *Connectivism*.

3. Materials and Methods

3.1 Research paradigms and methodological options

This research completed a study on the types of learning networks created in four online courses taught through the LMS *Moodle*, in a private institution of higher education in Portugal. Data collection was carried out during the 1st and 2nd semesters of the academic year of 2010/2011.

A case study approach was adopted because it is a methodology especially suited when seeking to understand, explore or describe events and complex contexts in which several factors are simultaneously involved. In the field of education research case studies provide knowledge of both teaching and learning practices and the effect of policy on teaching and learning. Mills, Wiebe, & Durepos (2009) argue that a case study can set standards for good teching practices (through the development and implementation of policy, and a gain of valuable experience by exposure to a particular phenomenon) as well as create konwledge and understanding.

Although the definition of case study has meanings and connotations that vary according to the research area and the paradigms that underlie them, we agree with the definition proposed by Mills et al. (2009) and in which this type of research strategy should include:

• a focus on the interrelationships that constitute the context of a specific entity (such as an organization, event, phenomenon, or person),

• an analysis of the relationship between the contextual factors and the entity being studied, and

• the explicit purpose of using those insights (of the interactions between contextual relationships and the entity in question) to generate theory and/or contribute to extant theory. (p. XXXII)

Yin (2003) adds that a case study is a research strategy with specific approaches to design, data collection techniques, and data analysis. In this sense the case study is a holistic research design aimed at understanding the phenomena and it is not just a technique for collecting and analysing data.

Merrian (1998) states that a case study can be further defined as being focused on a particular situation or phenomenon (particularistic), aiming for a complete description of what is under study (descriptive) and trying to illuminate the reader's understanding of the phenomenon (heuristic). A case study can facilitate the discovery of new meaning, extend previous experience, or confirm what is already known.

This research used both qualitative and quantitative techniques for collecting and processing data, thus it qualifies as a mixed method, case study research. This is in conform with Mills et al. (2009) who state that a case study can be seen as an approach and strategy that uses quantitative or qualitative data, or a combination of both. Typically, the case study studies the characteristics of the unit which is being analysed with the purpose to establish generalizations about the wider population to which the unit belongs from its life cycle (Cohen, Manion, & Morrison, 2005).

Creswell & Clark (2007) provide several arguments for the use of mix methods research. According to them this type of research provides strengths that offset the weaknesses of both qualitative and quantitative research alone. Among these they refer to the weakness of quantitative research in understanding the context and the fact that participants' voices are not directly heard. Qualitative research may also be seen as deficient due to three reasons: the researchers' personal interpretations, the resultant bias, and the limited number of participants studied (difficulty in generalizing).

Another argument for using mix methods research is that it provides a more comprehensive evidence for studying a research problem and researchers can use all of the tools of data collection available. Also it can help answer questions that cannot be answered by qualitative or quantitative approaches alone. According to Creswell & Clark mix methods encourages quantitative and qualitatives researchers to collaborate and encourages them to use their multiple worldviews or paradigms. Finally these authors argue that mixed methods research is "practical" because, as was previous stated, it allows the reseacher to use several methods to adress the research problem, but also because they employ mixed methods natural for 'understanding the world'.

According to Mills et al. (2009) there is no single methodology for a case study and it will depend, ultimately, on the research object.

The use of different sources and methods of data collection allowed us, according to Eisenhardt (1989), a stronger substantiation of constructs and hypotheses. We wanted to contribute to the quality of our study by diversifying the sources of data (as complementary processes) in order to further the answers to our research questions. Mills et al. (2009) argue that high quality analysis is the backbone of substantive case study research because it helps us to deeply access and understand particular aspects of the human experience. These aspects, which are often overlooked or unexamined, are studied through the researchers multiple approaches, triangulation and methodical interrogation.

The evaluation of quality is undoubtedly an important aspect to be considered in research and can be done by developing parameters of validity and reliability. "It is suggested that reliability is a necessary but insufficient condition for validity in research; reliability is a necessary precondition of validity, and validity may be a sufficient but not necessary condition for reliability." (Cohen et al., 2005:105) Also according to these authors, there are different ways to address validity in qualitative and quantitative data. For quantitative data they mention careful sampling, appropriate instrumentation and statistical treatment as ways to improve validity. Regarding qualitative data they propose "(…) honesty, depth, richness and scope of the data achieved, the participants approached, the extent of triangulation and the disinterestedness or objectivity of the researcher." (p. 105) We have tried to use the techniques mentioned above to establish reliability and validity in our quantitative and qualitative data collection and analysis and one of the most decisive one was triangulation.

According to Lather (2003) triangulation is critical to establishing data trustworthiness and includes the use of multiple data sources, methods, and theoretical schemes. It has expanded beyond the psychometric definition of multiple measures and helps the researcher seek counter patterns and convergences to assure data is credible.

Cohen et al. (2005) argued that two or more methods of data collection are used in triangulation. To these authors triangular techniques make use of both quantitative and qualitative data in order to more fully explain from more than one standpoint the complexity of human behaviour. The methods of data collection in our study which were used to triangulate our findings were: questionnaires, interviews and log files produced by *Moodle* in the four courses analysed.

Lather (2003) speaks of four types of triangulation: data triangulation, investigator triangulation, theoretical triangulation and triangulation methods. In this study the triangulation of data was gathered in different social situations, with a variety of people, using sampling strategies at different moments in time.

Reliability is understood and demonstrated differently in qualitative and quantitative investigation. Cohen et al.(2005) argue it is synonym for consistency and replicability over time and groups of respondents. In qualitative research "(…) reliability includes fidelity to real life, context and situation-specificity, authenticity, comprehensiveness, detail, honesty, depth of response and meaningfulness to the respondents." (p. 120)

As for the reliability or replicability of the findings of our study, and according to A. P. A. Alves (2007), those are related to the fact that, taking into account the data, we understand if the results make sense and not the presumption that others would obtain, if the study was repeated, exactly the same results.

Regarding the reliability of the questionnaires applied in this study we have tried to ensure it by pretesting with a small sample of the population in order to assess the need for any adjustments and / or corrections (Cohen et al., 2005).

Reliability is more challenging to achieve in the interviews because each one is unique. Nevertheless Leicester (2012) argues that standardized questions in one-to-one interviews appeared to contribute highly to reliability. We have also allowed respondents, to choose the date and location where the interview would take place. The aim was to provide them a supportive environment so they feel comfortable and provide the information required by the questions.

Case studies can never replace experimentation (Kazdin, 1981) and the debate on validity and how to collect and assess trustworthy data has been going on among researchers. According to Mills et al. (2009) traditional concepts of validity such as internal, external, and construct concept measurement are very important for the study design.

For example, Yin suggests theory in single case studies, and replication logic in multiple case studies to test external validity (or generalizability parameters). A conceptual alternative to validity and reliability appears in Thomas Schwandt's describing authenticity or trustworthiness criteria developed by Yvonna Lincoln and Egon Guba for qualitative studies[47] (p. 52)

Because of the goals of this research (study on the types of learning networks) qualitative structural analysis was used through a method of investigation called Social Network Analysis (SNA). Structural analysis concerns the form of relations between social actors. For structuralist theories social relations form follows principles that escape more or less to consciousness of social actors and whose transgression is extremely difficult (Lemieux & Ouimet, 2004).

Wellman (1988) has defined structural analysis as a way of analysing social structures by studying how resources are allocate in a social system through patterns of ties. He believes the

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[47] Egon Guba and Yvonna Lincoln five criteria for validity are: fairness, ontological authenticity educative authenticity, catalytic authenticity, and tactical authenticity.

strength of structural analysis is in its way of data collection/ analysis, integrated application of theoretical concepts and cumulating body of substantive findings.

According to Wellman structural analysis has five paradigmatic characteristics:

1. Behavior is interpreted in terms of structural constraints on activity, rather than in terms of inner forces within units (e.g., "socialization to norms") that impel behavior in a voluntaristic, sometimes teleological, push toward a desired goal.
2. Analyses focus on the relations between units, instead of trying to sort units into categories defined by the inner attributes (or essences) of these units.
3. A central consideration is how the patterned relationships among multiple alters jointly affect network members' behavior. Hence, it is not assumed that network members engage only in multiple duets with separate alters.
4. Structure is treated as a network of networks that may or may not be partitioned into discrete groups. It is not assumed a priori that tightly bounded groups are, intrinsically, the building blocks of the structure.
5. Analytic methods deal directly with the patterned, relational nature of social structure in order to supplement - and sometimes sup- plant - mainstream statistical methods that demand independent units of analysis. (p. 20)

Lemieux & Ouimet (2004) postulate the existence of two levels of structural analysis: in the first level the theories constructed are limited to treating the regularities in networks and other forms of organization while in the second level theories postulate principles underlying social networks and other forms of social organization. The first level theories were constructed from the research on social networks and that is where this investigation is.

Given the objectives of our study and the context in which it was conducted, the choice for this type of mixed approach has led us to try to contribute to the provision of useful information that would allow, in the future, not only a theoretical explanation of the phenomena of interactivity in learning management systems but also allow informed decisions on action and educational contexts.

3.2 Objectives of the study and research questions

Our research was based on the relevance of the topics described in the literature review and developed from a central problem and three research questions. The professional context of the candidate contributed decisively to the construction of the research problem. The teaching of some online courses, the importance of interactions for the learning process as well as the fact

that there are few systematic studies on types of interactions in online environments in higher education in Portugal demonstrates the importance of this topic.

Problem: What types of social learning networks supported by the LMS *Moodle* are created within higher education and training?

Q1 - What types of social learning networks are formed in LMS *Moodle*, in a Portuguese Higher education institution, as a mediated, on-line teaching and learning environment?

Q2 - What are the patterns of relationships established between users of the LMS, and features, activities that influence the formation of these patterns in the context of distance education at an institution of higher education in Portugal?

Q3 - How can the LMS, as a support environment for social learning networks, contribute to the organizational design and strategy of an institution of higher education in supporting the process of communication, sharing, knowledge building and management at distance?

The specific objectives were:

- Study the *Moodle* platform as it supports the development of social learning networks (its elements and characteristics);
- Determine the relationship, representation, distribution and distance between the users of the forums of the analysed courses[48] - find patterns of relationship in this type of social networks;
- Analyse the relationships and flow of communication in the learning forums among the users individually and in groups;
- Determine the type(s) of network(s) present in the learning forums of the courses studied and their relationship with the participants and their representativeness;
- Compare the different types of social networks created in the forums of the courses;
- Analyse the formation of subgroups within learning networks (moment of creation, participants and their representativeness, characteristics and types of subgroups);
- Identify the moments of formation of the networks within the courses and the possible causes of formation and closure through characterization of the activities undertaken by participants;
- Evaluate the relationship between the network(s) pattern(s) present in courses studied and the possible causes and processes behind the formation of that model(s);

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[48] The description of the courses is made in the section *Context and Participants.*

- Analyse the participants' perceptions of the features, interaction/collaboration (social and learning networks), learning/ teaching process and skills acquisition developed in the LMS context;

- Characterize the teaching / learning processes used in the courses;

- Characterize the strategy for the adoption / use of the LMS *Moodle* by the Higher education Institution;

- Characterize the strategy of the institution that drives the adoption of the particular model of distance education (process, characteristics and evolution);

3.3 Procedures prior to data collection

Prior to conducting this study we requested authorization to the private institution of higher education to collect data from teachers, students and *Moodle* platform. Approval was granted on the condition that the Institution and its participants remain anonymous and that access to the results would be available to the institution.

We explained, to teachers and students, the context of this research and asked them to answer a questionnaire at the end of the courses. We also requested teachers to have access to their courses in *Moodle* for data collection (this access to *Moodle* was done by placing the researcher as a non-editor teacher in the course) and also to participate in an interview.

Anonymity was guaranteed to all participants and participation was voluntary.

3.4 Context and participants

The LMS *Moodle* used to support the courses that took part in this study belongs to a private and cooperative higher education institution that operates in seven campuses in the country[49]. Although the institution offers face-to-face, campus courses, the administration decided

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[49] It also has schools in Mozambique, Angola, Cape Verde and Guinea Bissau.

in the academic year 2008/2009 to begin offering online courses as well [50] using the *Moodle* platform for this purpose. So far, more than three thousand students in all seven schools of the institution have been involved in various online courses. These courses work under a national system of classes with students from (potentially) all campuses of the institution in Portugal. The criteria behind the selection of the courses were essentially two: courses of the institutional matrix[51] and common to all undergraduate programs, and courses with few students enrolled in each Campus, thus creating opportunity to increase cost effectiveness by aggregating students from more than one campus. Despite these general criteria, other factors also influenced the selection of these courses such as the syllabus content and the 'teaching type'[52]. In the academic year in which it was carried out the data collection for this study (2010/2011) only four of the five courses on the institutional matrix were taught online.

Before deciding on the selection criteria for the courses whose forums we would choose for our research we did an exploratory study in the previous academic year (2009/2010) of the data collection. In this study of three different sized *Moodle* forums (small - 10 students, average - 59 students and large - 390 students), from three courses, we wanted to know the influence of class size on learning network patterns as well as the development of those patterns. We also wanted to ascertain whether there were other variables to consider in the analysis of social networks in online learning environments. The results of this study (Fidalgo & Freitas, 2010) revealed no significant differences in network patterns formed in courses analysed but allowed us to redefine the strategy of analysis in particular as regards the need for a content analysis of contributions to the forums.

We have then decided to analyse the four courses of the institutional matrix that were going to be taught online mainly because of two reasons: to increase the size of our sample with students of all undergraduate courses; to have a more heterogeneous sample with students not only from all courses but also with different degrees of *Moodle* usage (from the first and last years of those courses). Regarding the content of the courses, C1 was about epistemology, C2 about anthropology, C3 about general culture and history and C4 about reflection on problems of the contemporary world.

Although the four courses were from the institutional matrix (which means that all undergraduate students have to attend it) they had different number of students enrolled. That was mainly because the same course could be taught in the several campuses by different

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[50] The courses selected, despite being taught at distance also included two face-to-face meetings with the classes (at the beginning of the course and for the assessment).
[51] The courses of the 'institutional matrix' are common to all Undergraduate courses taught at the institution. Those are courses from areas such as anthropology, epistemology, general culture and history.
[52] Theoretical, theoretical-practical, laboratory, field work, seminar or tutorial.

teachers. When there was only one teacher the courses were larger; when there was more than one teacher several classes with lesser students were formed.

The participants in this study were recruited from courses taught by three teachers (one has taught two of the four courses we have analysed) and 371 students (15 from Course 1, 97 from Course 2, 79 from Course 3 and 180 from Course 4)[53] from a total of 683 students registered in the analysed courses (27 of C1, 151 of C2, 303 and 202 of C3 and C4). The students were mostly working students, for the first time in a higher education institution and were aged between 18 and 62 years (more descriptions provided in the *Findings* chapter). Of the four courses analysed, two were from the first year of undergraduate courses and two were from the third and final year. Two of the courses were taught in the first semester (C2 and C3) while the other two were taught in the second semester (C1e C4).

The researcher is a teacher at the institution where data was collected but was not responsible for any of the four courses analysed although some of the students from the courses were (or have been at some point) her students in other courses. The courses teachers have been her colleagues for several years.

She was also in the first group of teachers (called pioneers) that were responsible for the implementation of online educational project in the campuses of the institution. She has trained, over the last four years, students[54] and teachers for using *Moodle* and teachers for educational use of this LMS (see also *Motivation and relevance of the theme* chapter).

The researcher is part of the support office of the *Online Education Project* in the campus where she works. This office's mission is to provide training and support to all students and teachers in technical and pedagogical issues related to the use of *Moodle*.

She is among the teachers making greater use of *Moodle* at the institution, in online courses or as an enhancement to face-to-face classes. She has done previous research on the use of *Moodle* by teachers and by students (Patrícia Fidalgo & Freitas, 2010; Patrícia Fidalgo, Paz, & Santos, 2011; Patrícia Fidalgo & Freitas, 2011a; Patricia Fidalgo & Thormann, 2012).

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[53] From now on we will designate the courses by C1, C2, C3 and C4.
[54] At the beginning of each school year all undergraduate students enrolled in the 1st year are invited to attend training on the use of *Moodle.* The researcher is part of the trainers who give such training.

3.5.1 Learning forums of the courses

Data collection from the LMS aimed primarily at investigating the participatory dimension in e-learning environments more specifically in the learning forums[55] of the selected courses and was done through web tracking. This quantitative technique analyses the log files[56] for tracking changes in the web site over time. According to Nurmela, Lehtinen, & Palonen (1999) collaborative action is seen as a whole and can be enable by web tracking.

Ollington (2008) argues that data collection about whom a message/reply is sent, and about the identity of the receiver of a given message/reply as well as the frequency of visits and time spent on web pages during the navigation on a web is possible through web tracking.

The relational data obtained through the web tracking present some challenges and critical issues due to the difficulty in establishing a direct relationship between the log files and user behaviour. Among these critical aspects is the fact that the IP refers to the users' computer and not to the user creating a need to associate the IP to a user name. Another issue relates to the use of cache (RAM memory of the browser). The upload request to the server can be done from that cache and not to the page server. Finally, another critical aspect relates to determining what was actually done by users when they accessed the system. Have they read, carefully observed, studied, or simply looked at the page's content? And if some of these questions can be answered with information provided by the web tracking we must consider what other type of additional analysis may be necessary, in particular, as already noted, content analyses of the participation of students and teachers in the analysed forums.

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[55] We chose the analysis of the forums created by teachers about the themes of the content they were teaching (we have designate them as 'learning forums') and we left out the 'news forums' because only the teacher can post information and there are no interactions. The 'news forums' are created by default in each *Moodle* course and serve for teachers' announcements. We have also included the *Questions Forums* created by the teachers which serve for students to post questions, doubts, requests, and announcements or share any type of resources with their colleagues. These forums are more informal and do not have a single theme.

[56] "A log file is a file that contains a list of events, which have been "logged" by a computer. Log files are often generated during software installations and are created by Web servers, but they can be used for many other purposes as well. (…) Web servers use log files to record data about website visitors. This information typically includes the IP address of each visitor, the time of the visit, and the pages visited. The log file may also keep track of what resources were loaded during each visit, such as images, JavaScript, or CSS files." (TechTerms, 2010)

In this study relational data of the forums analysed was collected through web tracking which allowed us to construct the adjacency matrices[57] of relational data for undertaking the SNA. One of the main problems presented by the analysis of these matrices is related to the definition of sender / replier especially in the forums (the interface of the forum can have a decisive role here). There is no way to know if the receiver will read or reply to a message and sometimes replies do not refer to a single message but to a series of postings within the discussion as a whole (Mazzoni & Gaffuri, 2010:123). One solution to overcome this problem may be to consider all the participants to respond to a message or read so that the relationship analysed is sender-reader and not, the usual, sender-receiver. Once again an analysis of message content and its placement within the discussion can contribute to solving this problem.

Each course had a different number of forums. That was due to the fact that teachers were free to choose how many forums they would create and what kind of use they would make of them according to their pedagogical model and strategy. The directions they gave to students regarding their participation in the forums were about the type of participation (individual or group), the theme and the goal of the forum and if their participation was going to be assessed or not. Whenever students could participate in group the teacher provided the procedures. C2 teacher was the only one who provided students with a document about how to participate in the forums (see attachment 1).

The learning/questions forums analysed are, with their participants, what we called social learning networks. This designation was due to the fact that students, as participants of the forums, constitute groups whose interaction aimed learning (for this was intended by the teachers themselves who created these forums) through discussion / exchange of resources on subjects taught in the courses. This study aimed to research the frequency, direction and content of the interactions in the forums as indication of the activity of the networks.

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[57] Matrices formed by the relational data of a network. In the two axes of the matrix we find the network participants and in the rows and columns we find the interactions between them. In simple matrices is only indicated if there was (1) or not (0) interaction between the network participants. In weighted matrices is indicated the number of interactions that settled between the participants. Adjacent matrices "(…) represents who is next to, or adjacent to whom in the 'social space' mapped by the relations that we have measured." (Hanneman & Riddle, 2005:53)

3.6.1 Questionnaires and interviews

To collect information from teachers and students questionnaires were administered. According to Freixo (2010) these are the most commonly used instrument in the collection of information relating to persons opinions and conceptions.

The questionnaire has a job to do: its function is measurement. (…)The detailed specification of measurement aims must be precisely and logically related to the aims of the overall research plan and objectives. For each issue or topic to be investigated, and for each hypothesis to be explored, a precise operational statement is required about the variables to be measured. (Oppenheim, 2001:100)

The questionnaires were developed by the researcher because we have not found any instrument already validated that allowed the collection of the information that was needed for this study. After the development of the questionnaires they were pretested with a small sample of the population in order to assess the need for any adjustments and / or corrections. A final version of the questionnaires for teachers and students was then constructed using *Google Forms*. The teachers of the analysed courses asked the students, at the end of the course and through *Moodle*, to complete online these questionnaires. In addition, an e-mail was sent to students from the researcher repeating the request. For the four teachers an e-mail was sent with the request to fill the online questionnaire at the beginning of each course.

Students who attended the two courses in the first semester filled out the questionnaire online, while students who attended the courses during the second semester filled out the questionnaire on paper during class time, so we could get a higher number of responses. The main objective of the questionnaire given to students (c.f. *Appendix C*) was to assess their opinion and perception of the teaching and distance learning process through the use of the *Moodle* platform. The 22 questions in the questionnaire were essentially closed, multiple choice and we used nominal, ordinal, interval and ratio variables as appropriate. The questions were divided into the following subareas: experience / proficiency in the use of the platform, use of platform resources, Internet use and participation in social networks, and sociodemographic characteristics. The questionnaire also contained a section about the teaching and learning process in which students were asked, to respond to twenty two statements using 5 point Likert-like scale (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree and (5)

strongly agree. These statements concerned the functionality of the platform, the process of interaction / collaboration and the development of skills when using *Moodle*.

The data obtained using these questionnaires was analysed using *IBM SPSS*[58] statistics software (version 20) and *Microsoft Excel*[59] in order to meet the objectives of the study. The results were visualized with graphs and tables produced by *IBM SPSS*, and *Excel*[60] (c.f. sub-section *Statistical Analysis*).

The questionnaire for teachers (c.f. *Appendix B*) had a main objective to assess their perceptions about teaching and distance learning through the use of the *Moodle* platform. The 23 questions in the questionnaire were divided between open questions, closed and multiple choices, and we used nominal, ordinal, interval and ratio variables. In this questionnaire, the questions covered the following areas: teaching practice, use of *Moodle* features, resources and activities of the platform, experience and proficiency in the use of *Moodle*, courses taught through *Moodle* and sociodemographic characteristics. The questionnaire also contained a question about the teaching and learning process in which teachers were asked, according to a Likert scale of 5 points (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree and (5) strongly agree, their opinion on twenty one statements. These statements concerned the functionality of the platform and its impact on the process of preparing and teaching lessons, appearance and usefulness of *Moodle* and the process of interaction / collaboration with the students.

The interview was used in our study as a complementary method to gather information and triangulate results. We wanted, in the perspective of Cohen et al. (2005), more insight into the actions and motivations of participants. We have chosen the semi-structured interviews. According to these authors, in this type of conversational and situational interviews data collection is systematic for each respondent and the script increases the comprehensiveness of the data.

The interviews to the teachers were conducted after the end of the courses in locations chosen by them (three in school, one at home) and were recorded on a digital recorder for later transcription and analysis. Although there were only three teachers we have done four interviews because one of the teachers taught two courses, in different semesters, and with different class sizes. We thought that these factors might have some influence in his perception/opinion of the courses and of the learning and teaching process. We used a script (c.f. appendix D) and the purpose was to gather more information on the use that teachers made of *Moodle*, their opinion

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[58] Acronym for *Statistical Package for Social Sciences*. *SPSS Inc.* company was acquired by *IBM* in 2009 and this software has been renamed *IBM SPSS*.
[59] *Microsoft Excel* "is a commercial spreadsheet application written and distributed by *Microsoft* for *Microsoft Windows* and *Mac OS X*." (Wikimedia Foundation, 2012)
[60] For stylistic reasons the majority of tables and graphs were performed using *Microsoft Excel* software despite the fact that analyzes were mostly carried out by *IBM SPSS*.

and experience on the process of distance education, and on the interaction networks created under the courses taught by them.

We also carried out a semi-structured interview to the proponent and main responsible for the implementation of the *Moodle* platform and the *Online Education Project* (c.f. *Appendix E*) at the institution where our study took place. The aim was to contribute to the contextualization of our object of study and understand the strategy and organizational design behind the process of implementation of the *Moodle* platform and its use for teaching purposes by the institute.

3.7 Data Analysis

3.7.1 Data Mining

Data analysis of the *Moodle* courses was performed using a variety of *Data Mining*[61] techniques, including statistics, visualization, clustering, classification and SNA. These techniques were selected because we wanted a detailed analysis of data from the e-learning system. The traditional data analysis in the e-learning systems is essentially driven by hypotheses or assumptions that the researcher intends to confirm. This model is not however sufficient if we want to find more complex and exploratory patterns that relate to different aspects of the data. *Data Mining* "(…) is a process that uses a variety of data analysis tools to discover patterns and relationships in data that may be used to make valid predictions." (Two Crows Corporation, 1999:1) Through this technique we can construct models of analysis for the identification of interesting behaviour patterns and trends in the use that users make of the information. According to Larose (2005) *Data Mining* enables companies to uncover patterns and trends from databases which is a source of empowerment because it provides them with a valuable use for all the data they collect. This also can allow them to take advantage of the important and actionable

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[61] *Data Mining* or *Knowledge Discovery in Data Bases* (*KDDB*) consists of an automatic extraction of implicit and interesting patterns from large databases. (Romero et al., 2008) Recently a research area called the *Educational Data Mining* emerged. It aims to use data mining techniques to discover information and knowledge in the log files of the *Course Management Systems*. (Dringus & Ellis, 2005; Romero, Ventura & García, 2008; Mazzoni & Gaffuri, 2010)

information hidden in their repositories as well as given them a competitive advantage in the market and in relation to its competitors.

In our study we used and adapted the four stages of *Data Mining* for e-learning proposed by Romero, Ventura, & Garcia (2008):

1) Data collection from *Moodle*. *Moodle* stores extensive log files in a relational database (MySQL[62] and PostgreSQL[63] are the most common). Our data collection, as already mentioned, was done through web tracking of log files;

2) Pre-processing of data. Transformation of data collected in an appropriate format for the application of *Data Mining* algorithms. Several pre-processing tasks such as data cleaning, user identification, session identification, path completion, transaction identification, data transformation and enrichment, data integration, data reduction are done manually. (Romero et al., 2008). In *Moodle* pre-processing of data is simpler since it requires authentication from the users (via password) and log entries are saved allowing sessions to be identified. As we intended with our study the analysis of the courses forums, data preparation was limited to the extraction of the matrix constructed with the software Snapp in .vna format (c.f. subchapter of *Social Network Analysis, Clustering and Classification*). These matrices could then be imported by SNA *UCINET* program to perform the required analyses.

3) Application of *Data Mining* techniques for building and running a model that summarizes and discover the knowledge desired. In this step we used the software *UCINET* and *Netdraw* to create and visualize the SNA results. Here we wanted to extract as much information as possible from *Moodle* log files of the interaction of the participants of the courses analysed in order to discover implicit patterns behind them. The other *Data Mining* techniques, including statistical, clustering, classification and ARS, will be presented in subsequent subchapters due to the specificity and magnitude of the same.

4) Interpretation, evaluation and demonstration of results. After analysing the data collected proceeded to interpret the results and evaluate their validity.

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[62] *MySQL* "is the world's most used relational database management system (RDBMS) that runs as a server providing multi-user access to a number of databases." (Wikimedia Foundation, 2012)
[63] *PostgreSQL* "is an object-relational database management system (ORDBMS) available for many platforms including Linux, FreeBSD, Solaris, Microsoft Windows and Mac OS X." (Wikimedia Foundation, 2012)

3.7.2 Social network analysis, clustering and classification

SNA is a method of investigation which is used for qualitative structural analysis. Lemieux & Ouimet (2004) claim that among the advantages of using SNA is the possibility of instructors / teachers monitoring all participants, identifying critical areas of the network (e.g. where actors[64] are isolated), observing the aggregation, reciprocity in the forums discussions, exploring the existence and density of subgroups, among others.

SNA allow us to calculate indexes and draw diagrams that describe and illustrate the individual and collective communicative structure of a network.

There are two levels of relational analysis: the first relates to the analysis of egocentric networks (network analysis of a single participant) and the second level that has to do with the overall network analysis (analysis of social structure focusing all participants). Because we choose to investigate the participations in aggregate in the online forums networks our research falls in the second level of relational analysis.

The unique characteristics of SNA cause the usual statistical tools not to be suitable for the type of analysis and understanding we intended (different measures of interrelationship and network membership). For this reason we chose, for this study, a mathematical tool specific for SNA that enabled us to create indicators that explain the structure of a network, both as a whole and individually. The main function of *UCINET* software was the preparation and manipulation of reticular matrixes[65] that can be described as a package of applications for SNA because it works in conjunction with the software *Netdraw*, *Mage* and *Pajek*. According to *UCINET* authors this software can also be used for other 1 mode[66] and 2 mode[67] data and uses several matrix analysis routines, such as matrix algebra and multivariate statistics (Analytictech, 2010).

From this package of applications we only used *UCINET* and *Netdraw*. This software which can also be used independently, works directly with reticular data, in other words, both actors and their attributes must have as origin a matrix. Thus the analyst may modify the data while the mechanical work of plotting the network is automated. This software allows visualization of graphs of participants' interactions in two dimensions.

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[64] Term used by SNA to refer to participants in a network.
[65] Matrixes with a net shape which have resulted from the networks analyzed. According to Scott (2000), these matrices have many uses. "If the data have been converted from linked lists to matrices in binary or valued form, the spreadsheet can be used to calculate basic statistical measures such as row and column sums, frequency distributions, correlations and so on." (p. 51)
[66] Matrix where rows and columns refer to the same set of entities (Borgatti, 2009).
[67] Matrix where rows and columns index different sets of entities (Borgatti, 2009).

In addition to *UCINET* and *Netdraw* we used *Snapp*[68] software. *Snapp* is an application that was developed as part of the project *Seeing' networks: Visualizing and evaluating student learning networks* funded by the *Australian Council of Learning and Teaching* with the aim of developing information and communication technology resources in the area of data visualization (Wollongon, 2009). According to its authors *Snapp* provides a social network visualization (network diagram) directly below a threaded forum display allowing us to uncover any emerging patterns (Bakharia, Heathcote, & Dawson, 2009:50).

Snapp visualizes the information posted in the forums by the participants, the answers to those posts, which topics are most discussed, what is the 'size' of these discussions, the interactions in the forums, and present them in the form of a social network diagram. For forums facilitators this tool provides an opportunity to, at any stage of course progression, rapidly identify patterns of student behaviour (Centre for Educational Innovation Technology of the University of Queensland, 2010).

This application is especially useful if we are examining a large scale class where monitoring and manual analysis are not viable options. *Snapp* has the following characteristics (Bakharia et al., 2009):

- Visualization of the social network in real time;
- Crossing between LMS[69], the browser[70] and the support to the platform;
- Simple installation and use (you only need to place the link - a bookmarklet[71] in your bookmarks and activate it when viewing the forum);
- Export of data through *VNA* and *GraphML* formats (which can later be analysed in *UCINET* and *Netdraw*).

Snapp, despite allowing a statistical analysis as well as the visualization of networks, was used exclusively to export matrices for subsequent analysis by *UCINET*. This option was made because *Snapp* does not provide values for SNA measures nor does it perform many of the SNA tests.

The use of all these software allowed us a mathematical and visual (graphical) analysis of the networks that we studied.

The main indices calculated by SNA are *Cohesion, Centrality* and *Centralization* and *Closeness*.

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[68] Acronym for *Social Networks Adapting Pedagogical Practice.*
[69] *Blackboard, WebCT* and *Moodle.*
[70] *Firefox, Internet Explorer* and *Safari*.
[71] *JavaScript* program stored as a URL in our favorites.

Cohesion measures statistically how much the individuals socialize in a group (Romero, Ventura, Pechenizkiy, & Baker, 2011). This measure is used to assess the social capital[72] of a group since it reveals the patterns of interaction within that group (Carrington, Scott, & Wasserman, 2005). The reciprocity of interactions helps us know which actors socialize more and therefore have access to more information and resources. The overall level of *Cohesion* of a network is found by the degree of density. On the other hand the degree of *Centralization* of a network allows knowing the extent to which *Cohesion* is organized around focal points (Scott, 2000). Measurements of *Density* and *Centralization* are therefore complementary.

The *Density* of a graph[73] is a proportion of the maximum possible number of connections (the number of lines in a graph) (Scott, 2000). According to Scott, *Density* describes the general level of linking between the members of a network. *Density* is an attempt to measure how far from the state of complete graph, in which every member is connected to every other member, a certain network is. A complete graph is very rare even in small networks.

The *Centralization* index can be defined, according to Müller-Prothmann (2007), as a measure of the degree to which relationships are focused around one or a few central network members. It is a measure of the global centrality of a network and helps us know how dependent the knowledge flow is on few single nodes. If we remove these central network nodes a corruption of knowledge flow occurs.

The degree of *Centrality*[74], in turn, measures homogeneity / heterogeneity of the population of a network regarding the structural positions the members take up (Hanneman & Riddle, 2005). It allows us to know which actors occupy central positions and have potential in terms of 'power' in a network. If an actor has more connections he can gain an advantageous position by being able to meet his needs in alternatives ways and without depending as much on particular actors (Fidalgo & Freitas, 2011).

Centrality is also an indicator of experience and power of actors in a network. It measures the relationships members establish and that are established with them (Müller-Prothmann, 2007). Through the interactions, the actors (e.g. students) who need information or other resources can

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[72] According to Lin (1999) social capital is related to the investment that individuals make to have access to available network resources through social relations. The main objective is to "*enhance expected returns of instrumental or expressive actions*." (p. 39) See also Bourdieu (1980).
[73] Graphical representation of a network known as graph or sociogram. Can be defined as: "(…) simply a set of lines connecting points, and graph theory consists of a body of mathematical axioms and formulae that describe the properties of the patterns formed by the lines." (Scott, 2000:12) The points correspond to network actors (e.g. teachers, students) while the lines represent the interaction between the actors.
[74] One of the most widely used measures of *Centrality* is the one of Linton Freeman, one of the authors of *UCINET*.

get it more easily by occupying a central position in the network where they can establish more contacts and where they are in the 'path' of other actors.

In terms of *Centrality* there are two types of possible relationships between the actors of a network: *outDegree* when an actor contacts other(s); *inDegree* when an actor is contacted by other(s). These two types of relationship can still be measured in relation to 'Talk'[75] and 'Strength'[76].

Two other indices of *Centrality* analysis of networks are related to the distance (neighbourhood) between actors in a network. These indices are named *Betweenness* and *Closeness*. The *Betweenness* index was created by Linton Freeman as a way to analyse the binary relationships established in a network. According to R.A. Hanneman & Riddle (2005) "(…) *Betweenness* centrality views an actor as being in a favoured position to the extent that the actor falls on the geodesic paths between other pairs of actors in the network." (p. 67) John Scott (2000) adds that *Betweenness* allows us to know to which extent an actor has potential for controlling others by playing the part of a 'broker' or 'gatekeeper' in a network. The *Closeness* index measures the shortest distance between a pair of actors. This measure presents the distance between an actor and all other actors and describes similarities and differences in how closely actors are connected to the entire network population (Hanneman & Riddle, 2005:57).

According to these authors, the members of a network who can reach others by short distances are in a favoured position which can be a structural advantage translated into power. The distribution of *Closeness* and distance is seen as a source of power following a logic of structural advantage. For its part, the measure of *Closeness* can be divided, in simple matrices, in *inCloseness* (distance of other actors of the network to a particular actor) and *outCloseness* (distance from one actor to other network members).

Finally a network can be evaluated by measuring the number of *Cliques* or subgroups that exist in it. Dyads, triads, or a combination of these, are examples of such groups, and reflect substructures that may be present in the networks. A click can be defined as a subset of a network in which the players are more closely related. A clique is formed by actors who have all possible ties present among themselves (Hanneman & Riddle, 2005). Subgroups can be very important to understand the behaviour of a network as a whole because they help understand how small and tight components can help build solidarity and connection in large social structures.

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[75] Existence (or not) of interactions between the network participants.
[76] Total number of interactions among the participants in a network.

We can think about these subgroups in terms of the members who are part of them. If, for example, there is an overlap of members in various subgroups, mobilization and diffusion may spread rapidly and conflict is less likely than when the groups don't overlap.

But the subgroups may also help explain the behaviour of actors across a network through their kind / level of integration on that network. Still according to Hanneman & Riddle there are different kinds of behaviours among actors: some act as 'bridges' between groups; others may have all of their relationships within a subgroup; other are completely isolated, and others are a part of a tightly connected and closed elite.

These different ways for individuals to integrate the networks can have a large impact on how they behave and how they perceive their own activity.

SNA, by focusing on the relationship between actors, cannot study them independently from the ties they establish. The selection of the networks we want to analyse can be done by drawing up a list (stratified or grouped) with all actors and any individual element that is included in this list is only selected by probabilistic methods. This method treats individuals as a separate 'replication' and by that interchangeable with any other (R.A. Hanneman & Riddle, 2005). Thus, in our study, the criterion behind the determination of the networks, was the participation of the actors (students and teachers) in the learning forums of the selected courses.

The clustering technique, which we mainly used for SNA, had that criterion behind and grouped students according to their participation in the forums and not just because they are enrolled in the courses.

Clustering aims to discover the underlying structure of the natural grouping of data (Romero et al., 2011). Clustering has the capacity to group similar actors and visualization methods help to describe and explore those groups intuitively which can enhance the e-learning experience.

From the several visualization methods the dendograms were used as they are a visual representation of the hierarchical structure of clusters.

Among the existing clustering methods we opted for the division[77] based on a single attribute[78] (Scott, 2000). Still according to this author and regarding the composition of clusters, it

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[77] Scott (2000) describes the clustering dividing method as follows: "Starting from the graph as a whole, regarded as a single cluster, sub-sets are split off at reducing levels of similarity." (p. 130)
[78] "Single attribute methods begin by differentiating those points that possess a particular indicator or value from those who do not and the initial cluster is split into two on the basis of the possession or non-possession of this indicator. The same procedure is followed within each cluster at subsequent steps, in order to sub-divide each of them further." (Scott, 2000:130)

depended on the graph criteria. "The members of a cluster might be those that are similar to one another in terms of some graph theoretical criterion of closeness or distance from other points." (p. 129)

As for stratification carried out in our study, through statistical techniques, those were held mainly to demographic criteria (c.f. subchapter of *Statistical Analysis*).

SNA was completed with a comparative study between the results obtained in four courses in order to try to understand the similarities and differences observed between the networks.

All these types of analysis allowed us to construct a graphical representation of the network relationships (through graphs) and can be accessed, in a reduced version in table 10.

Table 10 Summary of the definition of SNA measures. Adaptation from Fazito (2002)

Descriptive measures	Definition
1. Density	It is the ratio of effective links between the possible ones. It is a measure of the degree of insertion of the actors in the network.
2. *Centrality*	Location of an actor in relation to the total network.
3. *Centralization*	Degree to which the relationships in a network are focused on one or more key actors.
4. *Closeness*	Degree of proximity to other network actors.
5. *Betweenness*	Measures the degree of intervention by an actor on others in the network.
6. Subgroups	Measures the degree of concentration and formation of subgroups in a network.

The classification of the networks studied in our research was conducted in relation to the patterns / types of networks found. One of the advantages of using SNA techniques relates to the fact that they provide a visual approach to the networks via the graphs. These can help you understand the networks in a holistic way through the location of the participants and their relationships. The three most common network patterns are: star, line and circle as shown in figures 4, 5 and 6 of R.A. Hanneman & Riddle (2005:61):
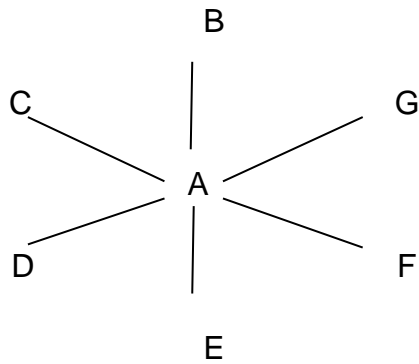
Figure 4 Star Pattern

Figure 5 Line Pattern
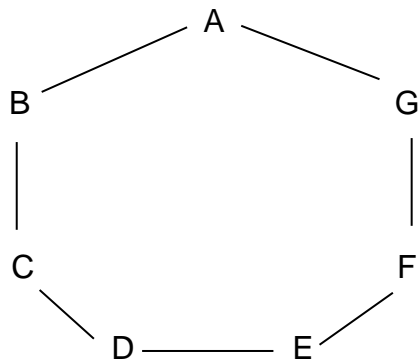
Figure 6 Circle Pattern

In the star pattern (figure 4) an actor occupies a central position due to the fact that the majority of the interactions (sometimes all) are held by him or with him by the other members of the network. This structural position allows him, for example, greater exchange or sharing of information and / or resources. In this type of pattern the degree of *Centralization* is very high and in terms of power distribution is uneven and concentrated in the actor that occupies the central position.

In the line pattern (figure 5), each player only contact with two other players and those who are at the ends of the line only contact or are contacted by one other actor. These actors appear to have a structural disadvantage while the remaining appear to be in the same position (R.A. Hanneman & Riddle, 2005).

In the circle pattern (figure 6) all positions are equally advantaged or disadvantaged because each actor has exactly the same number of alternative trading partners.

After the classification of the networks studied in the forums we proceed to a comparison of the different forums of the four courses analysed. We intended to understand if it was possible to establish a relationship between the networking patterns found and the values of SNA measures of those networks.

3.7.3 Statistical Analysis

Statistical analysis of data obtained in questionnaires completed by students, as mentioned earlier, was made through *the IBM SPSS* software for *Windows* and *Microsoft Excel* from *Microsoft Office*. After the application of the questionnaires, the answers were entered into SPSS in order to build a database with twenty two initial variables. The questionnaire produced (nominal and ordinal data such as gender and academic qualifications and responses to the Likert scales respectively) and interval data such as age. The variables, its description and the analysis performed are showed in table 11:

Table 11 Students questionnaire variables, level of measurement and type of analys

Variables/ dimensions	Level of Measurement	Analysis
Gender	Nominal	Descriptive analysis (Frequencies)
Age	Interval	Descriptive analysis (Central tendency
Working student	Nominal	Descriptive analysis (Frequencies)
Have previously finished a college degree	Nominal	Descriptive analysis (Frequencies)
What year course is attending	Nominal	Descriptive analysis (Frequencies)
How often uses Internet	Ordinal	Descriptive analysis (Frequencies)
Participation in other social networks	Nominal	Descriptive analysis (Frequencies)
Has invited colleagues to his social networks	Nominal	Descriptive analysis (Frequencies)
Has a different behaviour is the course forums networks	Nominal	Descriptive analysis (Frequencies)
How contacts friends & colleagues	Nominal	Descriptive analysis (Frequencies)
Has changed is learning routines for the online course because of *Moodle*	Nominal	Descriptive analysis (Frequencies)
Which learning routines has changed because of *Moodle*	Nominal	Descriptive analysis (Frequencies)
Has changed learning routines for face-t-face courses because of *Moodle* experience	Nominal	Descriptive analysis (Frequencies)
How contacts colleagues in the online course	Nominal	Descriptive analysis (Frequencies)
Previous experience using *Moodle*	Ordinal	Descriptive analysis (Frequencies)
Where prior experience was acquired	Nominal	Descriptive analysis (Frequencies)
When prior experience was acquired	Nominal	Descriptive analysis (Frequencies)
How as learned to use *Moodle*	Nominal	Descriptive analysis (Frequencies)
How one rates the ease of use of *Moodle*	Ordinal	Descriptive analysis (Frequencies)
How rates his/her competence in using *Moodle*	Ordinal	Descriptive analysis (Frequencies)
Which *Moodle* resources like to participate	Nominal	Descriptive analysis (Frequencies)
Individual Perceptions of LMS Moodle scale *(22 items)* Dimensions: Features Processes Interactions	Ordinal	 Principal Components Factor Analysis Descriptive analysis (Mean, SD)

First, descriptive statistics were run on all the variables in order to organize and classify the data. After checking the database we began descriptive statistics according to the variables types. Watson (2005) states this type of analysis serves to describe sample characteristics, address specific research questions and to check the variables for any violation of the assumptions underlying the statistical techniques.

Still on the descriptive statistics, and according to Marôco (2010):

De entre as várias formas de caracterizar amostras tomam particular importância as medidas de tendência central (que procuram caracterizar o valor da variável sob estudo que ocorre com mais frequência), a dispersão das observações em torno das estatísticas de tendência central ou na amostra (estas estatísticas designam-se por sua vez por medidas de dispersão) e as medidas da forma da distribuição dos elementos da amostra – as ditas medidas de assimetria e achatamento. (p. 33)[79]

In our study, the measures of central tendency used were the mean, median, mode and percentiles. Regarding the dispersion measures we have analysed the standard deviation and the range. Where applicable we analysed the distribution of study variables by using the Kolmogorov-Smirnov test to assess the normality of the distribution of scores. The following parametric analyses were performed with internal variables: the Student's t test, the F test, and analysis of variance. According to Mills et al. (2009) these tests search for true differences in population means or variances and allow the researcher to make inferences about the population at pre-specified confidence levels.

Non-parametric tests (like Mann–Whitney U test, Wilcoxon's signed rank test, the Kruskal–Wallis statistic, and the Kolmogorov– Smirnov test) and according to the same authors, are used when it is difficult or even impossible to make assumptions about the form of probability distribution of sample data. That is what often happens in case studies that measured data only at nominal and ordinal levels.

Among the parametric tests carried out we made an analysis of one factor variance (ONEWAY ANOVA) whenever it was necessary to compare mean values between at least three groups. To compare two independent groups we used *t* Student test (T-TEST). For the same type of comparisons when the dependent variables did not presented a non-normal distribution we have chosen the non-parametric equivalents. However, when there were no differences in results between the parametric and nonparametric options, the first was chosen (Bryman & Cramer, 1993).

An author developed the scale used to assess the perception of users of the LMS *Moodle*. This experimental version (c.f. subchapter *Questionnaires and interviews*) is composed of 22 items answered on a 5 points Likert scale ranging from (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree and (5) strongly agree.

It was first performed an analysis of internal consistency (Cronbach's α) among the 22 items of the scale. The reliability coefficient tell us if for yielding interpretable statements about

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[79] Translation: "Among the various ways of characterizing samples, measures of central tendency (which seek to characterize the value of the variable under study that occurs more often), the dispersion of observations around the central tendency statistics or around the sample (these statistics are called in turn by dispersion measures) and measures of the shape of the distribution of the sample elements – the said measures of skewness and flatness, take particular importance." (p. 33)

individual differences our test design was correct (Cronbach, 1951). We intended with this analysis to demonstrate the reliability of the scale and to determine if any of the scale items produced results that were inconsistent with the other items.

In order to explore the structure underlying the scale an exploratory factor analysis (FA) was performed. According to Marôco (2010) the FA detects and analyses the structure of a set of interrelated variables. The purpose is to build a scale for measuring intrinsic factors that in some way (more or less explicit) control the original variables.

Classical factor analysis assumes that both the manifest and the latent variables are continuous variables and is usually carried out by factor analysing the sample covariance or correlation matrix of the manifest variables. (Jöreskog & Moustaki, 2006) But in some cases when we deal with quantitative variables, more complete information can be achieve by describing a set of statistical unites in terms of interval data (Lauro & Palumbo, 2000).

Ordinal variables do not have a metric scale,

[h]owever an ordinal variable z can be thought of a crude representation of the unobserved continuous variable z^*. The correlation between to ordinal variable z^*1 and z^*2 is known as the polychoric correlation coefficient, and is an estimate of the unobserved relationship between two variables. (…) evidence suggests that in the presence of strong skewness and/or kurtosis – as is often the case with Likert items – it may be more appropriate to treat variables as z^*'s. (Gilley & Uhlig, 1993:259)

This approach assumes that a continuous, normal latent process determines each observed variable (Flora & Curran, 2004).

A typical situation involves the development or refinement of a psychometric test or survey in which a set of ordinally scaled items (e.g., 0 = strongly disagree, 1 = neither agree nor disagree, 2 = strongly agree) is used to assess one or more psychological constructs. Although the individual items are designed to measure a theoretically continuous construct, the observed responses are discrete realizations of a small number of categories. Statistical methods that assume continuous distributions are often applied to observed measures that are ordinally scaled. (p. 466)

Basilevsky (1994) reinforces this idea:

A relatively straightforward approach to a factor analysis of ordinal data is to assume an underlying continua for the population, which cannot be observed directly in a sample and which is consequently approximated by an ordinal scale of fixed length. Since ordinal scales are invariant with respect to continuous monotonic transformations, the positive integers 1, 2,…, k are normally used for convenience. Also, in order to have the mean (median) of the scale values itself a scale value, the integer k is often chosen to be odd. (p. 502)

Our exploratory FA was performed on the correlation matrix, with extraction of the factors by the method of principal components, followed by a *Varimax* rotation in order to investigate a possible underlying structure between the twenty two scale items.

To calculate the statistical power we used the *G*Power* software (version 3.1.3). This program performs, according Erdfelder, Faul, & Buchner (1996), analyses for the most frequent tests in behavioural research: t tests, F tests and X^2 tests. The G * Power:

(..) (1) power values for given sample sizes, effect sizes, α levels (post hoc power analysis); (2) sample sizes for given effect sizes and power values for α levels and power values (a priori power analyses); and (3) α and β values for given sample sizes, effect sizes, and β/α ratios (compromise power analyses). (p. 1)

In addition to these analyses, the G * Power also performs statistical tests for: simple linear regression coefficients, multiple linear regression coefficients, logistic regression coefficients, and Poisson regression coefficients. It also does one-sample correlation tests, and statistical tests comparing both dependent and independent Pearson correlations (Faul, Erdfelder, Buchner, & Lang, 2009).

The statistical power calculation was performed *a posteriori*, to a medium effect size at a level of $p<0.05$. According to these authors in this type of calculation "Statistical power 1-β is computed as a function of significance level α, sample size, and population effect size." (p. 1149)

3.7.4 Content Analysis of the interviews

The content analysis, according Rocha & Deusdará (2005) was born in the late 1960s due to shortcomings of text analysis that had been done until then and that were influenced by social behavioural psychology and by one conception of language influenced by the 'informational' communication schemes, especially that produced by Roman Jakobson. Bardin (2009) defined content analysis as set of techniques that uses systematic and objective procedures to describe the content of messages. Researcher can infer knowledge concerning the conditions of production / reception of the messages from quantitative (or not) indicators.

According to this author content analysis is closely linked to two scientific practices, the linguistic and documentary techniques and aims to logical deduct and justify the origin of the messages.

Krippendorff (2004) adds that content analysis can increase the researcher understanding of a phenomenon because provides new insights and involves specialized procedures.

As regard the definition of communications or texts which the content is analysed, Krippendorff states that these can be of different types (like images, maps, sounds, signs, symbols, etc.) provided they speak about phenomena outside of what can be sensed or observed.

The content analysis aims at objectivity through the systematization of the research on texts. According to Rock & Deusdará (2005) it seeks a profound significance of the texts through procedures that legitimize a given reading technique.

Holsti cited by Cohen et al. (2005) identified the following objectives for the content analysis:

- To describe trends in communication content.
- To relate known characteristics of sources to messages they produce.
- To audit communication content against standards.
- To analyze techniques of persuasion.
- To analyze style.
- To relate known attributes of the audience to messages produced for them.
- To describe patterns of communication. (p. 165)

Bardin (2009) claims that content analysis is a method that can be applied both in qualitative as in quantitative research[80] yet to do so differently in each. In quantitative research information is related to the frequency of occurrence; in qualitative it is the presence or absence of certain characteristics of the message content that is being analysed.

Holdford (2008) adds that content analysis value lies in its capacity to explore questions unanswerable by more quantitative methods.

Hsieh & Shannon (2005) described three distinct approaches to qualitative content analysis: conventional, direct and summative. The first approach does not use preconceived categories and is used with a study design whose aim is to describe a phenomenon. It is appropriate when the theory or research literature on a phenomenon is limited (see table 12).

According to Hsieh & Shannon the second approach to qualitative content analysis is the direct one and can be used to describe a phenomenon that is incomplete although theory or prior research exists. It helps determine the initial coding scheme or relationships between codes and can provide can provide predictions about the variables of interest or about the relationships among variables.

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[80] According to Holdford (2008) "Qualitative content analysis differs from quantitative content analysis primarily in its emphasis on interpretation over quantification, subjectivity over objectivity, flexibility in process over outcome, and concern for influence of context on the research process." (p. 174)

Finally, summative content analysis attempts not to infer meaning but to explore usage by going beyond mere word counts to include latent content analysis. It tries to understand the contextual use of the words or content after identifying and quantifying certain words or content in the text.

Table 12 Major Coding Differences Among Three Approaches to Content Analysis (Hsieh & Shannon, 2005:1286)

Type of Content Analysis	Study Starts With	Timing of Defining Codes or Keywords	Source of Codes or Keywords
Conventional content analysis	Observation	Codes are defined during data analysis	Codes are derived from data
Directed content analysis	Theory	Codes are defined before and during data analysis	Codes are derived theory or relevant research findings
Summative content analysis	Keywords	Keywords are identified before and during data analysis	Keywords are derived from interest of researchers or review of literature

For this study we have choose a conventional content analysis because, although there is some theory or research literature on the subject, we aimed to describe a phenomenon and did not use preconceived categories. We also choose to do a qualitative content analysis because it tries to examine themes, patterns and meanings that may be latent in a particular text (forums participations and interviews) aiming to understand social reality in a subjective but scientific manner (Zhang & Wildemuth, 2009).

With content analysis of teachers interviews who participated in our study we wanted to further the information collected with questionnaires. The interviews allowed participants to more freely express their opinion and knowledge on various topics related to DE. Because there were only five interviews (to 3 teachers[81] and a manager of the *Moodle* platform) and we wanted to try to understand the full meaning of the speech, including indicating their latent content (Oliveira, Ens, Andrade, & Mussis, 2003) we chose not to perform a quantitative analysis but a qualitative research as described in the preceding's paragraphs.

Although qualitative content analysis does not follow strict steps (Silva, Gobbi, & Simão, 2005) since the analysis itself has already been initiated during the data collection and its organization (as they were in turn guided by the research questions) we decided to use the stages

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[81] We have interviewed one teacher two times because he was responsible for two of the four courses analyzed in two different semesters.

proposed by Bardin (2009): 1) pre-analysis; 2) data exploration and processing of results and 3) inference and interpretation. In the pre-analysis data was organized so further analysis could be carried. In the second stage the exploration of the research material was thorough and guided by research questions and theoretical expectations. The last stage was the results treatment, inference and the interpretation. The analysis performed intended to do a reflection from the empirical material and try to arrive, if possible, to the basic proposal of transformations within the limits of specific and general structures (Silva, Gobbi, & Simão, 2005).

For the categories of analysis, and for the same reasons mentioned for the type of analysis, we chose a mixed model in which the main categories were selected on the construction of the interview script but were adjusted after analysis of respondents' answers.

3.7.5 Content Analysis of the Learning Forums

A content analysis of the posts of participants of the learning forums was also carried out using a qualitative content analysis (c.f. description in the previous subchapter).

In analysing the learning forums we have opted for an open model (Silva et al., 2005) in the construction of analytical and emergent categories. The categories were defined as they were found in the posts of the participants of the forums.

In this analysis we wanted to obtain information that would contribute to understanding the process of formation and participation in the analysed forums networks as well as the respective patterns. In our content analysis we wanted to verify if the topics of conversation among students and teachers were related to the objectives of the forums (or if the learning forums would have had some other kind of use by its participants). We wanted to further verify if there were other activities and insights beyond the exchange of information in the forums.

The specific objectives of our research (c.f. subchapter *Study Objectives and Research Questions*) served as a script to search for clues that would allow us to answer our research questions by analysing the content of participation in the forums.

3.8 Final remarks on the materials and methods

The formatting of the text of this thesis was done according to the Dispatch No. 2/2011 and No. 23/2011 from FCT / UNL[82], Guidelines for the presentation of Master and PhD Thesis and Guidelines for the covers of Doctoral Dissertations, respectively.

The formatting of the *Bibliography* was done with *Mendeley* referencing software[83] (version 1.3.1). This software allows managing, sharing and discovering content and contacts and it is a combination of a desktop application and a website (Mendeley Ltd., 2012). *Mendeley* uses APA[84] citation style (6th edition).

Table 13 summarizes the research methodology used in this dissertation. The specific objectives were shortened in three general objectives, each of which help to address one, two or three research questions. Data collection and analysis techniques were also chosen in order to help provide the information needed for this study. Finally the research methods used are presented in the last row of the table.

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[82] FCT/UNL – Faculdade de Ciências e Tecnologia/ Universidade Nova de Lisboa (College of Sciences and Technology / New University of Lisbon).
[83] When drafting this thesis *Mendeley* was using the 6th edition of the *APA* guidelines.
[84] Acronym for *American Psychological Association*.

Table 13 Summary of the research methods based on the research questions and objectives (adapted from Fernando Luis Santos[85])

Research Questions / *General objectives*	Q1 - What types of social learning networks are formed in a LMS *Moodle*, in a Portuguese Higher education institution, as a mediated, on-line teaching and learning environment?	Q2 - What are the patterns of relationships established between users of the LMS, and which features, and activities influence the formation of these patterns in the context of distance education at an institution of higher education in Portugal?	Q3 - How can the LMS, as a support environment for social learning networks, contribute to the organizational design and strategy of an institution of higher education in supporting the process of communication, sharing, knowledge building and management at distance?
Studying the forums of courses taught through *Moodle* platform as potential social learning networks (their constituents and processes)	■	■	
Analyse the participants' perceptions on the use / participation in *Moodle* and social networks that are constituted in the courses forums	■	■	■
Characterize the process of teaching / learning through the use of an LMS as a support of a social network in the context of distance higher education			■
Data sources	Web tracking	Web tracking Questionnaires Interviews	Questionnaires Interviews
Data treatment	*Data Mining* Techniques (Statistics, Clustering, Social Networks Analysis and Visualization)	*Data Mining* Techniques (Statistics, Clustering, Social Networks Analysis and Visualization) Conventional content analysis	*Data Mining* Techniques (Statistics) Conventional content analysis
Methods	Case study / Qualitative Structural Analysis	Case study / Qualitative Structural Analysis	Case study / Qualitative Structural Analysis

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[85] Fernando Luís Santos is the author the table structure and by the time this dissertation was written he had not yet published that structure anywhere. Because of that he could not be referenced in the bibliography.

4. Findings

4.1 Explanations prior to the presentation of findings

In order to improve reading we decided to provide some information that is important to understand the presentation of the findings:

- In C1 one of the forums was subdivided in three other forums by the teacher due to the fact that the main purpose for all three was the same (discussion of group tasks). For that reason we decided to call those forums 5 A, 5 B and 5 C. Also because of this decision in the figures and tables no other course has values for forums 5 B and 5 C.
- C2 did not have a Questions Forum.
- The teacher of C1 and C4 was the same. These courses were taught in different semesters.
- In C1 the 4th forum did not had any participation.
- The total number of forums in each Course was: C1 with ten forums, C2 with two forums, C3 with fourteen forums and Course 4 with five forums.
- Some findings are presented in tables. Due to stylistic reasons and the size of some tables we chose to display them divided into two or more pages.
- Because one of our goals for this study was to compare the results of the four courses, some SNA presents the highest and the lowest values from all those courses forums (and not from each forum of the courses); we did not intend to compare the forums within the same course.

4.2.1 Frequencies

The final sample of our research consisted in 371 participants who were enrolled in one of the fifteen undergraduate courses offered by the University. Sixty five per cent were women and 35,3% were men, and 65% were working students. Fifty two per cent of the participants were aged between 18 and 25 and 48% between 26 and 62 years old. The average age was 29 years.

About 73% were attending University, for the first time, while 20% already had attended University but without concluding any degree. Seven per cent had already graduated from University previously.

Seventy one per cent of the students were in the first year of their courses while 26% were in the third and last year[86]. The remaining participants were students attending the courses we have analysed because they had failed the previous year.

From our sample, 84,6% used the Internet every day of the week, 13,5% two or three times a week and the remaining 1 or less times a week.

Almost half of the students did not had prior experience using *Moodle* while 13,5% had much experience. From those who had prior experience 25,9% acquire that experience here, at the University in previous years. The rest acquire their experience in High School, other Universities or schools and at work.

When asked how they have learned to use *Moodle*, respondents (who could choose more than one option) answer as shown in figure 7.

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[86] Since the implementation of the *Bologna Process* the majority of the undergraduate courses last three years.
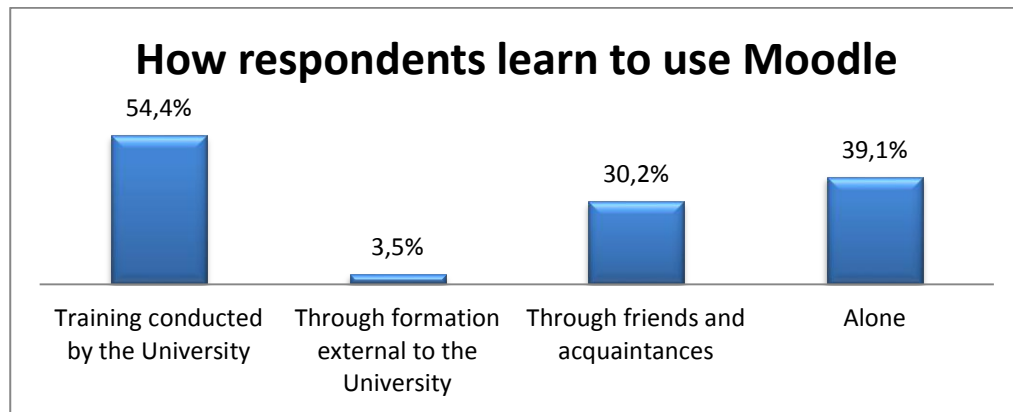
Figure 7 Different ways in which respondents learned to use *Moodle*

Regarding the ease of use of *Moodle*, 57,9% classify it as 'easy' or 'very easy' and less than 6% classify it as 'difficult or 'very difficult. From the rest of the respondents, 36,1%, classify it as 'normal'.

Participants were also asked how they classified their skills in the use of *Moodle*. Four per cent reply their skills were weak, 35,8% elementary, 49,6% good and 10,5% very good.

Concerning the use of *Moodle* features, the respondents show their preferences as follow: 1) to do assignments 2) view audio-visual resources 3) testing 4) participate in the discussion boards – forums 5) text reading 6) participate in surveys 7) use the glossary 8) use the chat 9) use the student's blog 10) participate in wikis and 11) participate in referendums.

We also wanted to know which learning routines (if so) students had changed in the online course (compared to learning routines in classroom courses). The students had multiple choices in their answers and the results were as shown in figure 8. Although the majority of students had changed at least one learning routine in the online course, 16% said they did not change any routine.

Students were then asked if by attending an online course they had change the way they study for the classroom courses. Thirty two per cent said they did not change anything, 45,8% said they had changed little, 18,3% said they had changed some and 4% said they had changed a lot.

Change of learning routines

- ◼ Changed the type / amount of summaries
- ◼ Changed my study schedule
- ◼ Changed my readings (types and amount of texts)
- ◼ Changed my place of study
- ◼ Study more often alone
- ◼ Contact more my colleagues to collaborate in my study
- ◼ Ask more questions to the teacher
- ◼ Go less to the library
- ◼ Use more the resources provided by the teacher (summaries, handhouts, etc.) than resources surveyed by me
- ◼ Did not changed any routines

18%   38%   16%   35%   22%   10%   12%   21%   37%   16%

1
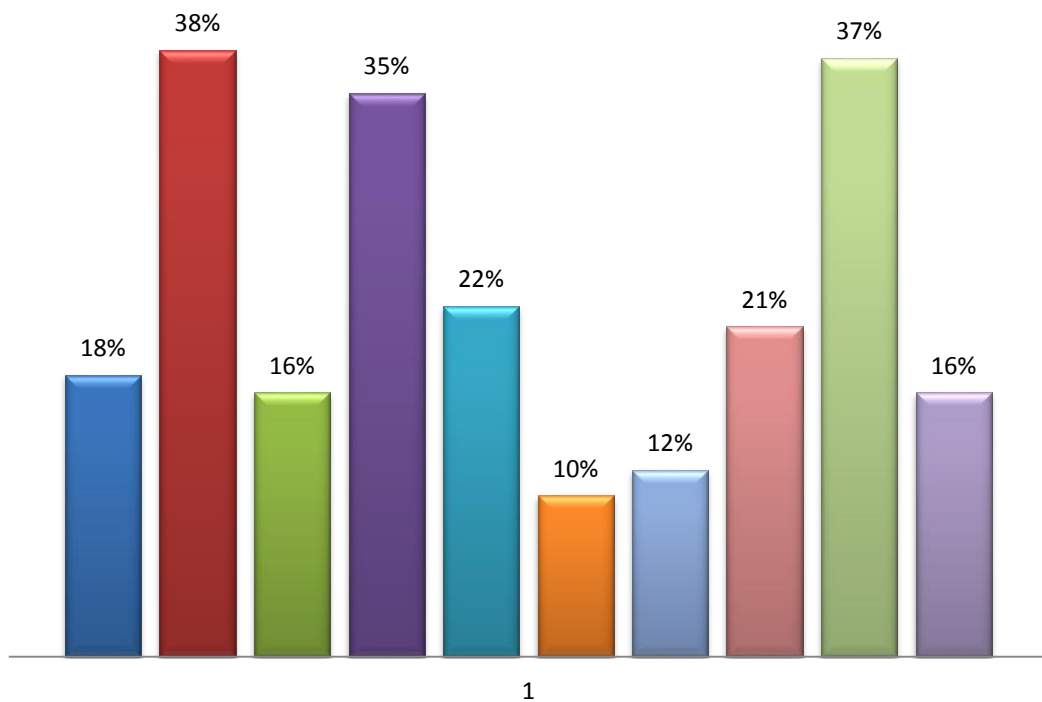
Figure 8 What routines (if any) students have changed in the online course

Regarding interaction we wanted to know which *Moodle* features students used to contact with each other, which other non-*Moodle* resources they used to establish their contacts, if they belonged to any social network (e.g. *Facebook*, *Twitter*, *Linkedin* or other) and if they had use *Moodle* to invite their colleagues to those social networks[87]. We also wanted to know if they consider they had a different behaviour in those social networks compared to their behaviour in *Moodle* forums (seen as leaning networks).

About the *Moodle* features used by students to contact their colleagues, 45% answered they had used the e-mail[88], 40,2% used *Moodle* forums, 21,8% used the personal messages system from *Moodle* and 4,9% used the *Moodle* chat. Regarding the non-*Moodle* resources use to establish contacts, 70,9% used text messages from their mobile phones, 68,7% used the e-mail, 50,7% made phone calls, 38% used chat programs from *Facebook*, *Messenger* and *Skype*, 2,2% used Blogs or other personal web pages and 1,3% other Internet chat rooms. Despite all these resources used to interact, 17,3% of the students said that their contacts with friends, colleagues and family are face-to-face.

When asked to which social networks they belonged in the Internet, students replied as shown in figure 9. As we can see a large majority of the students (83%) used *Facebook* and the second most used social network was *Hi5*. Twelve per cent of the students said they do not belong to any social network. Also a large majority of the students (78,7%) said they did not invite any colleague to the social networks they belonged and less than 2% said they had invited all their colleagues. The remaining respondents said they had invited the majority (1,6%) or some (3%) colleagues.

Finally we wanted to know how students feel they behave in social networks compared to how the behaved in *Moodle*. Fifty four per cent of the respondents said they do not change their behaviour while 24,5 % said they changed their behaviour because the reasons for using *Moodle* are different from the reasons they use a social network like *Facebook* or *Hi5*. Nineteen per cent said they changed their behaviour because they felt the environment in *Moodle* was more formal. Two per cent of the students also said that they had changed their behaviour because of the 'presence' of the teacher.

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[87] Multiple choice questions.
[88] The LMS *Moodle* used by the University has an e-mail account embedded. This e-mail account is called 'student's institutional e-mail' and it's an account created by the University when the student enrolls a course. The majority of the students have also other e-mail accounts (personal, work).
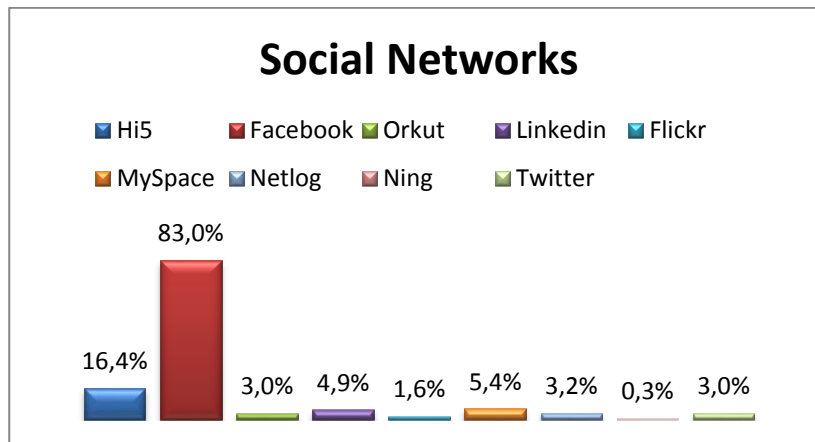
Figure 9 Social Networks in which the respondents participate

As mentioned in the subchapter Q*uestionnaires and Interviews*, we developed an experimental version of a scale to assess the perceptions from *Moodle* users which we have called *Individual Perceptions of LMS Moodle* scale.

An internal consistency analysis was done to the 22 item from the scale with a result of Cronbach's α of .949 and none of the items needed to be excluded in order to improve the reliability of the subscales.

To investigate the factor structure of the scale used to measure the utilization of the *Moodle* platform and to determine which of the items were likely to represent dimensions, an exploratory Principal Components Analysis (PCA) was conducted on the data collected from the 371 participants. Varimax rotation was used and the selection criteria were eigenvalues greater than 1.1. In the first analysis the 22 items entered into the PCA. This produced a 3-factor solution which together accounted for 61% of the variance. Items with loadings equal to or greater than 0.5 were interpreted to represent a particular factor. The content of these loadings are presented on the next table. The dimensions were 'Interactions', '*Moodle* features' and 'Processes'.

All the dimensions demonstrated fairly good internal reliability, ranging from 0.81 to 0.92 (see table 14).

Table 14 Principal Component Analysis of the 22 items assessing individual perception of the students about LMS *Moodle* (N= 371)

	Factor I	Factor II	Factor III
I feel more motivated to learn thanks to *Moodle*	**.807**		
I learn more easily through the *Moodle* platform	**.800**		
Moodle makes the learning process more effective	**.749**		
Through *Moodle* I can perform more activities than in face-to-face classes	**.699**		
Moodle will increase my motivation to the learning process	**.657**	.439	
The lower face-to-face interaction between teachers and students will not harm the quality of teaching and learning	**.603**		
Moodle makes the learning process more flexible	**.569**		.518
Moodle allows me to better schedule my activities as a student	**.556**		.529
In *Moodle* I have more information / resources (texts, videos, etc..) available for study than in face-to-face classes	**.534**		
I am more independent in my learning thanks to *Moodle*	**.534**		.493
Moodle facilitates interaction with my colleagues and from my colleagues with me		**.827**	
The *Moodle* platform facilitates collaborative work with my colleagues and the teacher		**.772**	
Thanks to *Moodle* I interact more often with my colleagues	.505	**.660**	
Thanks to *Moodle* interact more frequently with the teacher	.534	**.553**	
I have acquired more skills thanks to *Moodle*	.479	**.523**	
Moodle has created a social learning network		**.496**	
Work on *Moodle* from any location will facilitate my work as a student			**.815**
Work on *Moodle* at any time that is convenient to me will help me in learning			**.812**
The *Moodle* is an innovation for the teaching and learning process			**.623**
	Moodle features	Interaction	Processes
Number of items	10	6	3
Eigenvalue	10.741	1.212	1.486
Variance explained %	26.55	17.5	17.37
Alpha de Cronbach's	.917	.866	.811

In order to assess possible differences between socio-demographic characteristics concerning the dimensions of the *Individual Perceptions of LMS Moodle* scale, some comparison

analyses were carried out. To investigate whether there were significant differences between age groups concerning the 3 dimensions an ONEWAY ANOVA was performed. The age variable was recorded in 3 groups: (18 thru 22=1) (23 thru 31=2) (+ 32 = 3). The results indicated that there were no significant differences between the age groups. The dimensions of the platform according to the t-test showed no significant differences between the first and the third academic year, as well as for sex. However, in order to test for significant differences within-subjects concerning the three dimensions ('Interactions', '*Moodle* features' and 'Processes') we used the ANOVA repeated measures test. Mauchly's test indicated that the assumption of sphericity had been violated ($W = .916$, $\chi 2(2) = 32.4$, $p =.000$). Therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon =.922$). There were significant differences within-subjects on the dimensions of the *Individual Perceptions of LMS Moodle* scale ($F(1.8, 369) = 420.4$, $p<.001$, $\eta 2$ part$=.532$, observed power = 1) (see figure 10).

	Mean	
Interactions	2,8	(sd = 0,81)
Features	3,8	(sd = 0,79)
Processes	3,0	(sd = 0,80)
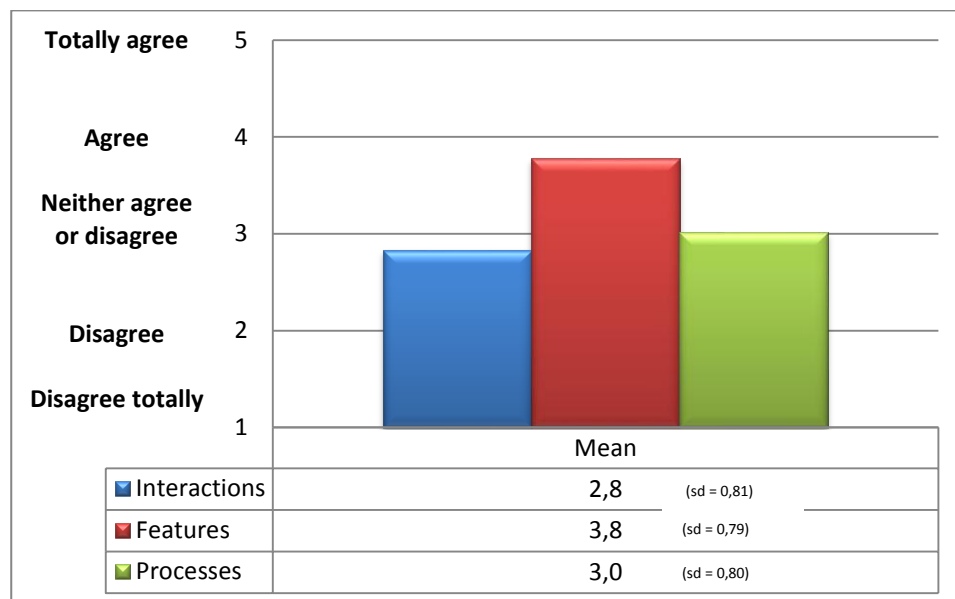
···<p .001

Figure 10 Dimensions of the Individual perceptions of *Moodle*

The statistical power was calculated *a posteriori* for a medium effect size of p<0,05 for each test performed as show in table 15.

Table 15 Measurement of the Statistical Power

Statistical Tests	Effect Size	N	Statistical Power
T-tests	d = 0,5	371	100%
ANOVA - repeated measures	f = 0,25	371	100%
ANOVA – One-way	f = 0,25	371	100%

The statistical power for each test performed was of 100%.

4.3 Social Network Analysis

4.3.1 Degree of participation

The *Degree of Participation* (table 16) varied, in C1, from no actors to 15 actors with an average of 5 actors participating in the Course forums. The two forums of C2 had the same number of participants (average of 77) while in C3 the number of participants varied from 2 to 69 corresponding to an average participation of 11 actors. In the last forum analysed the Degree of Participation varied from 9 actors to 124 (average of more than 48 participants).

Some students did not participate in any forum while the teachers were present in all the forums analysed (except in the 1st and 7th forums of C1).

Table 16 Total number of students enrolled in each course and number of participants in each course forum

Forums	Course 1	Course 2	Course 3	Course 4
	Total size of the courses networks (students enrolled)			
	27	151	303	202
	Participants who have posted per Course Forum			
Questions Forum	9	-	69	33
1st Forum	1	77	24	21
2nd Forum	3	77	10	9
3rd Forum	14	-	7	56
4th Forum	0	-	8	124
5th A Forum	3	-	6	-
5th B Forum	3	-	-	-
5th C Forum	1	-	-	-
6th Forum	15	-	4	-
7th Forum	4	-	7	-
8th Forum	-	-	3	-
9th Forum	-	-	2	-
10th Forum	-	-	3	-
11th Forum	-	-	5	-
12th Forum	-	-	2	-
13th Forum	-	-	5	-
Mean	*6,5*	*77*	*11,1*	*48,6*

Table 17 shows the number of posts of the teachers versus the students in each forum from the four courses:

Table 17 Number of post from each teacher and from all the students that have participated in the courses forums

Forums	Course 1		Course 2		Course 3		Course 4	
	Number of posts		Number of posts		Number of posts		Number of posts	
	Teacher	Students	Teacher	Students	Teacher	Students	Teacher	Students
Questions Forum	10	9			78	165	65	95
1st Forum	0	1	38	139	9	33	11	26
2nd Forum	1	3	39	139	3	9	7	9
3rd Forum	6	21			3	7	61	70
4th Forum	0	0			8	5	6	147
5th A Forum	3	9			2	5		
5th B Forum	1	4						
5th C Forum	1	2						
6th Forum	7	13			2	4		
7th Forum	0	5			2	7		
8th Forum					2	2		
9th Forum					2	1		
10th Forum					2	3		
11th Forum					3	8		
12th Forum					1	2		
13th Forum					2	5		

In most forums the teachers were the ones with the highest number of posts (there very few exceptions) which is also reflected in other SNA findings.

Figure 11 shows an example of a forum with one of the highest number of participants (the central green square represents the teacher and all the other blue squares represent students).
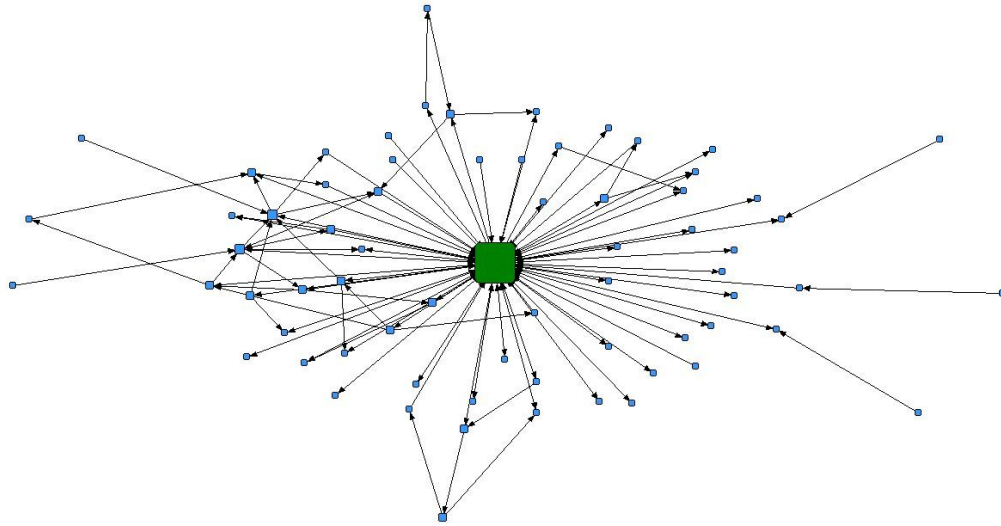
Figure 11 Graph of a forum with one of the highest number of participants (*Questions Forum* of course 3)

4.3.2 Inclusiveness

The *Inclusiveness* index refers to the ratio of network actors that have actually participate in the forums. According to Scott (2000): "Inclusiveness refers to the number of points that are included within the various connected parts of the graph. Put in another way, the inclusiveness of a graph is the total number of points minus the number of isolated points." (p. 70)

Regarding the *Inclusiveness* index (figure 12) in C1 it varied from 0% (no actors) in the 4th forum to 55,56% (15 actors) in the 8th forum while in the C2 the *Inclusiveness* index was the same in the two forums (50,9% corresponding to 77 actors). In the C3 the *Inclusiveness* index varied from 0,7% (2 actors in the 9th and 12th forums) to 22,8% (69 actors in the *Questions* Forum).

Finally in C4 this index varied from 1,98% (9 actors) in the 2nd Forum to 71,3% (124 actors) in the 4th forum.

Inclusion Index

	UC1	UC2	UC3	UC4
Minimum	0,00%	50,99%	0,66%	1,98%
Maximum	55,56%	50,99%	22,77%	71,29%
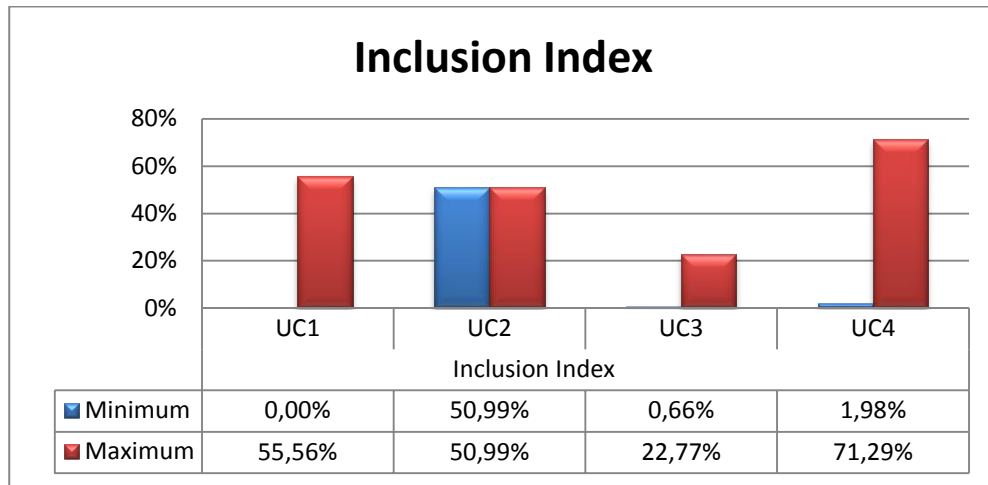
Figure 12 Comparison of the lowest and higher values of the *Inclusion Index* between the forums of the four courses

We also observed several isolated actors in many of the forums we analysed from the four courses (sometimes even the majority of the forums participants). That means that these actors posted their participation in the forums and those participations did not get any reply from the other participants. It also means that their posts were not a reply to any other actors' participations. From SNA point of view there was no interaction in these cases and these actors did not contribute to the networks *Density*.[89]

Figure 13 shows an example of a forum with several isolated actors (red squares).

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[89] "An isolated point is an incident with no lines and so can contribute nothing to the density of the graph." (Scott, 2000: 70)
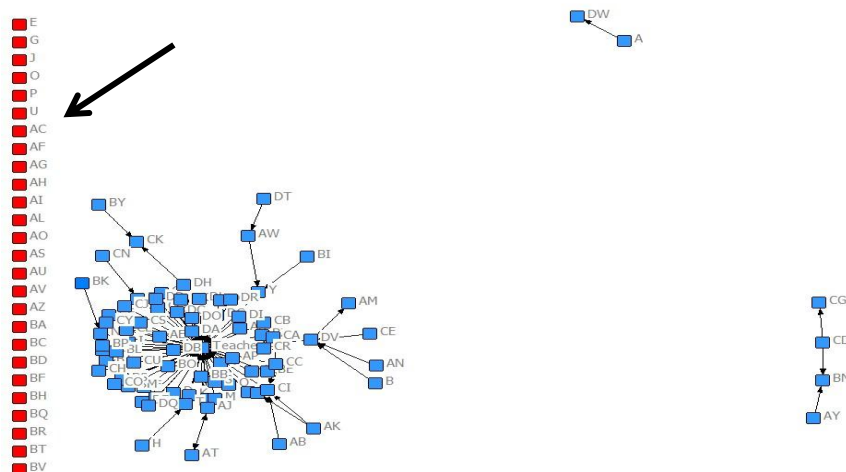
Figure 13 Isolated actors (red squares) of the 4th forum of course 4

4.3.3 Cohesion

The *Density* it is a cohesion measure that allow us to know the overall linkage between network actors (Müller-Prothmann, 2007). Through *Density* we can gauge the speed of dissemination of information among the actors. *Density* also allows us to gauge to which extent actors have a high degree of social capital and / or social constraint (Robert A. Hanneman & Riddle, 2005). We can define social capital as the investment that individual make to gain access to embedded resources through social relations (Lin, 1999). "In contrast we may think of social constraint as not having access (or having reduced access) to embedded resources because of the kind/number of interactions and position in the network that individuals may have." (Fidalgo & Thormann, 2012:7)

Regarding the *Density* values (figure 14) in C1 they varied from 0% to 35% while in C2 the *Density* had the same values (2%) in both forums. In C3 the values were from 7% to 100% and in C4 Density varied from 1% to 10%.
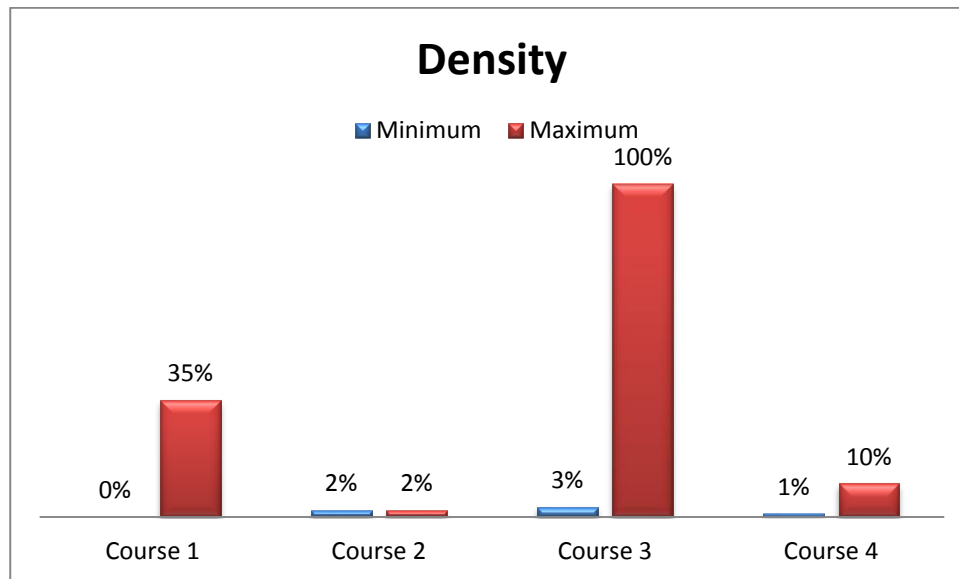
Figure 14 Minimum and maximum *Density* percentages of the forums of the four courses

The *Density* values do not indicate the number of participants in a network but the connectivity between those who actually participate. Lower figures of *Density* indicate a low connectivity between participants while a higher degree of *Density* may indicate that actors have voluntarily participated in discussions in which they felt more motivated.

In C1 the lowest *Density* values were found in forums 1 and 6 with 0% and 3% respectively. The higher values, in this course, were found in four forums (35% in the 4th and 5th A and 33% in the 5th B and 5% C forums).

In C2, *Density* had the same values (2%) in both forums of the course. Although this course had an *Inclusion* index of 50,99% the connectivity between the actors was low.

C3 had the higher values of *Density* in the 9th and 10th forums (100% and 67% respectively) and the lower values in the 1st Forum and *Questions Forum* (7% and 3%). Despite having the best *Inclusion Index* of the entire Course, in the *Questions Forum* (22,8%) the connectivity between the participants was very low there.

Finally in C4, the *Density* values were low in all the forums. The lowest value was found in 3rd and 4th forums (2% and 1%) and the highest value was 10% and was found in the 2nd Forum.

According to Shaqifah, Sani, Taib, Jusoff, & Shazi (2011) *Centrality* measures helps us find the degree of access to information from the network actors.

This can be thought of as an iterative process, where in each step a vertex sends information to its neighbors. The amount of information sent depends on the importance of the vertex itself and the strength of the relation to the receiving vertex. (Magnusson, 2012: 14)

With regard to *Freeman's Degree of Centrality Measures* (table 18) the mean values of *OutDegree* and *InDegree* of C1 were the same and ranged from 0% (1st and 4th[90] forums) to 35% (5th A forum). The reason for the 1st Forum value was due to the fact the only one actor (a student) participate. The teacher always had the higher values of *OutDegree* (22% in the 6th forum, 3% in the 3rd forum). The teacher shared his values with two students in 5th A forum, one student in 5th B forum and one student in 5th C forum. The higher values of *InDegree* belonged, in the majority of the forums, to students. Nevertheless, students shared those values with the teacher in forums 5 B and 6.

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[90] There were no participations in the 4th forum of C1.

Table 18 Mean values of Freeman's Degree of Centrality from all the forums of the four courses

	Mean NrmOutDeg	Mean NrmInDeg	Mean NrmOutDeg	Mean NrmInDeg	Mean NrmOutDeg	Mean NrmInDeg	Mean NrmOutDeg	Mean NrmInDeg
	Course 1		Course 2		Course 3		Course 4	
1st Forum	0%	0%	1,6%	1,6%	6,5%	6,5%	3,6%	3,6%
2nd Forum	16,7%	16,7%	2,1%	2,1%	12,2%	12,2%	8,3%	8,3%
3rd Forum	5,5%	5,5%			19%	19%	1,1%	1,1%
4th Forum	0%	0%			19,6%	19,6%	0,6%	0,6%
5th A Forum	35%	35%			20%	20%		
5th B Forum	33,3%	33,3%						
5th C Forum	33,3%	33,3%						
6th Forum	33,3%	33,3%			33,3%	33,3%		
7th Forum	33,3%	33,3%			16,7%	16,7%		
8th Forum					50%	50%		
9th Forum					100%	100%		
10th Forum					66,7%	66,7%		
11th Forum					45%	45%		
12th Forum					50%	50%		
13th Forum					25%	25%		
Questions Forum	25%	25%			3%	3%	4,7%	4,7%

In C2 *Centrality* mean values for *OutDegree* and *InDegree* were of 1,6% (1st Forum) and 2,1% (2nd Forum). The teacher had, in both measures, the highest values in the two forums (*OutDegree* of 34% in the 2nd Forum and 22% of *InDegree* in the 1st Forum).

In C3 the mean values of *Centrality* for *OutDegree* and *InDegree* ranged from 3% (Questions Forum) to 100% (9th Forum). The highest figures of *OutDegree* belonged to the teacher in the majority of the forums except in the 6th, 9th 12th and 13th (where he shared the highest values with all the other participants) and 10th and 11th (where he shared the highest values with one student). The highest value of *OutDegree* of the teacher was 47% in the Questions Forum. Regarding the highest *InDegree* values they were also from the teacher in the majority of the forums except the 9th. Also in the Questions Forum we could observe the highest value of *InDegree* (56%) from the teacher.

In the last Course Freeman's Degree of *Centrality* mean measures ranged from 0,5% (4th Forum) to 8,3% in the 2nd Forum. The highest values both of *OutDegree* and *InDegree* were from the teacher (49% in the 3rd Forum and 66% in the 4th Forum, respectively).

The higher values of OutDegree from an actor indicate that the actor initiated more contacts with others than the rest of the participants. On the other side, higher values of InDegree indicate that an actor received more contacts from other participants than any other actor from the network. This means that that specific actor could access more easily to information than others.

4.3.5 Centralization

The *Centralization* degree of a network allows us to know to what extent density is organized around focal points. It is a special condition in which an actor plays a central role by being connected to all other actors, which need to go through him to connect to each other (Alejandro & Norman, 2005).

In C1 the values of *Network Centralization* (figure 15) ranged from 0% to 62,5% *(outDegree)* and from 0% to 50% *(inDegree)* while in C2 the values ranged from 33% to 43,2% *(outDegree)* and from 25,8% to 27,7% *(inDegree)*. In C3 minimum and maximum values of *outDegree* and *inDegree Centralization* were the same and ranged from 0% to 100%. In the last course *Centralization* values ranged from 1,9% to 88,6% *(outDegree)* and from 6,8% and 49,8% *(inDegree)*.

Network Centralization

	Minimum	Maximum	Minimum	Maximum
	Outdegree		Indegree	
■ Course 1	0,0%	62,5%	0,0%	50,0%
■ Course 2	33,0%	43,2%	25,8%	27,7%
■ Course 3	0,0%	100,0%	0,0%	100,0%
■ Course 4	1,9%	88,6%	6,8%	49,8%
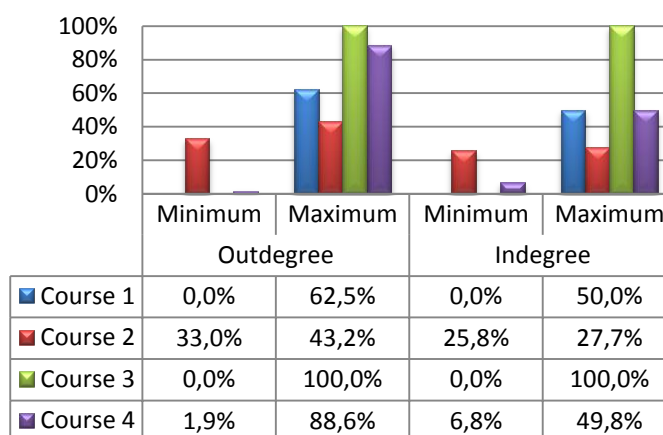
Figure 15 Minimum and maximum values of *Network Centralization* of the four courses

Regarding the focal points of the courses forums to which the *Centralization* values refer to they belonged to different actors (table 19).

In C1, for the *outDegree* measure, the teacher was the only focal point of half of the forums (five). On three other forums the teacher and students were the focal points and in the remaining forums students had that role. Concerning the *inDegree* measure, students were the focal point in eight of the ten forums.

In the *OutDegree* and *InDegree* measures of C2 the teacher was the focal point of the two forums. The same happened in all the forums of C4.

In C3, for the *OutDegree* measure, the teacher and students were the focal point in six of the fourteen forums. In the remaining forums the teacher was the focal point in five forums while students were the focal point in three forums. Concerning the *inDegree* measure the teacher was the focal point in twelve forums. In the remaining two forums the teacher and students were the focal point.

In C4 the teacher was the focal point of all the forums both in *OutDegree* and *InDegree* measures.

Table 19 Focal points of *outDegree* and *inDegree* Centralization values of the forums of the four courses

	Course 1		Course 2		Course 3		Course 4	
	OutDeg	InDeg	OutDeg	InDeg	OutDeg	InDeg	OutDeg	InDeg
Focal Points								
1st Forum	Student	Student	Teacher	Teacher	Teacher	Teacher & Students	Teacher	Teacher
2nd Forum	Teacher	Student	Teacher	Teacher	Teacher	Teacher	Teacher	Teacher
3rd Forum	Teacher	Student			Teacher	Teacher	Teacher	Teacher
4th Forum	No participations	No participations			Teacher	Teacher	Teacher	Teacher
5th Forum A	Teacher & Students	Student			Teacher & Students	Teacher		
5th Forum B	Teacher & Student	Teacher & Student						
5th Forum C	Teacher & Student	Student						
6th Forum	Teacher	Students			Teacher & Students	Teacher		
7th Forum	Student	Other Student			Teacher & Students	Teacher		
8th Forum					Student	Teacher		
9th Forum					Teacher & Student	Teacher & Student		
10th Forum					Teacher & Student	Teacher		
11th Forum					Student	Teacher		
12th Forum					Student	Teacher		
13th Forum					Teacher & Student	Teacher		
Questions Forum	Teacher	Student			Teacher	Teacher	Teacher	Teacher

Betweenness centrality, according to P. R. Doran, Doran, & Mazur (2011), is "(…) the degree to which each participant serves as a "link" or "bridge" among other participants" (p. 3). This measure allows us to know how vital an actor is to the network with respect to help other members connect. "Betweenness centrality allows one to quantify how highly connected an individual may be to others in the network, whether through direct or indirect interaction." (p. 4)

In C1 the lowest mean value of *Betweenness* (table 20) was of 0% (1st, 2nd, 4th, 5th B, 5th C and 7th forums) and the highest was 11,7% (5th A Forum). Neither the teacher nor the student's had the majority of higher values, moreover in the majority of the forums the *Betweenness* value was zero.

In C2 the mean values of *Betweenness* ranged from 0,4% (1st Forum) and 0,9% (2nd Forum) and the highest values were from the teacher in both cases.

Regarding mean values of *Betweenness* in C3 they ranged from 0% (forums 8, 9 and 12) to 33% (10th Forum) in the fourteen forums analysed. The highest values belonged to the teacher in nine forums and he shared his highest values with students in two other forums (10th and 11th).

In C4 *Betweenness* mean values were between 0% (4th Forum) and 1,59% (2nd Forum) and the highest values belonged to the teacher in all the forums analysed.

Table 20 Freeman *Betweenness Centrality* mean values of the forums of the four courses

	Course 1	Course 2	Course 3	Course 4
Questions Forum	0%	0,4%	3,3%	0,4%
1st Forum	0%	0,9%	3,6%	1,6%
2nd Forum	1,2%		5,7%	0,5%
3rd Forum	0%		8,0%	0%
4th Forum	11,7%		3,3%	
5th A Forum	0%			
5th B Forum	0%			
5th C Forum	0,1%		8,3%	
6th Forum	0%		5,7%	
7th Forum			0%	
8th Forum			0%	
9th Forum			33,3%	
10th Forum			26,7%	
11th Forum			0%	
12th Forum			5%	
13th Forum	8,3%		1,7%	1,4%

4.3.7 Closeness

Closeness centrality, according to P. R. Doran et al. (2011) tries to answer the question "(…) is a participant connected directly to all other participants, or would information need to travel through a number of other participants in order to reach that individual?" (p. 4)

Regarding the analysis of the *Closeness* mean values of forums from the four Courses (table 21) we observed, in C1, that those values ranged from 0 to 41,6 (*inCloseness*) in forums 1 (and 4, 5 B and 5 C) and forum 5 B, respectively. Regarding *outCloseness* the values were from 0 (1st, 4th, 5th B and 5th C forums) to 40,7 (5th A forum). In C2 *Closeness* values of *inCloseness* were from 1,8 to 2,44 (1st and 2nd forums) and from1,77 to 2,34 for *outCloseness* (1st and 2nd forums also). In the third Course *inCloseness* values ranged from 0 (9th and 12th forums) to 77,78 (10th forum) while *outCloseness* values ranged from 0 (9th and 12th forums) to 77,78 (10th forum). Finally in C4, *inCloseness* values were from 0,85 (4th forum) to 13,94 (2nd forum) while *outCloseness* values were from 0,82 (4th forum) to 21,35 (*Questions Forum*).

Table 21 *Closeness* mean values of the forums of the four courses

	Mean inCloseness	Mean outCloseness	Mean inCloseness	Mean outCloseness	Mean inCloseness	Mean outCloseness	Mean inCloseness	Mean outCloseness
	Course 1		Course 2		Course 3		Course 4	
1st Forum	0	0	1,8	1,77	20,69	7,33	5,26	5,46
2nd Forum	38,9	38,9	2,44	2,34	23,84	13,83	13,94	13,94
3rd Forum	8,5	8,5			34,46	21,33	2,34	4,82
4th Forum	0	0			41,67	24,54	0,85	0,82
5th A Forum	41,6	40,7			37,04	22,54		
5th B Forum	0	0						
5th C Forum	0	0						
6th Forum					52,5	38,1		
7th Forum					26,92	19,8		
8th Forum					61,11	61,11		
9th Forum					0	0		
10th Forum					77,78	77,78		
11th Forum					58,76	58,76		
12th Forum					0	0		
13th Forum					43,43	28,46		
Questions Forum	32,8	37,4			37,12	7,73	4,82	21,35

The meaning of high *Closeness* values indicate a greater autonomy of an actor while low *Closeness* indicates a higher dependency from an actor from the others willingness to give access to the network's resources (Müller-Prothmann, 2007).

4.3.8 Cliques

"A community may be defined by structure, e.g. communities as cliques." (Spiliopoulou, 2011: 153) *Cliques* are subgroups or subsets of actors that show preference for 'specific' neighbours and usually represent the most interactive zones of a network regarding knowledge and other resources (Mazzoni & Gaffuri, 2010).

In none of the forums from the four courses we found *Cliques* with more than 3 actors (table 22).

Table 22 Total number of *Cliques* from the forums of the four courses

	Dyads	*Cliques* of 3 actors	Dyads	*Cliques* of 3 actors	Dyads	*Cliques* of 3 actors	Dyads	*Cliques* of 3 actors
	Course 1		Course 2		Course 3		Course 4	
1st Forum	0	0	18	0	7	0	2	0
2nd Forum	0	0	22	1	2	0	1	0
3rd Forum	2	0			2	0	9	0
4th Forum	0	0			4	0	4	0
5th A Forum	2	0			1	0	9	0
5th B Forum	1	0						
5th C Forum	0	0						
6th Forum	1	0			1	0		
7th Forum	0	0			1	0		
8th Forum					0	0		
9th Forum					1	0		
10th Forum					1	0		
11th Forum					4	0		
12th Forum					0	0		
13th Forum					1	0		
Questions Forum	1	0			44	0	9	1

In C1, in half of the forums there were no *Cliques* created by the participants. In the rest of the forums there were only dyads (3rd, 5th A, 5th B, 6th forums and *Questions Forum*) and no subsets of three actors.

In C2 there were 18 and 22 dyads (1st and 2nd forums respectively) and one *clique* of three actors in the 2nd forum.

In C3 there were only dyads and in two forums (8th and 12th) there were no *Cliques* at all.

In the last course all the forums had dyads and the 5th A forum and *Questions Forum* had one clique of three actors respectively.

Regarding the total number of *Cliques* C1 had 7, C2 had 41, C3 had 69 and C4 had 36.

In the largest majority of all the analysed forums the teacher was one of the actors of the *Cliques.*

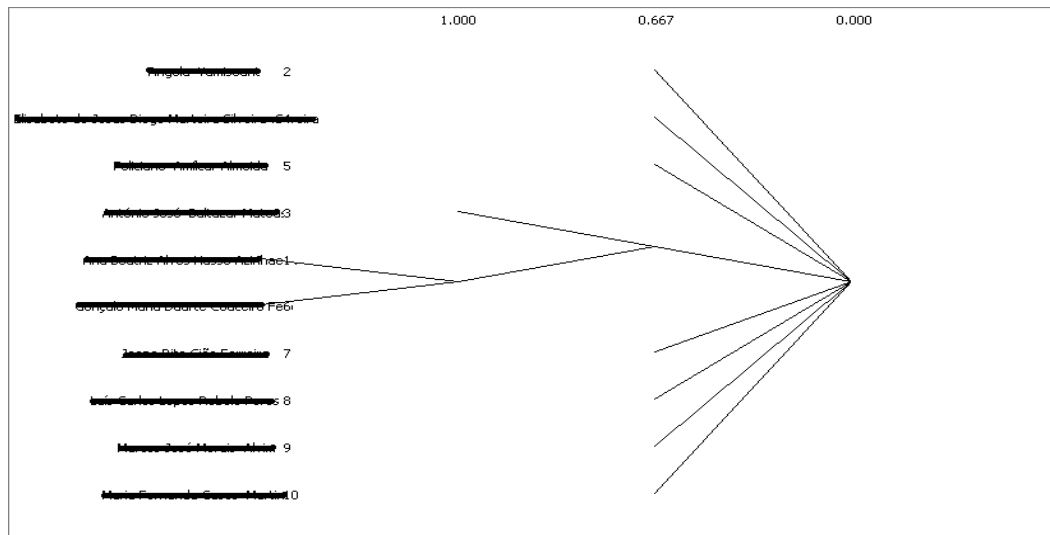Figure 16 illustrates a tree diagram of two actors' *Cliques* from C3[91].

Figure 16 *Cliques* of two actors from the 2nd forum of course 3

The meaning of the SNA measures values in four courses is addressed next, in the *Discussion Chapter* of this thesis.

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[91] For confidentiality reasons the names of the actors were hidden.

Regarding the network patterns found in the forums the most common was the star pattern (figure 17). With very few exceptions the teacher was always in the centre of the star. The tip of the arrow shows the direction of the interaction (who contacted who). When an arrow has two tips it means the relation was reciprocal. An actor talked to another actor who replied back (between the teacher and student B). The size of the shapes has to with de actor's degree of *Centrality*. The higher the degree, the bigger the shape.
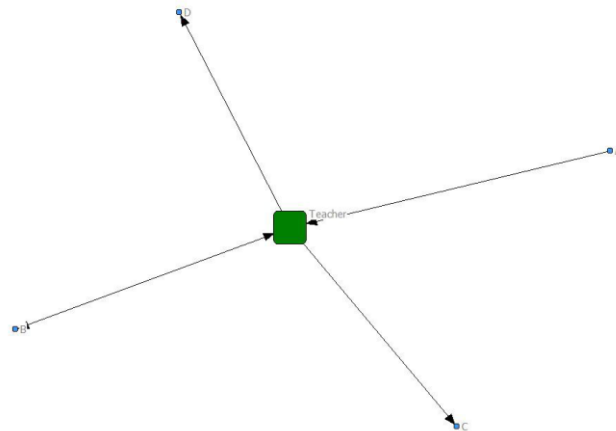
Figure 17 Example of the most common pattern found in the forums, the star pattern (6th forum of course 3)

In figure 18 the predominant pattern was still the star pattern but we can also observe many *Cliques* (dyads mainly) composed of the teacher and students (red arrows) although there are some *Cliques* composed only by students. In this forum we witnessed much more interaction (that in the one of the previous figure) and the presence of several *Cliques* although in many there is some overlapping of actors, especially by the teacher who is one of the actors of many *Cliques* (red circles). In this graph the teacher had the highest degree of *Centrality* and that is reflect in the size of the green central shape that represents him.
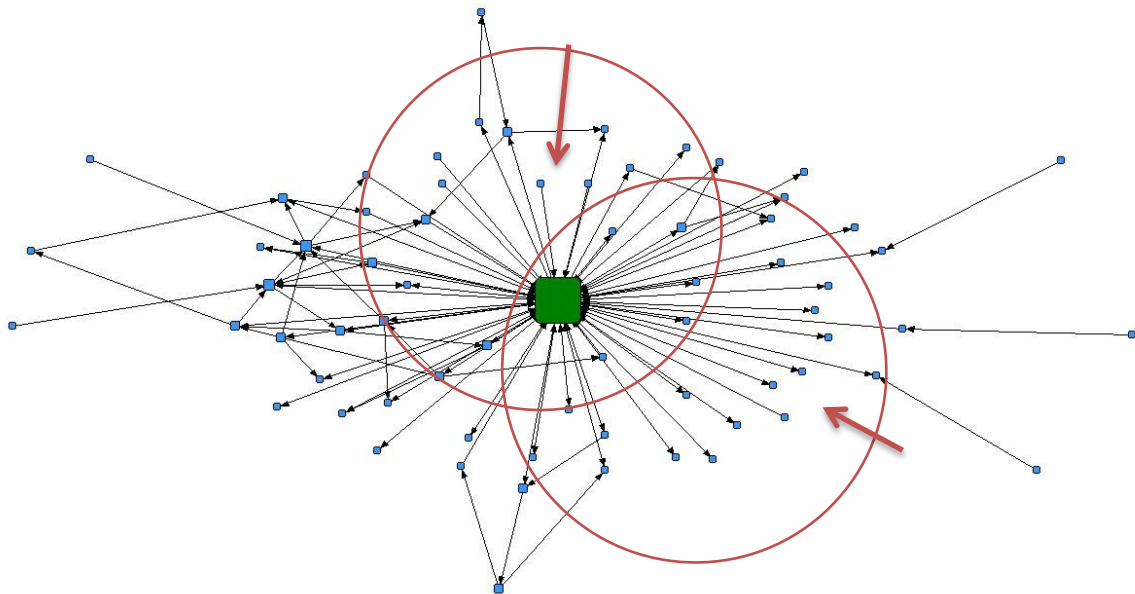
Figure 18 Example of much interaction especially between the students and the teacher (inside the red circles) of the 2nd forum of course 2

Some forums had very little interaction and still had isolated actors (in figure 19 pointed by the black arrow). Less interaction results, many times, in equal degrees of *Centrality* shared between the actors (represented in the next image by a dyad with actors with the same shape size). This image also represents a very usual behaviour in the forums: non-reciprocal relations. This happens when an actor post without getting any reply from others.
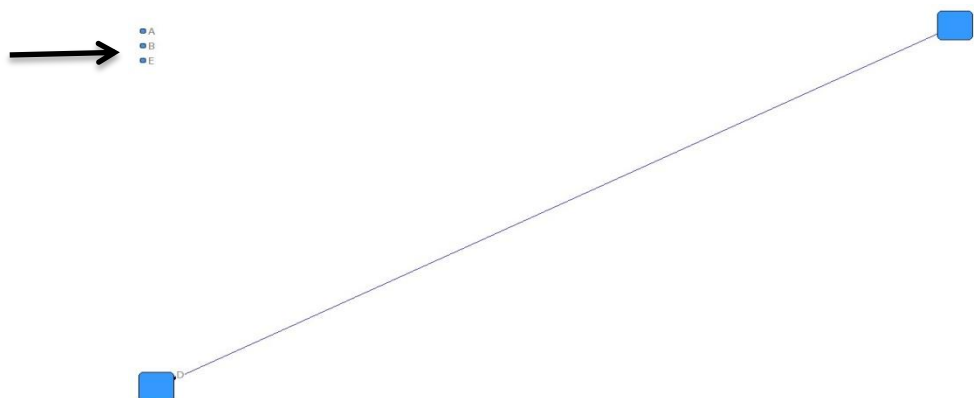
Figure 19 Example of a forum with a very small participation (7th forum of course 1)

Although the most frequent pattern was the star one, we can also found some other patterns in some regions of the networks (figures 20 & 21). Inside the blue circle in figures 20 and 21 are two examples of the line pattern. In figure 20 students A, E, D and G are part of the line and each only contact with two others and those who are at the ends of the line only contact or are contacted by one other student. In figure 21 students CE, CA, BL and AV are part of an independent subset which forms a line pattern.

We cannot say, though, that these networks have a line pattern because there are other interactions beside the ones within the lines (with a higher number of actors involved) and because some of those interactions are from some actors that belong already to the line (figure 20).

Another pattern that can be found in figure 20 is the circle pattern (inside de red circle) which comprises students K, G, D and the teacher (green square). In this pattern all the participants have same number (two) of alternative trading partners. Students F, D and the teacher also are an example of this type of pattern. Again, e because of the reasons stated above for the line pattern, we cannot say that the entire network has a circle pattern.

These two forums networks provide an example of, although networks usually have a predominant pattern, it is also possible to found in certain parts of those networks, other patterns.
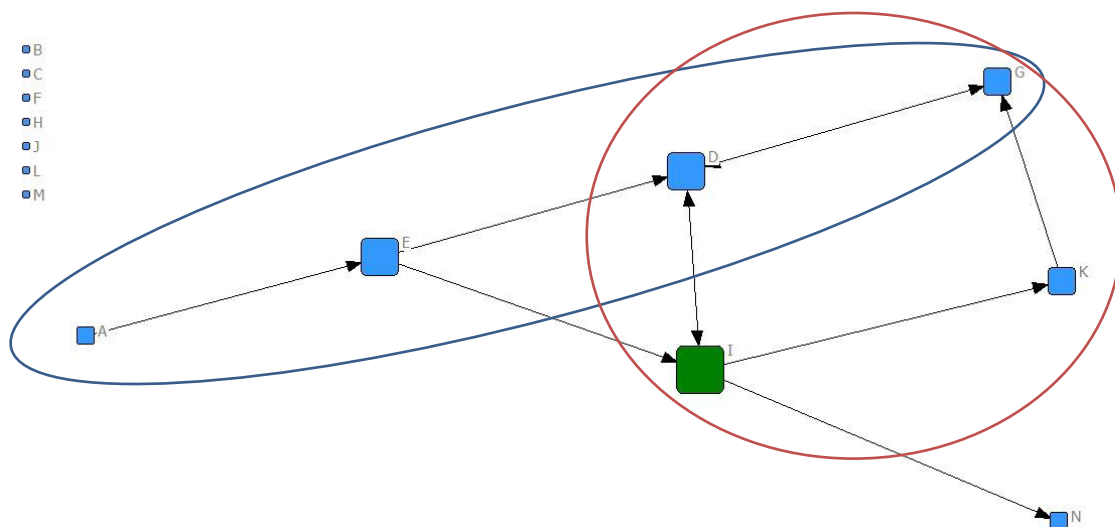
Figure 20 Example of a circle pattern (inside the red circle) and a line pattern (inside the blue line) within the network of the 3rd forum of course 1
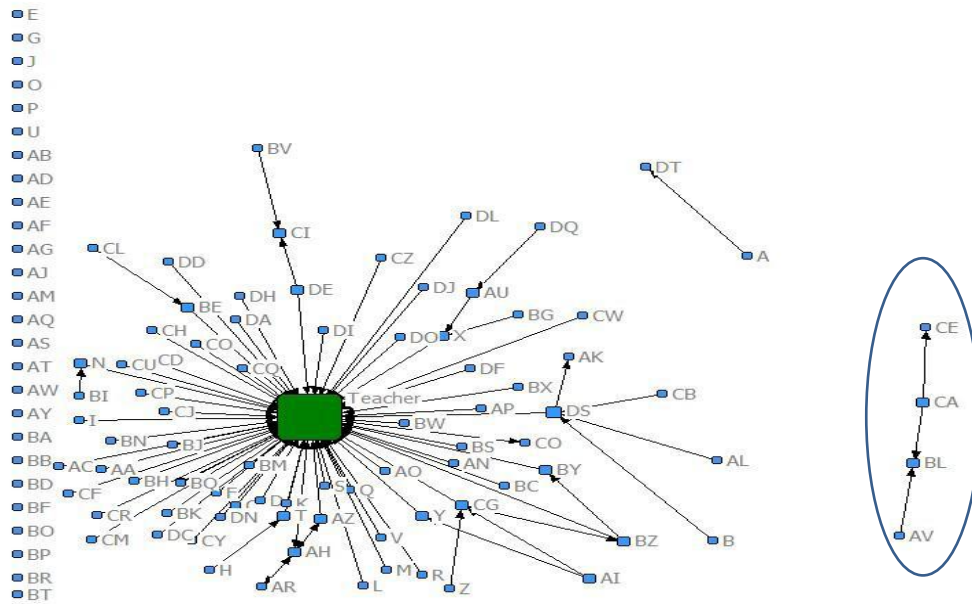
Figure 21 Example of the line pattern within a network (blue circle) from the 4th forum of course 4

In this research we also found two examples networks with a circle pattern (see figure 22).
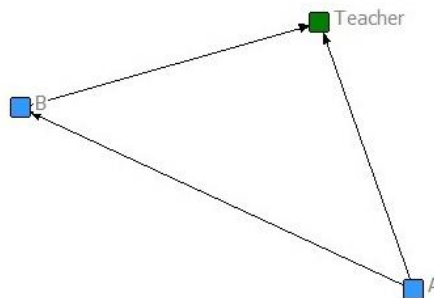
Figure 22 Example of a circle pattern (8th forum of course 3)

Figure 23 provides some of the same information of the previous images: dyads (green arrows), isolated actors (black arrow) and the star pattern (red arrows). However this image also

offers an example of what Patricia Fidalgo & Thormann (2012) called a multi-stars pattern[92]. In this type of pattern more than one actor (in this case the teacher and students X and AY), share close *Centrality* values by being in the centre of different stars within the network. This may reflect some degree of homogeneity of the network exactly because participants share power through the position occupied in that network. These stars, however, share some common actors, so we propose to call it of *linked multi-star pattern*.
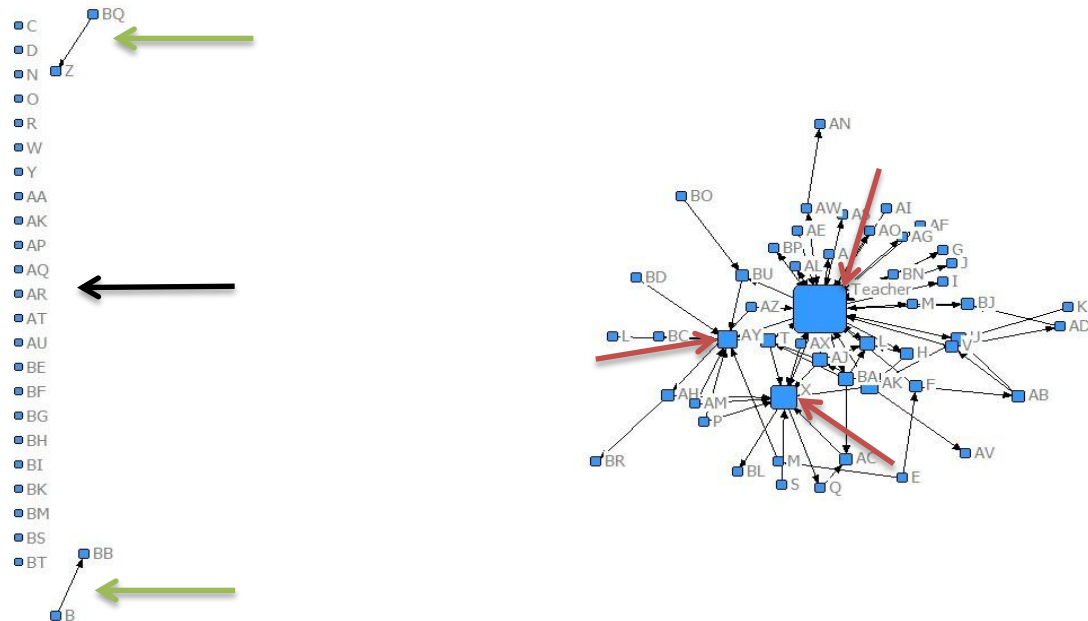
Figure 23 Example of star network patterns (red arrows), dyads (green arrows) and isolated actors (black arrow) from the 1st forum of course 2

The total number of forums in each Course was: C1 with ten forums, C2 with two forums, C3 with fourteen forums and C4 with five forums.

Regarding the frequency of the predominant pattern found in C1 from a total of ten forums, one did not have any participation and two had only one actor, so there were no patterns found. Of the remaining seven forums, three only had three participants and the pattern found (maybe due to the low participation) was the line pattern. In the last four forums, two had line patterns and two had star patterns.

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[92] The authors claim they have not read about the multi-star network patterns in the SNA literature.

In C2 there were only two forums and in both we found predominantly the star pattern.

Regarding the forums of C3, ten had a star pattern, two a circle pattern and two a line pattern.

Finally, the star pattern was the most frequent one on C4 five forums.

From a total of thirty one forums analysed nineteen had star patterns, seven had line patterns, two had circle patterns. The remaining did not have any pattern due the low (only one actor) or no participation.

4.4 Content Analysis

4.4.1 Teachers' interviews

According to what has been described by us in the *Materials and Methods* chapter we did the content analysis of the interviews in three phases: pre-analysis, the analytical description and interpretation of reference. We are going to present now the first two phases and leave the third one for the *Discussion Chapter* of our research.

In the pre-analysis all interviews were transcribed and we made a table with all the main categories we had in the interview guide. New categories were added (when needed) during the analysis of the interviews. The main categories we had in the interview guide were: the use that teachers had done of *Moodle*, their opinion on the process of DE and their own experience of the same, and the interaction networks created on the courses taught by them. From the main categories we have also constructed subcategories. These subcategories correspond to questions that we have made on each of the major categories and were: positive and negative features of the *Moodle*, pedagogical model for online teaching, course forums created by the teachers in their courses, types and kinds of interactions in the course forums, course learning networks, SNA of the course forums, DE positives and negatives and DE implementation process by the institution. From the analysis of the interviews were also added the following subcategories: course assessment, course characteristics (suitability for being taught online).

Then we have proceeded to the coding of the categories as shown in table 23:

Table 23 Coding of the teachers interview categories

Main categories	Code
Teachers' use of LMS *Moodle*	TU-LMS
Teachers' opinion of DE process	TO-DE
Teachers experience on DE	TE-DE
Networks in the courses taught by them	T-NTW
Subcategories	**Code**
General use of the LMS *Moodle*	TU-LMS-GNR
Positive features of the LMS *Moodle*	TU-LMS-POS
Negative features of the LMS *Moodle*	TU-LMS-NEG
Course forums created by the teachers in their courses	T-NTW-FORS
Types and kinds of Interactions in the course forums	T-NTW-INTER
Course learning network	T-NTW-LEARN
SNA of the course forums	T-NTW-SNA
Pedagogical model for online teaching	TO-DE-PDG
DE positives	TO-DE-POS
DE negatives	TO-DE-NEG
DE implementation process by the institution (school)	TO-DE-SCOL
Added subcategories	**Code**
Course assessment	TU-LMS-ASS
Course characteristics (suitability for being taught online)	TO-DE-COUR
Course size (number of students enrolled)	TO-DE-COSZ

For the sake of a more systematic presentation of the results from the interviews, we opted for the creation of tables that would summarize the responses and we have only made description of the teachers' answers the times they emphasized or mentioned something new.

The left column of the tables has the categories and subcategories codes while the right column has a summary of the responses given by the teachers.

Table 24 summarizes the answers of C1 teacher interview:

Table 24 Interview summary - course 1 teacher

	Course 1 Teacher
Subcategories	**Answers/ Opinions**
TU-LMS-GNR	*Moodle* serves his purpose of being a LMS that can be used for online or classroom classes. It was a positive experience. He did not do used more *Moodle* features than originally planned.
TU-LMS-POS	Easy to communicate with students. Possibility of an asynchronous learning scheme.
TU-LMS-NEG	Resources update and upload process is slow.
TO-DE-PDG	Classic model of DE with moments of self-learning and moments of group learning (with interactions). Nevertheless the resources he made available for students were the same he use in classroom courses.
T-NTW-FORS	Main purposes of the forums: to develop skills and knowledge. Only some goals of the forums were achieved. The level of interaction could have been better.
T-NTW-INTER	Regarding the work of individual students, the pedagogical model depended on some of the interactions. Regarding the group work the model depended more on interactions between students (and less with him).
T-NTW-LEARN	He does not know if there were more or less interactions in the online course (when compared with the classroom courses). He is a great supporter of the online interactions. In this course participants interacted more in the forums (and not by using e-mail or *Moodle* chat room).
T-NTW-SNA	Could be useful but he does not know if having access to that kind of information would change the way he manages forums. When presented with a graph of one of his forums he said that information might be useful but he does not think that would change his behaviour (perhaps if he was doing research he might change). SNA can bring more data to make a diagnosis of the situation. SNA can be useful to manage the course but he does not know if it's essential. He does not think SNA could be useful for other people (school managers) beyond teachers.
TO-DE-POS	When students achieved the goals and maximized the collaborative aspects. DE has many potentialities.
TO-DE-NEG	When students do the minimum (just enough to ensure they pass in the course).
TO-DE-SCOL	It is not a bad model but he was not very well implemented.
TU-LMS-ASS	Assessment was partly different (from classroom courses) because there were online activities different from classroom activities. The final test was done in a classroom. Some of the students' participation in the forums was assessed.
TO-DE-COUR	This course is a good candidate for online learning.
TO-DE-COSZ	The size of the course brings to much workload to the teacher.

Regarding the forums, C1 teacher said that his goals were to stimulate students to wright and have asynchronous interactions and to develop more skills and knowledge than those they could develop on their own. He also added that some interactions could not be present in the forums because the students worked in groups and interact in other ways too.

When presented with a graph of one of his forums the teacher commented that interactions seem to be centred on him but that in that case he was not making transmission of information. He was the one who started the debate in the forum so it was normal that students replied to him and speak less with each other. He also said that he was aware of some information provided by SNA even before seeing the graph and don't know exactly what use to

give it because "to change the behaviour as a teacher is not always possible due to the workload." (Course 1 teacher, personal communication, March 2011)

Although this teacher said that SNA might be of some use he thinks that the qualitative analysis of the SNA results should be made by the teacher (and not by the researcher who gathers the data and makes the quantitative analysis).

When he was asked about the overall picture he makes about his experience in this course he replied:

Some of the moments were worth it because they hit some of the goals I had originally thought (there was a real interaction, proper use of resources, discussion) but I also had some other times (this may have to do with the students profile) were I was unhappy because students did not use *Moodle* to its full potential or they did not maximized the use of the platform. (Course 1 teacher, personal communication, March 2011)

Regarding the interview done to C2 teacher we have made the tables 25 and 26 which summarize his answers:

Table 25 Interview summary - course 2 teacher

Course 2 Teacher	
Subcategories	**Answers/ Opinions**
TU-LMS-GNR	He did not have the time or the will to explore all *Moodle* features. Technically the platform did not bring anything 'stronger' as a novelty. Did not do more activities than those who had initially anticipated. Only improved activities.
TU-LMS-POS	Nothing.
TU-LMS-NEG	The negative aspects were insignificant but annoying (students tried and failed to deliver assessments, uploads could take too much time, not all videos could be uploaded). He does not understand these technical difficulties.
TO-DE-PDG	He tried to preserve the 'soul' of the course (tried to keep the logic and main objectives). It is a hybrid model (tried to preserve the 'soul' of the classroom model and keep it in the online environment). He thinks these goals were not achieve because of the platform. He outlined, in writing, the path that each student should do to achieve the course goals. For each step he outlined the objectives and documents that should be consulted to achieve those objectives. He thinks his pedagogical model was excellent if it had been properly thought. It was a botched adoption of the classroom model because it was not properly thought.
T-NTW-FORS	He used the forums for the first time. The forums are an asset but did not bring anything specific unless the possibility of a different organization. The goal was to have a debate in the course but it was not achieved. It was difficult to control interventions. Students repeated information that has been said by colleagues and saw the participation in forums as a 'job' and did it to dispatch the task.
T-NTW-INTER	His course depended 40% on interactions with the teacher, 40% on interaction with the resources and 20% in the interactions between students. *Moodle* encourages interactions (because students hide behind the computer) but they only did for assessment purposes. He thinks students interacted more using the e-mail and the direct messages system from *Moodle*.

Table 26 Interview summary - course 2 teacher (continuation)

	Course 2 Teacher
Subcategories	**Answers/ Opinions**
T-NTW-LEARN	He does not think that a learning network has been created. He does not know if other kinds of networks were created because 'not everything was visible to him'.
T-NTW-SNA	When presented with a graph of one of his forums commented that kind of information might be useful but he had to analyse the content of the participations. Everything depends on the reflection that the teacher makes of such data.
TO-DE-POS	Overall is for DE as a possibility because it solves some problems. For the teacher DE has concrete gains.
TO-DE-NEG	There is always a cost and that cost can be the malfunction of the course from the students' point of view.
TO-DE-SCOL	He felt that the model was not planned. Disagreed with the process in the first year because it was imposed. In the second year things were better (also because he fought to make things better).
TU-LMS-ASS	Three individual online assignments and one final test done in a classroom. Participation in one of the forums was also assessed.
TO-DE-COUR	This course can be an excellent example in online education if there were a good basis for work and if students participated. The base rests on a good clarification of roles and that each is aware of its role
TO-DE-COSZ	Organization helps to overcome the difficulties of large classes. DE should serve to include a greater number of people.

For this teacher it was the second academic year he was using *Moodle* and in the first year he used it only as a content repository.

The teacher also said that the adjustments he was accustomed to do during the classroom courses (content and teaching dynamics) were not possible in *Moodle* perhaps due to the fact he still has much learning to do about the platform. But he did not have time to do it.

Although he rated is teaching model as excellent and sees many possibilities in the platform, he added: "But are they achievable in light of the specific context in which we operate or not? The institution itself is available to explore that? And will the profile of our students allow the same?" (Course 2 teacher, personal communication, March 2011)

He thinks that in his course there was a real possibility of true online teaching but that did not happen. For him true online teaching is:

Something that is not devoid of a direct contact with the teacher. How will exist and in what format? This is where there is a change. Does not have to always be in a classroom and there may be direct contact without physical contact. (Course 2 teacher, personal communication, March 2011)

This teacher also said that when he talks he has in mind the British University model where the teacher is not concerned with the details because the study of details is done by students on their own. And something similar should happen in the distance learning "Students must acquire the autonomy to be a key link in the learning process and teacher's role changes

completely. There can be no absolute teaching online." (Course 2 teacher, personal communication, March 2011) For him the teacher is just a catalyst. Its role is limited to clarify. He described his teaching model as 'responding to the urgent' without having time to anything else.

Regarding the forums he thinks that it is possible to use them thanks to computers and not to the LMS. He said that he had new problems in the online forums when compared to the classroom debates.

When we are discussing in a closed space together there is a rule that students must acquire (anyone in general) that is when one person talks the others have to listen. This is already difficult to establish in physical space but in the platform is even worse. I cannot control it. I have had students who will make interventions and do not know that aspect has been said earlier by colleagues. They were in a confined space, they were supposed to communicate. But they did not. They do not read things and then post an idea and talk about that idea as if nothing had happened before. (Course 2 teacher, personal communication, March 2011)

Regarding the students' participation in the forums the teacher added an episode that has happened during the course. The theme of one of the forums was 'gender' and one student complained to the school board that 'unacceptable things' were posted in that forum. The teacher thinks that was exactly the goal. For students to speak out freely. He also thinks the student who did the complaint should have done it in the forum.

The teacher said he did not give much thought to the interaction among students because the requirement level was not very high. "If it were, the dynamics between them [students} would be worth much." (Course 2 teacher, personal communication, March 2011) He also thinks the quality of those interactions was not higher than those in a face-to-face class.

As regards to the statistics provided by *Moodle* the teacher said he used them for assessment purposes [to confirm students had seen the resources and participate in the forums] but not in a systematic and continuous way. Statistics could be more useful if they were better structured.

When presented with a graph of one of his forums the teacher said this kind of information could have saved him some time effort trying to know what was going on in the forums. It also would be interesting to do a longitudinal study. He also said (when he saw a star pattern in the forum network) he did not intend to have that pattern in his forums. "There should have been several stars or even other atypical forms" (Course 2 teacher, personal communication, March 2011) and students should be in the centre. He thinks the theme of the forum, the fact that the teacher replied to almost all the students' interventions may help explain that pattern. He also added that the isolated actors [shown in the graph] may be due to the fact the, in the end, he did not had time to reply to all the students.

The graph itself is graphically satisfactory but it needed a qualitative analysis. He thinks the qualitative analysis could be made by the students as a fieldwork complemented by interviews. SNA could also help students to manage their participation in the forums.

The teacher thinks the online can be either an excellent space or a failure for interactions. It all depends on the course structure. He also added that it might be important if 'someone' would check what happened in all the online courses.

To manage the course he does not need SNA but it may be an interesting technical advantage and that is important for him. For other faculty members and for the institution may not be.

For the DE model to work "everyone must know their roles and the base must be clear, that we know what we are talking about and what is being done." (Course 2 teacher, personal communication, March 2011) The teacher thinks a good DE model would be a balanced model that takes into account the profile of our students and institutional constraints (economics, etc.). "A model that considers all the variables. Where we can earn more and spend less. It's a business calculation. Cost benefit. What has been done until now is to think about the costs and not the benefits." (Course 2 teacher, personal communication, March 2011)

This teacher concluded he would rather be a classroom teacher.

Tables 27 and 28 summarize the answers of C3 teacher interview:

Table 27 Interview summary - course 3 teacher

	Course 3 Teacher
Subcategories	Answers/ Opinions
TU-LMS-GNR	Use it as supplementary tool. Eventually used the platform more than had initially planned increasing the quality of the resources shared with students as well as communication.
TU-LMS-POS	Have useful features. A very good and simple communication tool to talk to students and share resources. Good for students' assessment. Good tool to record and analyse the route of each individual student.
TU-LMS-NEG	He cannot respond because of his incipient use of the *Moodle*, and some technical problems associated with the server where it is housed.

Table 28 Interview summary - course 3 teacher (continuation)

	Course 3 Teacher
Subcategories	**Answers/ Opinions**
TO-DE-PDG	Thinks he's model in an incomplete one and does not like it. Has transposed the classroom teaching model to the online environment and does not considered he has been very successful in this process.
T-NTW-FORS	Forums were designed as places to discuss specific issues of each syllabus subject. He had a minor intervention in the forums being particularly attentive to what goes on in the *Questions Forum*. The forums that were attended by students were successful. Participation in the forums was not assessed.
T-NTW-INTER	In addition to the forum he did not encourage other types of interaction among students. His pedagogical model did not depended much on interactions between the participants but depended very much on the interactions with the resources he shared with the students. The *Moodle* stimulates less the interactions between the users and it is difficult to stimulate participation. The quality of interactions / interventions was good.
T-NTW-LEARN	Does not have sufficient information to answer but thinks that it was not created a learning network.
T-NTW-SNA	SNA could be useful to have a better knowledge about students' behaviour and performance, and would consider using that information for assessment purposes. Helps to have a real perception about the interactions with the students. When presented with a graph of one of his forums commented that it seemed a very univocal relationship between him and the students and if he had access to that information he had to think what to do with it and he might have changed the way he has managed the forums. Don't think it would be useful for students to have access to this kind of information.
TO-DE-POS	Useful. Excellent supplementary tool. Disagrees with a full replacement of the classroom courses for the online ones.
TO-DE-NEG	Is conditioned by the learning objectives and the target audience.
TO-DE-SCOL	Lacks face-to-face moments with the students. Little preparation of teachers and students for this online model. A mixed model (face-to-face/online) would be better.
TU-LMS-ASS	Four online tests and one classroom test.
TO-DE-COUR	This course is a good candidate for online learning but still needs several classroom moments.
TO-DE-COSZ	Size course was too large. Difficult to manage the course. Too much workload.

The teacher also mentioned that his online course had benefited very much from the classroom moments he had[93] with the students and a reflection of this was the increased online participation the weeks after those moments.

He also said that his pedagogical model depended very little on the interactions between the students with him and between themselves. He argues that even in the classroom courses he does not leave much room for interaction because of the amount of contents he has to teach and because of the high number of students enrolled which makes very difficult to manage their participations. He added that he had transposed that low interaction model to the online environment.

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[93] This teacher had three face-to-face classes during his online course: in the first one he presented himself and the syllabus of the course, in the second one he taught a chapter of the syllabus and in the third one he prepared the students for the final test.

Regarding the quality of interactions / interventions of the students in the forums the teacher said: "So in terms of quality participation is good, careful, it's interesting the kind of doubts that arise and debates taking place in the forums, but they are scarce." (Course 3 teacher, personal communication, July 2011)

When asked if he think a learning network was built in his online course the teacher said he does not believe such network had really been created. The reason is the limited participation from the students. He believes that the only 20 students (from the 303 he had) have participated in the forums and that is not enough to create a learning network.

Concerning the possibility of having access to SNA results of his online courses he thinks that that information could be very useful but only if used for assessment purposes. Nevertheless the qualitative analysis of that information should only be made by the teacher (and not by the researcher who gathers the data and makes the quantitative analysis).

When asked if the school managers could benefit from SNA information, the teacher answered: "It could be useful. But the first question that comes to my mind is: with what criteria and what purposes would it serve?" (Course 3 teacher, personal communication, July 2011)

Finally regarding the DE process implemented by the school he thinks it needs to be reviewed and it could be improved.

(…) it seems to me that we can do a lot to make online teaching more attractive and interesting but if on the other side there is not a student or a group of students who understand the whole process of learning through the platform, we can even make the pin but not miracles. I still find that students do not even understand what they are doing in the platform, do not read the contents, do not read the rules, do not read the forms of assessment, or the GPS, do not read anything at all and at the end of the semester have more questions than certainties. (Course 3 teacher, personal communication, July 2011)

The teacher adds how the audience could become more collaborative with this form of learning:

In a first phase, preparation of students at the beginning of the academic year. Serious preparation. So students can understand the platform as a learning tool and not as playful tool and ... ensure that the faculty members who teach online have better technical training and more time to face and be able to address this all issue differently. (Course 3 teacher, personal communication, July 2011)

Although the teacher would like to continue to be a part of the DE process at the school he believes that a mixed model would work better.

Table 29 summarizes the answers of C4 teacher interview:

Table 29 Interview summary - course 4 teacher

	Course 4 Teacher
Subcategories	**Answers/ Opinions**
TU-LMS-GNR	Good general opinion about *Moodle*. It was a positive experience but he is not completely satisfied. Some students spent more on the platform while others worked the minimum.
TU-LMS-POS	Easy for distributing resources to the students. Easy to communicate with students.
TU-LMS-NEG	*Moodle* does not have a good management system for group tasks. The assessment system for groups is not good or easy and he had to do it outside *Moodle*.
TO-DE-PDG	Not similar to the classroom model. Had to redo the whole process in a different logic more focused on students learning rather than in the teacher transmission of knowledge.
T-NTW-FORS	Main purposes: to develop skills and knowledge. It was difficult, even dividing students by groups, to manage so many interventions. Except in a few cases he thinks he did not achieved all the goals he wanted with the forums.
T-NTW-INTER	His pedagogical model depended largely on the interactions between students and with him. Regarding the interaction with the resources he expected that students would search for new one on their own e would not depend exclusively on the resources he made available.
T-NTW-LEARN	He believes that interactions are different in online environments because students have more time to think and research before participating. He believes that the networks created in his course were learning networks.
T-NTW-SNA	Could be useful. Teachers have an intuition about how things are going in their courses and with SNA they could have information more accurate. Does not know if that kind of information would change anything in its activity as a teacher. When presented with a graph of one of his forums commented that there is a centring on the teacher regarding the forums interactions. I would be interesting to have SNA not only in the forums but also in the other interactions in *Moodle*.
TO-DE-POS	If you find a new feature at any time you can make it available. When students achieved the goals and maximized the collaborative aspects. He is an advocate and believes in the DE.
TO-DE-NEG	When students do the minimum just enough to ensure they pass in the course
TO-DE-SCOL	It is not a bad model but he was not very well implemented. If management had been made in a more educational perspective rather than an administrative perspective, things would have gone better.
TU-LMS-ASS	Some small tasks were similar to what students do in the classroom, some other were different. The final test was in a classroom. Some of the students' participation in the forums was assessed.
TO-DE-COUR	This course is a good candidate for online learning.
TO-DE-COSZ	Problems with managing such large groups.

C4 teacher referred that there were times when his pedagogical model (more focused on students) was difficult to implement due to the high number of students.

Regarding interaction the teacher said:

I am an advocate of online interactions even though not all students are able to do that very well. Theoretically there are all conditions for the quality of online interactions to be higher because the student has time to research and reflect before intervening. Although in face-to-face there is liveliness there are other less positive factors (coherence and consistency of the response is different). (Course 4 teacher, personal communication, July 2011)

He also said that the informal interaction spaces he created in the course were rarely used.

Concerning the forums the teacher said the interaction could have been higher and richer. He thinks that the type of activity in the forums is the responsibility of students but also of teachers who can think on activities to encourage more the participation. In his case there was however a problem. "How to build collaboration in such large groups?" (Course 4 teacher, personal communication, July 2011) He also added that too much information may lead to the dispersion of student from the focus of the discussions in the forums.

About SNA he thinks students should have access to that kind of information because it could be a motivating factor. He also added that there are also arguments against because "students know very well with who they are interacting and that they are interacting little. It may be intentional." (Course 4 teacher, personal communication, July 2011)

When asked about the DE process implemented by the school he said:

There were decisions that were taken that were not in logic with the online teaching, but in an administrative logic (which may still have some advantages). I do not know which way the institution should follow in the DE process. There should be greater control of processes. A more developed appreciation of what is being done [by teachers]. Eventually, even, research. (Course 4 teacher, personal communication, July 2011)

The teacher also said that students should be better prepared for DE. "A student who has been trained to be an online student will know how to make online interactions and will get more from them." (Course 4 teacher, personal communication, July 2011)

He would like to continue being a teacher in DE model and he would also be in favour of a mixed system if there were conditions to do so.

4.4.2 Interview to the proponent and main responsible for the implementation of the Moodle platform and the Online Education Project at the institution

The proponent and main responsible for the *Online Education Project* of the institution was also interviewed. As stated in the Methods chapter the purpose was to understand the context of our object of study and understand the strategy and organizational design behind the

process of implementation of the *Moodle* platform and its use for teaching purposes by the institute.

Table 30 shows the coding of the main categories and subcategories from the interview to the responsible of the *Online Project*.

Table 30 Coding of the responsible interview categories

Main categories	Code
Online educational project implementation	OEP-I
Online educational project assessment	OEP-A
Pedagogical model of the online educational project	OEP-P
Online educational project and *Moodle* features	OEP-MF

Subcategories	Code
Decision-making process	OEP-I-DM
Online educational project implementation challenges	OEP-I-C
Moodle in the online educational project implementation	OEP-I-M
People involved in the implementation of the *Online Project*	OEP-I-PI
Online educational project assessment from the teachers	OEP-A-T
Online educational project assessment from the students	OEP-A-S
Online educational project assessment by the responsible for the implementation	OEP-A-R
Pedagogical model of the courses chosen to be a part of the *Online Project*	OEP-P-C
Pedagogical model of the online educational project - general characterization	OEP-P-GC
Online educational project and *Moodle* features for the creation of virtual communities	OEP-MF-VC
Pedagogical model of the online educational project and virtual communities	OEP-P-VC
Virtual communities analysis (SNA)	OEP-MF-SNA
General opinion about the online educational project and *Moodle* features	OEP-MF-GO

After coding the interview of the responsible for the implementation of the *Online Project* we have also decided to present a summary of his answers in a table (see tables 31 and 32). This was the longest interview and was the one which provided us with much crucial information for understanding our research object.

Table 31 Interview summary of the main responsible for the *Online Education Project*

Subcategories	Answers/ Opinions
OEP-I-DM	The project was proposed by him to the institution in 2007 and the direction board agreed to test it. Between January 2008 and September 2008 he went to all to campuses to train the teachers. The campuses directions participated in the planning of the training courses and disclosure of the project. By then the entire project was managed by him and his team. From 2009 on the schools and the direction of the institution took over. From then, he and his team have only a supporting role to all the teachers that want to use *Moodle*. That was when *Support Offices* in every campus were created. Since 2009 the project has enter a new different phase and it is not called *Online Education Project* but just *Online Project*.
OEP-I-C	There were no major technical challenges. The institution already had servers and staff. Regarding the courses one major problem was the fact that the teachers who had the initial training were not the same (in many cases) that those who were responsible for the first courses taught according to the *Online Project* (courses from the 'institutional matrix'[94]). They were not from the pioneers or pivot group. Some other teachers did not agree with the *Online Project* and offered resistance. The number of teachers interested in the *Online Project* model has decreased and he believes that is because many of the initial teachers that were trained are no longer teaching at the institute. Students also offered much resistance. The courses chosen to be taught online, the number of online classes and the national classes[95] hindered the process. After the first and a half year the implementation team lost control of the process and the direction of the institution took control.
OEP-I-M	*Moodle* was chosen because it was the LMS recommended by the Ministry of Education, because it was open source and could be quickly disseminated and because there was little investment to be done.
OEP-I-PI	The first team consisted of two persons, him and a technician. After that the team grew and had five persons (all of them working in the same campus) and is now reduced to the starting people. Regarding the teachers there 150 involved and all were trained during three courses. From these, 48 ended the training and became responsible for the disclosure of the *Online Project*. They were called the *pioneers*. And from those 48 some were invited to become responsible for the *Online Project* offices in each campus. They were called *pivots*. The potential of these groups of pioneers and pivots was not fully achieved because some of them were not involved in the courses which were later chosen to be taught online. The directions of all schools in each campus were also involved and from 2009 were responsible to decide which courses would be taught online in their campus.
OEP-A-T	The first group of teachers involved had a very positive experience. After 2009 some of them offered resistance because they were nominated to teach online. Participation was not voluntary. Some of the nominated did not have training or any prior experience. Some complained the online teaching was taking much of their time and some were worried with the size of the classes. Some kind of rewarding system to them was proposed by the responsible of the project but that was not accepted by the institution direction.
OEP-A-S	In the beginning students also offered much resistance. They were not prepared to be so 'far' from the teachers. Although training was provided each year to them many did not attended. They did not understand the project and thought that economic motivations were behind the project implementation

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[94] See also *Context and Participants* chapter.
[95] See also *Context and Participants* chapter.

Subcategories	Answers/ Opinions
OEP-A-R	The first phase (one and a half year) was great. Many teachers were interested and many have participated in training. The institution was so pleased that decided to put the courses from the 'institutional matrix' in the *Online Project*. After that the institution made so many changes that things start to go wrong and the initial purposes of the project were undermined and the project itself died. Classes were to large, students were not ready, teachers were nominated rather than volunteered, classes were taught exclusively online and the initial pedagogical model was not being followed.
OEP-P-C	The pedagogical model proposed was a blended one that was supposed to be implemented in the first three years and then evolve from there. It was a student-centred model, with focus in the learning process and the creation of learning virtual communities rather than in the use of technologies. Students were supposed to be less exposed to contents and have more preparation for the online environment. It was not an e-learning project because the focus was not on the technology but on the students and the learning process. It was online education because it used ICT and the Internet and because we could do different things online than we do in face-to-face classes. It was necessary that the teachers realized the pedagogical implications and what was at stake, and not tried to experiment using the platform (they were advised to follow the model proposed in the training courses they had attended).
OEP-P-GC	At first the model proposed was called the complement model (all classes were face-to-face and *Moodle* was used for placing support materials) and lasted until 2009. Then the substitution model was implemented and a percentage of the classes should be taught online. Although it was a blended learning model what actually happened was that many courses were taught according a DE model. The full potential of the pedagogical model of the *Online Project* was not achieve. From 2009, with the creation of national classes, the Open University model was adopted (one course responsible and tutors to monitor and help students).
OEP-MF-VC	The model that actually was implemented could not create virtual learning communities because of the number (hundreds) of students that some courses had and because some teachers and students were not prepared. The initial model was students-centred and aimed the creation of learning virtual communities. Regarding *Moodle* features, he thinks they are not good for synchronous activities but regarding all other activities it serves well the purpose.
OEP-P-VC	The project aimed the creation of virtual communities not only among students but also among teachers. That did not happen because the classes were too large, teachers were inexperienced and tired from all the hours spend preparing classes, students were not motivated (except when threatened with assessment). Also because teachers and students don't have an accurate image of their behaviour in the online environments.
OEP-MF-SNA	The analysis of the information produced by *Moodle* could be very useful and has never been done before. Something is being done now by a master student but she has not finish yet. People should know what they are doing in *Moodle*. That analysis should be done by researchers and not by the teachers involved in the courses. Students and teachers should have access to the results. It is important for participants to know their behaviour in online environments. If the project had not changed after one and a half year perhaps they would have had the opportunity to use *Moodle* statistics and the opportunity of analysing it.
OEP-MF-GO	His opinion has changed over the years. He thought online education was the future and the institution would follow that direction but now he thinks that changes will take much longer. Evolution was not the predictable. There are still online courses and national classes but that is a local decision of each school and institutional strategy from the institution for all the campuses. Under the new school regulations the teacher has to propose the course (and not the school) and prove that they have training and skills to teach online. Despite all that has happen he believes online education is the future of the institute.

The implementation of the online educational project was done following the Ph.D. research of the proponent. Beside the low cost of *Moodle's* implementation one way to lure the institution for the project was to ensure that the remaining administrative information systems in the schools could be integrated in to *Moodle*. And this has been achieved over the years.

Regarding the decision to use the LMS *Moodle* he thinks that it made sense because the Ministry of Education had recommended it for public schools all over the country. "Since we train teachers it makes sense that we train them with something they will have to use later with their own students." (Person responsible for the online educational project, personal communication, June 2011)

For the installation of *Moodle* a company was hired and worked closely with the technical staff of the institute. According to this responsible those were easy times and everything went very well.

The project was presented to the campus directors and the first phase was supposed to last three years but after one and a half year the institution decided to change the process. During the first phase teachers were supposed to be trained (and use *Moodle* only to share resources with students) and after those three years an assessment would be made and a decision made on what direction to take from there. According to the respondent the initial project was a b-learning model (at the most only 50% of the classes would be taught online), then in the future could evolve (if there were no legal impediments) to a DE model. The training given to teachers was made according to a typified model and the expectation was that teachers would adopt it and that they would not do experiences on their own.

But the institution decided to try to test even further the project by doing national classes with students from courses of the "institutional matrix". It was also decided to nominate teachers for the courses that would be taught online (many were not volunteers and many did not belonged to the initial group of 150 that were trained). Another problem, according to this responsible, was that even if the model was a blended one because classes had students from different campuses across the country it was very difficult to schedule the displacement of the teachers for the face-to-face classes. The result was that many courses were taught almost exclusively online with a DE model. And that still happens today although the institution has never called it DE. "The idea was that teachers would use the platform as a complement to their classes and that they would gradually appropriate its technical and pedagogical features." (Person responsible for the online educational project, personal communication, June 2011)

Why did the institution decide to change the project?

In June 2009 there was a report about education in Portugal and the Minister Mariano Gago said that it was needed a huge increase of distance learning in universities. (…) and because the first year and a half went so well, the direction of the institution decided to take a turn and stretch things further." (Person responsible for the online educational project, personal communication, June 2011)

Only 3% of the Portuguese students are in DE courses, and from those 90% are in the Open University.

The country was miles from Europe and that [DE] needed a huge increase. And that was when the Board decided to cease the supplement model and wanted for teachers not to have so many face-to-face classes and started to teach online so they could teach in more than one school. (Person responsible for the online educational project, personal communication, June 2011)

In this new phase the 'complement model' was renamed as 'the replacement model'. Face-to-face classes were supposed to be replaced by online classes. How many? No one knows exactly (a real statistic of how many courses, teachers and students involved was never done). Not more than 50% of each course but that was not what happened and suddenly many students were attending online classes.

When asked what was the difference between the "complement model" (the one for the first phase of the project) and the "replacement model" (the one that the institution decided to use after one and a half year), he responded:

In the 'complement model' all classes are face-to-face (and that is what was in the project because even from a legal point of view there was no framework to do it otherwise) and the teachers could use the platform the way they wanted. We asked them to put the syllabus there, to ask their students to hand over the assignments there, to give all information to students via the platform. (…) In the 'replacement model' a percentage of the classes is taught online. (Person responsible for the online educational project, personal communication, June 2011)

In the beginning the characteristics of the courses were not being addressed. Any course, if the teacher wanted, could use *Moodle*. When the institution took over the project the decision about which courses would be taught online was centralized (although any teacher can still use *Moodle* as tool in face-to-face classes).

When asked why the students offered initially so much resistance the *Online Project* the respondent said:

The model used was not creating learning communities, because when you have hundreds of students that it is not possible. It was a self-training model, a distance education model. It was a more suffered model for the students. The students had to prepare themselves better. (…)The students were much more exposed by the absence and presence. For students it was much more complicated and there were many students who were not prepared. (Person responsible for the online educational project, personal communication, June 2011)

About the large courses we asked what was the ideal number of students per course that the project had in mind. He replied he did not know exactly, but no more than 40. There was not much prior experience in this field so it was difficult to know exactly the ideal number of students per class.

More than that was speculation. We did not know what could happen. (…) Suddenly we had much larger classes with inexperienced people, some were not interested, did not have appropriate training. (…) We tried to minimize this by creating the figure of the tutor. That was someone who helped the teachers. (Person responsible for the online educational project, personal communication, June 2011)

In this phase the education model of the Open University was adopted[96]. The courses had one scientific/ pedagogic responsible and tutors to help deal with the large number of students that were enrolled.

In the second phase the team of the project was asked to still ensure the training of the teachers and *Support Offices* were created in each campus. From then on the project lost the word 'education' from its name.

In September 2009 we presented a different model where we were careful to say that the project was over and we were creating a physical structure to operate in each of the schools to support students and teachers. I stopped centralizing things. And the project died that day although it is still called online education. (Person responsible for the online educational project, personal communication, June 2011)

When asked why the initial project did not work, he replied:

Now I do a completely separate assessment. Everything I had read about the resistance to change and I knew that we had it here... I thought that when new students arrived, having used ICT in primary and secondary schools, and new teachers, things would be different. After 10 years we are in the same place. Nor are the older teachers who are most resistant, teachers and younger students are also resistant. This did not evolve as predicted. (Person responsible for the online educational project, personal communication, June 2011)

Nevertheless the institution has two online graduated courses which have success and the respondent believes that is because the "(…) public has more appetite for this type of education." And perhaps the future is there. Younger and more inexperienced students do not know how to deal and take advantage from this model.

When asked to do an evaluation of this experience he said: "For 10 years I thought this was the track we should follow and that everyone would understand. But it was I who was hampered by magic. People were not minimally interested and distance education was not what I

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[96] See also the *Development of Distance Education in Portugal* chapter.

thought it was." (Person responsible for the online educational project, personal communication, June 2011)

Nevertheless his opinion about online education is positive and when asked if that is still in the future of the institution he replied: "If that is not the path then is the institution that has no future." (Person responsible for the online educational project, personal communication, June 2011)

4.4.3 Participants interventions in the forums

In order to understand what has happened in the forums concerning the process of formation and participation in the networks we have decided to do a content analysis of all posts in the forums as summarized in tables from 33 to 39. As mentioned in the *Methods Chapter* we wanted to verify if the topics of conversation among students and teachers were related to the themes/ objectives of the forums or if the forums have had some other kind of use by its participants[97]. We wanted to further verify if beyond the exchange of information there also had been exchanges of other resources. Once again we opted for the summary presentation of the content analysis in tables in order to contribute to a more rapid and simplified reading of the results.

Regarding C1 forums we have found the contents summarized in table 33:

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[97] We did not want to do an analysis on the quality of the posts and accordingly we have just tried to establish a relationship between what was said by the participants and the theme of the forums.

Table 33 Content analysis of the posts in the forums of course 1

Course 1 forums

	Posts content
1st Forum	How to carry out a procedure
2nd Forum	Reflection/ opinion about the forum/ syllabus content Types of knowledge Doubts about a procedure
3rd Forum	Reflection/ opinion about the forum/ syllabus content Sharing of ideas from other authors not mentioned in the course bibliography External links to other texts Questioning colleagues about the forum theme Concepts definition and clarification Definition of types of knowledge Sharing of a Text (PDF) Link to web pages related to the forum theme References to books not mentioned in the course bibliography
4th Forum	Nothing/ no participations
5th A Forum	Sharing of files with groups tasks Questioning of teacher about the groups tasks References to books not mentioned in the course bibliography Theories definitions Clarification about the assignments' themes
5th B Forum	Syllabus summary Theories definitions Link to web pages related to the forum theme
5th C Forum	Reflection about the forum theme Concepts definition and clarification
6th Forum	Link to web pages related to the forum theme Quotes from other authors not mentioned in the course bibliography External links to other texts Reflection/ opinion about the forum/ syllabus content Sharing of files from an individual assignment Texts summary References to books not mentioned in the course bibliography Professor systematization of the information exchanged in the forum
7th Forum	External links to other texts Link to web pages related to the forum theme Concepts definition and clarification Reflection/ opinion about the forum/ syllabus content Sharing of ideas from other authors not mentioned in the course bibliography One student used this forum to question the teacher about her grading References to books not mentioned in the course bibliography Texts summary
***Questions* Forum**	Clarification of the assignments' goals Assignments' deadlines Assessments' grades Delay in delivering assignments Technical difficulties in delivering assignments

In C1 almost all the participants' interventions (just two exceptions in the 2nd and the 7th forums) were about the forums themes. Beside the exchange of information students and teachers also shared other resources through external links (e.g. links to webpages). Although the main goals of the forums were to promote debate, most participants only posted their interventions

and/or reply to the teacher and they have repeated many times the same ideas (the *Questions Forum* was the greatest example of this). Nevertheless in some few occasions we could observe interaction/ debate among students and teachers and the content of the posts in some forums was relatively heterogeneous.

Regarding C2 forums we have found the contents summarized in table 34:

Table 34 Content analysis of the posts in the forums of course 2

Course 2 forums

	POSTS CONTENT
1st Forum	Reflection/ opinion about the forum/ syllabus content Concepts definition and clarification Link to web pages related to the syllabus content References to books mentioned in the course bibliography Link to legislation web page Systematization of previous interventions of colleagues Link to a YouTube video about the forum theme Sharing examples about what happens in real world situations Link to Wikipedia Quote from the Bible Opinions on how to live in society Student's interpellation of the colleagues with new questions Historical facts and analysis Generalizations
2nd Forum	Reflection/ opinion about the forum/ syllabus content Sharing examples about what happens in real world situations Interpellation of the colleagues with new questions Historical information about the theme Link to web pages with statistics Link to web pages related to the syllabus content References to books mentioned in the course bibliography Link to a newspaper article Mentions to the Penal Code Concepts definition and clarification Personal examples Link to the *Declaration of the Rights of Women and Citizens* Personal examples Opinion of other colleagues interventions/ posts Quotations from authors (not mentioned in the course bibliography) about the forum theme Historical facts and analysis Challenges of the teacher to the students Reference to newspaper articles Generalizations Reference to statistics Link to webpages about Portuguese historical facts Mentions to the Portuguese Labour Law

In C2 almost all participants' interventions were about the forums themes and we could observe, in several moments, the sharing of other resources through external links (e.g. links to videos, newspaper articles, and webpages). The main goals of the forums were to promote

debate and that could be observed throughout the two forums. Nevertheless many participants have posted single interventions to which there were no replies or comments from the others. In this course there were many replies and challenges from the teacher to the students and also much repetition of ideas. Nevertheless the content of the posts in the two forums was very heterogeneous. Although there was not a *Questions Forum* students did not use the two learning forums to raise issues (e.g. technical problems with *Moodle*) that were not related to the forums themes.

Regarding C3 forums we have found the contents summarized in tables 35 and 36:

Table 35 Content analysis of the posts in the forums of course 3

Course 3 forums

	POSTS CONTENT
1st Forum	Reflection/ opinion about the forum/ syllabus content Concepts definition and clarification Examples about the forum theme Exchange of arguments among students due to the comments made to the forum theme Quoting of authors mentioned in the course bibliography Doubts about the syllabus content Link to web pages related to the forum theme Dictionary definition Historical facts and analysis Summary of the syllabus content Link to a YouTube video about the forum theme Questioning about the time schedule for the classroom moments Theories summary Questioning of students by the teacher to clarify their statements in the forums
2nd Forum	Questioning about the grading system of the forums Concepts definition and clarification Quoting of authors mentioned in the course bibliography Syllabus summary Reflection/ opinion about the forum/ syllabus content Examples about to the forum theme Historical facts and analysis Questioning of students by the teacher to clarify their statements in the forums
3rd Forum	Historical facts, examples and analysis Reflection/ opinion about the forum/ syllabus content Concepts definition and clarification Portuguese examples about the forum theme Syllabus summary
4th Forum	Reflection/ opinion about the forum/ syllabus content Historical facts, examples and analysis Questioning of students by the teacher to clarify their statements in the forums Concepts definition and clarification Historical examples about the forum theme Portuguese examples about the forum theme International examples about the forum theme Students questioned colleagues directly Reference to other authors (not included in the course bibliography)

Table 36 Content analysis of the posts in the forums of course 3 (continuation)

Course 3 forums

	POSTS CONTENT
5th Forum	Reflection/ opinion about the forum/ syllabus content Link to web pages related to the forum theme Syllabus summary Quotations (no sources provided) Quoting of authors from the course bibliography Concepts definition and clarification
6th Forum	Quotations (no sources provided) Questioning of students by the teacher to clarify their statements in the forums Syllabus summary Personal examples Reflection/ opinion about the forum/ syllabus content
7th Forum	Reflection/ opinion about the forum/ syllabus content Historical facts, examples and analysis Personal examples
8th Forum	Reference to newspaper articles Reflection/ opinion about the forum/ syllabus content Statistics Historical facts, examples and analysis Portuguese examples about the forum theme
9th Forum	Historical facts, examples and analysis Reflection/ opinion about the forum/ syllabus content
10th Forum	Reflection/ opinion about the forum/ syllabus content Definition, Purpose, Membership and Structure of the UN
11th Forum	Reflection/ opinion about the forum/ syllabus content Personal examples Reference to newspaper articles Historical facts, examples and analysis Link to web pages related to the forum theme Doubts about the content of some texts provided by the teacher
12th Forum	Reflection/ opinion about the forum/ syllabus content Historical facts, examples and analysis
13th Forum	Reflection/ opinion about the forum/ syllabus content Concepts definition and clarification Historical facts, examples and analysis
Questions **Forum**	Content of the tests Doubts about the course bibliography Questions about the grading of the assignments Technical issues about the platform Students giving information to colleagues on how to solve technical issues Questioning about the time schedule for the classroom moments Content of the final test Date of the final test Date of the final exam Questioning about when does the course ends Consultation with students about possible dates for the test Information about additional assignments Information about the grades of the assignments Information about what went wrong in some students final test Problem accessing to the grades of the assignments Clarification on the course evaluation system

In C3, with exception of the Questions Forum, participation was gradually reduced over the forums, which is reflected in the amount of posts from the participants. Although the main purpose of the forums was to promote debate that could only be observed in some moments because most of the students only posted their interventions and/or reply to the teacher. Towards the last forums the participants were almost always the same and they were very few. Nevertheless all participants' interventions were always about the forums themes (exception in the 2nd forum). Although there was much repetition of ideas (particularly in the *Questions Forum*) the content of the posts in most the forums was relatively heterogeneous. Participants have also shared other resources through external links to webpages and videos for example.

Regarding C4 forums we have found the contents summarized in tables 37, 38 and 39:

Table 37 Content analysis of the posts in the forums of course 4

Course 4 forums

	POSTS CONTENT
1st Forum	Request to postpone the delivery of a task Sharing an image on the theme of the forum Reflection/ opinion about the forum/ syllabus content Link to web pages related to the forum theme Quotes from newspaper articles Link to texts related to the forum theme Reference to books (that were not in the course bibliography) Link to a YouTube video about the forum theme Clarification of the upload limit for files Quotes from the Bible Correction of spelling errors and suggestion on how to avoid them Quotes from authors (that were not in the course bibliography) Link from the teacher to a new feature (text on the theme of the forum) Compilation of the subtitles of a video suggested by the teacher Link to a TED video about the forum theme
2nd Forum	Delivery of assignments Reflection/ opinion about the forum/ syllabus content Concepts definition and clarification Reflection on the tasks Reflection on the online learning process Quotes from authors from the course bibliography Mention to UN reports Syllabus summary

Table 38 Content analysis of the posts in the forums of course 4 (continuation)

Course 4 forums

	POSTS CONTENT
3rd Forum	Sharing of information obtained in a newspaper Sharing of information obtained TV program Reflection/ opinion about the forum/ syllabus content Concepts definition and clarification Link from the teacher to a new feature (text on the theme of the forum) Historical facts, examples and analysis Reference to a book from the course bibliography Reference to a book not in the course bibliography Quotes from authors (that were not in the course bibliography) Sharing of an image about the theme of the forum Comparison of theoretical proposals Reference to statistics Delivery of assignments Reference to international reference documents (e.g. The Belgrade Charter, The Millennium Declaration and the Earth Charter) Link to texts related to the forum theme Syllabus summary Information about the closure of the forum
4th Forum	Reflection/ opinion about the forum/ syllabus content Reference/ quotes from authors from the course bibliography Reference to Earth Charter Concepts definition and clarification Examples of the forum theme Reflection on DL process Link to web pages related to the forum theme Link to an online encyclopaedia Theories presentation Reference to UN documents Historical facts, examples and analysis Syllabus summary Reference to statistics Reference to UNESCO documents Reference to religious leaders Reference to newspaper article Sharing of a text (PDF) Link to a YouTube video about the forum theme Reference to international reference documents (e.g. The Earth Charter, the Kyoto Protocol and the Declaration of Human Rights) Sharing of a poem Quotes about the forum theme from authors that were not in the course bibliography Sharing of a video (embed)

Table 39 Content analysis of the posts in the forums of course 4 (continuation)

Course 4 forums

	POSTS CONTENT
***Questions* Forum**	Problem accessing to the assignments' grades Questioning about the grading system of the course Clarification of the assessment procedure Assessments deadlines Students giving information to colleagues about the grading system Problems related to the use of the software that should have been used to perform one of the group tasks Technical issues about the platform Students giving information to colleagues about the content from the other forums of the course Final test date Negotiation of a new date for the final test Doubts about what to do in the assignments Content of the final test Request of a live class Clarification on the participation in the forums Reference to one of the course tutorials Image of how to do a procedure (how to upload o file) Word file with a list of the course groups Links with the location of groups of tasks Problems in the delivery of the assignments Information about the members who compose the groups Students giving information to colleagues about how to do a procedure Delivery of files with group tasks Sharing of a book (PDF file) Request for clarification of concepts Doubts about the content of the test

Regarding C4 there was some information and resources exchange among the participants through external links and through files (e.g. PDFs and links to webpages). The main purposes of the forums were to promote debate but that only happened in few moments because students only posted their interventions and/or reply to the teacher not interacting very much with the colleagues. As in C1 and C3 the *Questions Forum* was the one where there was more repetition of ideas but that could also be observed in the other forums. Nevertheless the content of the posts in all the forums was quite heterogeneous.

After analysing the posts in the forums we made two tables (40 and 41) with the categories found and their encoding. The main categories found in the courses forums correspond to general types of exchanges made by the participants while the subcategories correspond to specific forms of exchanges found in the participants' posts.

Table 40 Categories found in the content analysis of all the forums from the four courses

Main categories	Code
Information	I
Questioning	Q
Reflection/ opinion	RO
Information/ resources sharing	SH
Subcategories	**Code**
General information about the forum theme/ syllabus	I – G
Information of concepts and theories about the forum theme (e.g. definitions and theories presentation)	I – CT
Information about procedures (e.g. how to upload a file)	I – P
Information about legal documents (e.g. Penal Code)	I – LD
Information about statistics	I – S
Information about newspaper articles	I – NA
Information about television programs	I – TP
Information about international reference documents (e.g. Chart of Human Rights)	I – IRD
Information about religious documents (e.g. Bible)	I – RD
Information about historical facts	I – HF
Information about the assignments and grading system	I – AG
Information about technical issues of *Moodle*	I – TIM
Information - Quotes from authors from the course bibliography	I – QTCB
Information - Quotes from authors not in the course bibliography	I – QTNCB
Questioning about the forum theme	Q – F
Questioning about the assignments/ tests/ exam	Q – A
Questioning about the grading system of the course	Q – G
General questions about classes	Q - C
Questioning about deadlines	Q – D
Questioning about the syllabus	Q – S
Questioning about procedures	Q – P
Questioning about technical issues of *Moodle*	Q – T
Reflection/ opinion about the forum theme	RO – F
Reflection/ opinion about the posts of the other participants	RO – PP
Reflection/ opinion – personal examples	RO – PE
Reflection/ opinion – general examples	RO – GE
Reflection/ opinion - debate	RO – DEB
Sharing of external links to videos (e.g. TED and YouTube)	SR – VID
Sharing of external links to webpages	SR – WEB
Sharing of external links to files (e.g. PDFs)	SR – WF
Files sharing (e.g. PDF and DOCX) about the forum theme	SR – FIL
Files sharing (e.g. PDF and DOCX) with individual and/ or group assignments	SR – FILASS

We found thirty two subcategories after analysing the content of all posts from the course forums. These subcategories belong to the four main categories identified. The great majority of the subcategories found were present in at least one forum of C3 and C4 (tables 41 and 42). C1 and C2 had occurrences in 16 and 15 categories respectively.

The categories that were present in the forums[98] of all the four courses were: I – G (General information about the forum theme/ syllabus), I – CT (Information of concepts and theories about the forum theme), I – QTCB (Information - Quotes from authors from the course bibliography), RO – F (Reflection/ opinion about the forum theme), RO – PP (Reflection/ opinion about the posts of the other participants) and RO – DEB (Reflection/ opinion - debate).

The categories that had less occurrences were I – TP (Information about television programs), Q – F (Questioning about the forum theme), Q – P (Questioning about procedures), SR –WF (Sharing of external links to files) and SR - FILASS (Files sharing with individual and/ or group assignments).

Table 41 Occurrences in each category from the forums of the four courses

Code	Occurrences			
	Course 1 forums	**Course 2 forums**	**Course 3 forums**	**Course 4 forums**
I - G	✔	✔	✔	✔
I - CT	✔	✔	✔	✔
I - P	✔	✖	✖	✔
I - LD	✖	✔	✖	✔
I - S	✖	✖	✔	✔
I - NA	✖	✔	✔	✔
I - TP	✖	✖	✖	✔
I - IRD	✖	✔	✔	✔
I - RD	✖	✔	✖	✔
I - HF	✖	✔	✔	✔
I - AG	✖	✖	✔	✔
I - TIM	✖	✖	✖	✔
I - QTCB	✔	✔	✔	✔
I - QTNCB	✔	✔	✖	✔
Q - F	✖	✖	✖	✔
Q - A	✔	✖	✔	✖
Q - G	✔	✖	✔	✔
Q - D	✔	✖	✔	✔

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[98] Occurrences, in at least one of the courses forums.

Table 42 Occurrences in each category from the forums of the four courses (continuation)

Code	Occurrences			
	Course 1 forums	**Course 2 forums**	**Course 3 forums**	**Course 4 forums**
Q - S	✘	✘	✔	✔
Q - P	✔	✘	✘	✘
Q - T	✔	✘	✔	✔
Q - C	✔	✘	✔	✘
RO – F	✔	✔	✔	✔
RO - PP	✔	✔	✔	✔
RO – PE	✘	✔	✔	✘
RO – GE	✘	✘	✔	✔
RO – DEB	✔	✔	✔	✔
SR – VID	✘	✔	✔	✔
SR – WEB	✔	✔	✔	✔
SR – WF	✘	✘	✘	✔
SR - FIL	✔	✘	✘	✔
SR - FILASS	✘	✘	✘	✔
TOTAL OF ✔	16	15	21	28
TOTAL OF ✘	16	17	11	4

Legend 1✔ Occurrence ✘ No Occurrence

The discussion of the results obtained from the content analysis of the forums will be held next chapter.

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5. Discussion

5.1 Explanations prior to the discussion

The discussion of results intended to confront what was explored in the literature review and the results obtained in our study. We also wanted to answer our research questions in view of our general and specific objectives.

To facilitate the systematization of ideas tables were created with summaries of the resulting triangulation of data collected and analysed. Every table corresponds to a research question and research dimension and the discussion is made after each. For all the three main areas studied possible explanations for the findings are proposed.

The structure of the discussion is presented in figure 24 which illustrates our methodology and the key areas of our study. The different colors used in the image are intended to help provide depth to the object and give a sense of three layers. The first layer (the innermost) presents the three ways used to collect data. The second layer corresponds to the three types of data analysis. The outer layer relates to the three dimensions of online interaction that were researched.
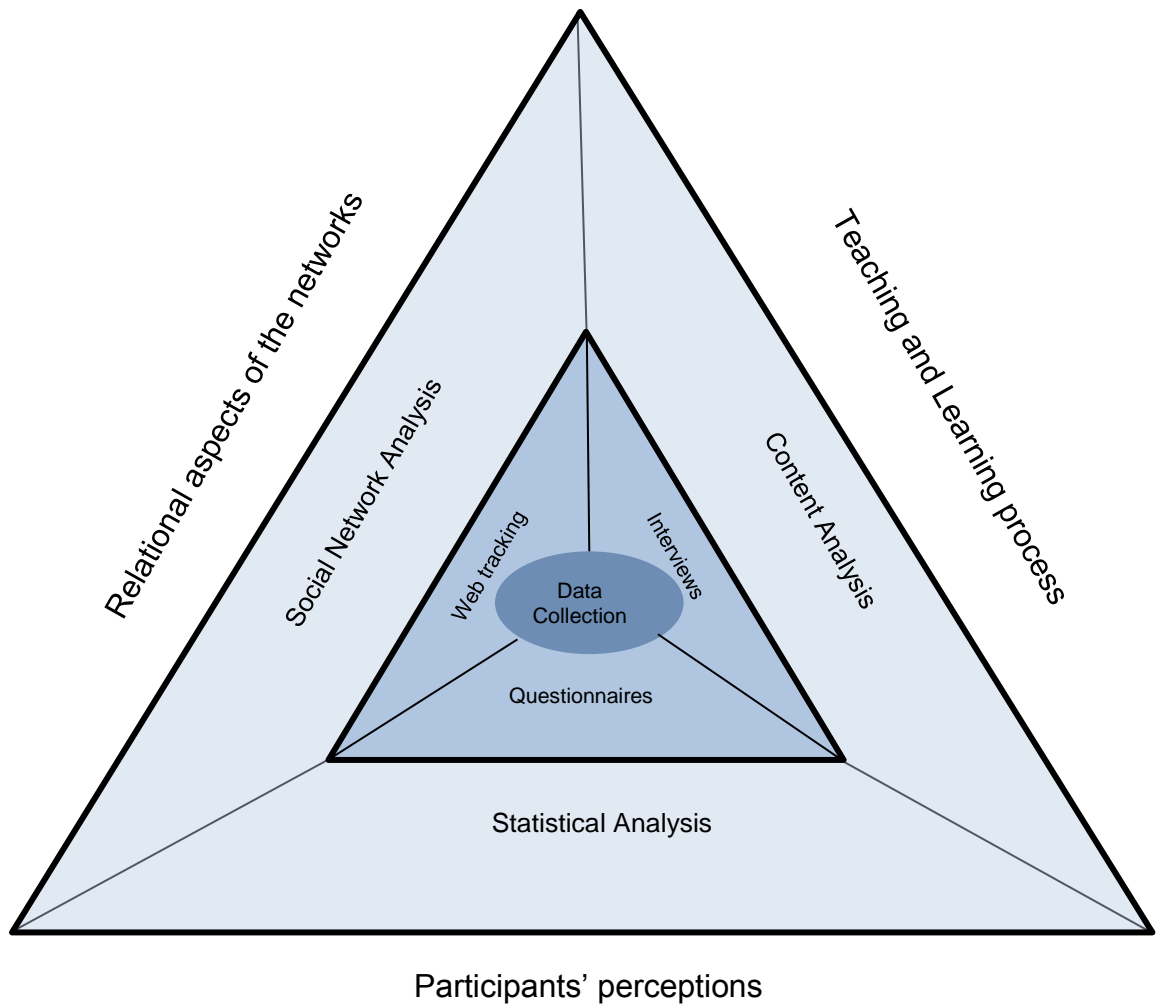
Figure 24 Study main areas of research and respective data collection methods and analysis

5.2 Relational aspects of networks

Table 43 summarizes the most common results found in this study related to our first research question.

Table 43 Summary of the resulting triangulation of data collected and analysed to answer the first research question

General objectives		Q1 - *What types of social learning networks are formed in a LMS Moodle as a mediated, on-line teaching and learning environment?*
Social Learning Networks	Specific objectives	Essentially formal networks induced by the courses structure which was planned and implemented by the teachers
		Networks with an almost permanent participation of the teacher
		Networks with a low/ medium degree of participation and *Closeness*
		Networks low connected and with low interactivity among participants (although there was more interaction with the resources that teachers made available in the forums – e.g. texts)
		Networks with low values of *Betweenness*
		Networks with essentially subgroups of two actors and with much overlapping
		Networks where communication flow was frequently unidirectional
		Networks where the most representative actor was the teacher
		Networks where most of the resources exchanged were those provided by the teachers
		Networks with many redundant information
		Networks were redundancy seemed to be more difficult to manage by the teachers due to the nature asynchronous of the forums
		Networks whose moments of constitution and the moments of most interactivity occurred mainly due to two reasons: the intervention of teachers and closing dates for evaluation
Participants' perceptions		Teachers from C2 and C3 did not believed that social learning networks were created in the forums despite their efforts. C1 and C4 teacher had an opposite view
		Teachers did not believed there was much collaborative learning among students
		Most students said *Moodle* features facilitate interaction and resources exchange although they feel that because interaction was not face-to-face that could harm the learning process. Despite this opinion students also said they did not interact more because of *Moodle*
		Most students said that *Moodle* had created a social learning network
		Most students do not believe *Moodle* facilitates the collaborative work
Teaching and learning process		Teachers of C2 and C3 reproduced their pedagogical classroom model in the online environment and the third teacher reproduced what he called the classical model of DE, student-centred, with group-learning and self-learning moments
		The teaching and learning process presupposed a greater autonomy from the students
		Part of the courses grading systems relied on interaction among students
		Some learning routines of students were changed in the online course

SNA was performed to assess the relational aspects of the forums networks. We started by measuring the degree of participation. After analysing the forums content and the teachers' interviews some reasons may help explain the values found:

- Most of the forums were not assessed which may have led students to oversee the benefits/ purposes of the interaction in the forums;

- The participation in the forums assessed contributed with a small percentage for the final grade and the students did not get their ratings before the end of the courses. The rewarding system of students' participations was not immediate or great which may have led to a lesser participation;

- The only feedback that students had about their participation were some of the teachers' comments; in some cases, though, the teachers did not interacted with the students in the forums. Teachers said they did not have time to comment each student posts due to the courses size and due to workload. Another reason mentioned by teachers was the degree of duplication of the content in students' posts which led them to not comment all the posts;

- C1 and C3 had a large number of forums (ten and fourteen respectively) which meant that students had to participate in a different forum, with a different theme, almost every week of the semester[99]. One week it is a short period of time for the students of such big size courses to participate. Asynchronous interaction needs time to take place and the fact that the theme of discussions kept changing on a weekly base may have not helped motivate the participation;

- In C2 the participation was exactly the same in the two forums and had the second largest forums from the four courses. Only one forum was assessed but both had the same theme, *The sexual dichotomy: Male/Female*. One was intended to be a generic discussion while the other a debate adapted to the Portuguese reality. The nature of the theme and fact that it allowed many personal comments may help explain the degree of participation.

Some studies like the one conducted by Gerbic (2003) found assessment to be one of the most influential factors for students' participation in online forums. That was observed in our study. But that kind of participation from the students did not led to greater interaction. Some part of the final grades (C1, C2 and C4) depended on the interaction in the forums but students seem to have perceived participation as just posting and not as interacting. We think the small percentage of the final grade given to forums' participation may have been a major factor. Students had other ways to ensure their final grade.

The discussion about instructors' behaviours for improving students' participation has been held by several authors (Cifuents et al., 1997; Gerbic, 2003; Pelz, 2004; Hew & Cheung, 2008) for some time without a consensus. We have observed, in this study, most of the strategies proposed by Pelz (2004) for increasing teaching presence on the forums by facilitating the discussion and by direct instruction. But that did not seem to have influenced the relational outcomes expected. This study led us to a similar conclusion to the one of Mazzoli & Maddison (2003). In their study active instructors in the forums did not appear to stimulate discussions but limited their amount

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[99] Each semester has an average of fourteen weeks.

and length. That could have been one of the reasons for the limited interaction observed in our study.

According to Dawley (2007) one of the strengths of forums is the time students have for in-depth reflection. In the courses with the larger number of forums that was something difficult to promote. They did not have enough time to participate before the next forum was created (usually with a different theme).

When trying to relate the themes of the forums in the four courses with the degree of participation we have observed:

- In C1, C3 and C4 the relation could not be established because in the forums with the highest degree of participation the themes were about different syllabus contents;
- In C2 the theme seemed less formal and, as stated before, students had more opportunity to express their personal opinions. This was the only occasion it seemed to be a relation between the theme of the forums and the degree/ type of participation. We believe that the more informal characteristics of these two forums may have helped promote participation and interaction;
- The content analysis of the forums led us to believe that towards the end of the assessed forums students messages were wrote in order to ensure their participation and help improve their grades. There was very little interaction and many content recurrences. It seemed students were sending messages only to the teachers.

Blignaut & Trollip (2003) found that the nature of content addressed by the discussion topic and the type of the discussion were variables that contribute to the quality of online discussions. We found some evidence of that, especially in C2, which the forums theme seemed to have stimulated more the students to express their personal views in a more informal way.

We also found that most of the students were, according to Nandi, Hamilton & Harland (2012), in the second level of participation in discussion forums. They used the forums to post their messages (often without any connection with what had previously been said and often repeating information already given) and had limited interaction.

Another SNA index analysed was *Inclusiveness.* From that analysis one major question aroused: the definition of participation. Authors like Lipponen et al. (2003), Davies & Graff (2005) and Hrastinski (2008) have discussed several definitions of online learner participation. The last author has even proposed six levels of researchers' perceptions when studying the complexity of online participation. In this study SNA has put us in the first level (participation being equal to learners' quantity of messages or units) which we have tried to overtake with the content analysis.

Our perception and the perception of the teachers was more near the sixth level: participation as taking part and joining a rewarding dialogue. And we tried to found evidences of that with the content analysis. Although teachers intended forums to be spaces of meaningful and engage participation that only happened few times. The times when there was more interaction, students were expressing personal opinions/ examples related to the forums themes. And that seemed to have triggered the participation of other students and even the teachers. Some degree of informality, the feedback and engagement seemed to have contributed to more interaction through a larger participation.

Regarding the overall linkage between network members we have observed that:

• The higher and the lowest values were from the smallest forums. That was due either because with fewer actors *Density* it is easier (high connectivity is expected and that was what happened) or because some forums only had one participant;

• Some of the forums with the highest degree of participation had a low connectivity which means that actors were not interacting, dialoguing with each other;

• Many of the discussions in the forums appear to be isolated postings from the students – many repeated ideas; no apparent connection with previous posts; no replies from the other participants; little evidence of dialogue or connectivity. This was also confirmed by teachers' interviews.

These findings back what was said by Nandi et al. (2012) about students' engagement in online forums not being automatic. Although authors like Vonderwell & Zachariah (2005), Dawley (2007) and Arulchelvan (2011) stress out the potential of discussion forums that did not seemed to be perceived by the students. Once more there was also a lack of clarity about the ideal role of instructors in the forums (Nandi et al., 2012) and that was also mentioned by the teachers in the interviews.

Density also allows us to gauge the speed of dissemination of information in a network. The low connectivity observed, especially in the larger forums indicate that information had a slow speed. If participants were highly connected we would have not observed the need for so much duplication of information. This fact also reflects something that was told by teachers in the interviews: students seemed to be posting without reading what was previously said by their colleagues in the forums. Information was not getting through.

Through low *Density* values and according to Hanneman & Riddle, 2005, we can also measure the degree of social constraint of the actors. And that was what we have observed. Through the content analysis of the forums (reinforced by teachers' interviews) we saw that students were not investing in social relations with their colleagues. Many posts just reflected their

need to be 'present' rather than a need to engage in a relation with other participants or strengthen their position. Fidalgo & Thormann (2012) caracterize this situation as of social constraint due to the kind/number of interactions and position in the network that individuals have.

The next SNA measures analysed were *Centrality* and *Centralization*. Although different values of *Centrality* were found in the forums of the four courses they reinforce the discussion above about *Density* (*Cohesion*). The highest values of *Centrality* were observed in the forums that had also the highest values of *Density*. A higher network *Cohesion* provides its members with more opportunities to access information and is also an indicator of experience and power (Müller-Prothmann, 2007). And that was what happened in this study. Overall in the majority of the forums teachers had the highest values of *outDegree* and *inDegree* which means that they were the ones who replied more in the forums and were those who received more messages from the students. According to Fidalgo & Freitas (2011) network actors can gain an advantageous position if they have more connections because they have alternative ways to meet their needs depending less on other actors. That was the case in this study with the teachers who exhibited more experience and power although that was not intended by them.

The *Centralization* values also confirmed what was found in *Centrality* measures. The focal points where mostly the teachers. According to teachers' interviews they did not wanted to have a prominent role in the discussions. Müller-Prothmann (2007) refer that in this cases knowledge flows are dependent on few single nodes. And that was what we observed in most forums networks. Nevertheless it is also important to mention that the central role played by focal points was, in several cases, shared between teachers and some students. That could especially be observed in the forums where there was more interaction (dialogue) between the participants. In those cases students also stood out sharing the central role. *Centralization* also measures the homogeneity / heterogeneity of the population of a network (Hanneman & Riddle, 2005). We have observed a wide variation in *Centralization* values but in the majority of the cases values were high. Hanneman & Riddle state that high values of *Centralization* mean that the power of individual actors has varied rather substantially. Generally positional advantages were rather unequally distributed in the networks analysed.

We could also observe some relation between *Centralization* values and forums themes. In C1, in forums 5A, 5B and 5C, teacher and students shared the role of focal points. These forums had the purpose of discussion of group tasks done by students so a bigger participation of them was expected. Students could comment on their colleagues tasks and then groups would reply to those comments 'defending' their works. We could not establish the same relation in the other forums analysed.

It is also important to mention that in Courses 2 and 4 teachers were the only focal points. We could not establish a relation between that fact and the forums themes or the number of forums in each course (C2 had the lowest number of forums and C4 the highest). But something else caught our attention. C2 teacher was the most active in the forums. His lack of experience in DE seems to have led them to feel he had to participate quite often as he does in face-to-face classes. That was also confirmed in his interviews. Despite his original intent to make some changes in his pedagogical model for the online environment he attempted to reproduce online some of his classroom behaviours. All the courses teachers said they felt they were in a transition phase still trying to find the right model for the online environment. It is also important to mention the lack of previous experience in using *Moodle* of almost half of the students and the fact that for the large majority of them it was their first experience in an online course. We can say that for teachers and students DE was a new experience.

Betweenness centrality values allowed us to know to which degree the actors serve as a link among the others participants and mean values were never high. *Betweenness* is also a reflex of connectivity because it tell us how highly connected actors are. *Density* values have already provided us information of low connectivity in the networks. Low values of *Betweenness* mean that actors depend less on others to establish connections. In terms of power that also means that actors did not have much power because the others participants had alternative ways (paths) to connect to each other without depending on a third part. In the large majority of the forums analysed the *Betweenness* values were really low which tells us that:

- Although some networks size was large (e.g. 77 and 124 participants) the fact that students were not interacting much among themselves lower the *Betweenness* values by shortening the geodesic paths between them;
- Participants did not depend much on others to establish connections and we think this happened because of the low interest in participating;
- Because of low *Betweenness* values power was more equally distributed in the networks. Despite the teachers being among the more active actors in most cases that was not reflected in the *Betweenness* values because of the low connectivity. Overall teachers participated more but the other participants did not depend on them to interact. Again this is also a reflection of the little interaction in the forums.

We have also analysed *Closeness* centrality values. Basically *Closeness* calculates the 'far-ness' of each participant from all others by summing the distance (lengths of the shortest paths) between them (Robert A. Hanneman & Riddle, 2005). Since the network information was directed we have values for *inCloseness* and *outCloseness*.

In Courses 1, 2 and 3 values of *inClosenes* were slightly higher which means that distances to be reached by other participants were shorter than the ones to reach them. In C4 the opposite happened in half of the forums. Lower values of both measures reflect the non-reciprocity of many the relations established rather than the size of the networks (e.g. forums of C2 which had 77 participants). Once more these values reinforce the overall low connectivity and reciprocity of the networks.

Finally we have analysed the number of *Cliques* (subgroups) of the networks forums. *Cliques* result from reciprocal relations established between participants. From the *Cliques* analysis we could conclude that:

- Conversations range was small which also indicates low connectivity (already verified in previous SNA measures);
- Due to overlapping many *Cliques* had one member (mainly the teacher) who has participated in several subgroups. That reflects the teachers' engagement in responding to students posts. Nevertheless some subsets had only students but interaction was always in small groups;
- C2 had more subgroups in the learning forums. The course teacher was the one who replied more to students from all the teachers of this study which may help explained the high number of dyads. Despite this teacher effort interaction did not resulted in the constitution of larger groups of discussion;
- The small subsets (with overlapping of one same actor) have determined the more common network pattern we found: the star pattern. Students were essentially 'speaking' to the teachers and that is way they were at the centre of most 'stars'.

Data mining techniques can provide a key tool to teachers for delivering group discussions (Baepler & Murdoch, 2010) and give them an opportunity to improve pedagogical practices by analysing new data sets (S. Dawson, 2009). That was not done by the institution or the teachers from this study. Teachers were not surprised with the SNA results showed to them and they found that kind of information to be useful and some even said they could have changed their behaviour in the forums if they had access to this material. The large size of the courses and the workload might have contributed for them to not always have a clear view of what was happening in the forums.

Regarding the networks patterns what stood out most in our analysis was the possibility of finding different patterns in different regions of the networks. Although just one pattern was dominant, we believe this kind of analysis could allow us a deeper understanding of networks. The content analysis of those regions also provided useful information. In some brief moments

students formed small subgroups of discussion whose subjects were mostly personal opinions and examples. In some of those moments they replicated the dominant pattern (star pattern) while in other moments they replicated the line pattern. In the first pattern one student was centralizing the debate and his colleagues were essentially talking to him. In the second pattern students were essentially talking to just one or two colleagues. The students at the end of the line were just interacting with one other colleague. In this case there is not much interaction which reflects the other SNA findings.

To conclude the SNA analysis we have proposed a designation for a network pattern: the linked multi-stars pattern[100]. We based this proposal on the belief that a predominant pattern can be duplicated in different regions of a network. For instance, if the most predominant pattern is a star, it is also possible to find some smaller stars in some sub regions of the network. These smaller stars are similar to the larger one but with fewer actors. Due to frequent overlapping of actors in the subgroups (they can simultaneously belong to two or more of those subgroups) a certain degree of linkage exists between all the participants involved in the stars. The linkage is often made through indirect connections but still allow the participants to access to areas of the network that otherwise would not be available to them. The actors that are common to more than one star serve as a bridge between different areas of the network allowing the flow of information and resources. These actors that act as bridges between subgroups can be considered as cosmopolitans and/or boundary spanners. Their social capital is usually higher because they are in an advantageous position. There are still other advantages in the existence of overlapping in the linked multi-stars. According to Hanneman & Riddle (2005) less conflict may be expected where the groups overlap and mobilization and diffusion may spread rapidly across the entire network thanks to the participants that act like bridges. The knowledge on how linked multi-stars work can be useful in the management of online interactions. If a quick diffusion of information and/ or resources is wanted and there are different isolated subgroups, then it may be a good tactic to stimulate the co-participation of some actors (e.g. students) in different subgroups. The teacher can also play this role but that will depend on the desired objectives for the interactions. The tactic co-participation can also have other purposes: it can be used to reduce conflicts between different regions of a network; so that different subgroups meet; or even to increase the size of the networks. Further research on this type of network pattern is advised in order to have access to greater knowledge about its functioning and to know how to create/ use that pattern in function of certain goals.

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[100] This pattern is also going to be presented by Joan Thormann, Samuel Gable, Patrícia Fidalgo and George Blakeslee in an article submitted to IRRODL (Thormann, Gable, Fidalgo, & Blakeslee, n.d.).

Questionnaires and interviews allowed us to gather important data that have contributed to a better understanding of participants' opinions and behaviour.

The information in tables 44 and 45 tries to answer to our second research question by focusing in the participants perceptions.

Table 44 Summary of the resulting triangulation of data collected and analysed to answer the second research question

General objectives		Q2 - What are the patterns of relationships established between users of the LMS, and which features and activities influence the formation of these patterns?
Social Learning Networks	Specific objectives	The most common relationship pattern found in the forums was the *star pattern*
		Networks were mainly centred in one single actor – the teacher – but with different degrees of *Centralization* due to variation in the number of participants in the forums
		Some other network patterns were found in networks sub regions. They were just a few isolated cases
		We also found a pattern we have called multi-stars pattern
		Despite differences between the teachers, courses content, forums themes, courses size, and assessment, there were no significant differences between the network patterns of the four courses
		Moodle features allow teachers to create several types of forums where participants may initiate new themes or may not and have to participate in one single thread of discussion. C2 teacher was the only one to choose the second type of forum and that may have contributed even more to the star pattern of his course networks
		Moodle features for asynchronous interaction (forums, group messages, private messages and e-mail) were the most used ones
Participants' perceptions		*Moodle* features are, according to the teachers, good for asynchronous discussions (forums, group messages, private messages and e-mail were the most used ones) and not so good for synchronous interaction (none of the teachers used *Moodle* chat)
		Teachers felt they were in the centre of forums discussions although they did not intend it
		C2 teacher stated that he was expecting some other network patterns in the forums. C1, C3 and C4 teachers were not surprised with the star pattern of their networks
		C2 and C3 teachers said they might have changed their forums management if they had access to SNA measures
		C1 and C4 teacher said that *Moodle* does not have a good management system for groups tasks
		More than 40% of the students said they behaved differently in forum networks because they felt it was a more formal environment with different purposes (when compared to other social networks)
		Students did not invited their course colleagues to other social networks

Table 45 Summary of the resulting triangulation of data collected and analysed to answer the second research question (continuation)

General objectives		Q2 - What are the patterns of relationships established between users of the LMS, and which features and activities influence the formation of these patterns?
Teaching and learning process	**Specific objectives**	Although two of the three teachers transposed their classroom pedagogical model to the online environment their goals in the forums were for students to discuss among themselves with little intervention from them
		Without being totally aware teachers have contributed to the most common network pattern
		The exceptions to the most common focal point were when students had to comment on colleagues tasks. In those few cases students and teachers shared a central role

An experimental version of a scale to assess participants' perceptions was developed for this study.

Regarding the students' answers to the 22 items of the scale, these generated three dimensions: *Moodle* features, interaction, processes. One of the questionnaire goals was to assess if (and how) participants' perceived *Moodle* as a tool to interact with others, to learn and with technical characteristics they have to master. The factor analysis confirmed the participants' perceptions of the three dimensions. That goal was achieved with students answers and confirmed by the factor analysis.

The good internal consistency of the factors indicates that participants have understood similarly the scale dimensions and that the factors are reliable. But there were differences in the perception of the dimensions, and on average each individual had significant different perception of each one.

The findings also suggest that students agreed more regarding *Moodle* features than regarding the use of *Moodle* to interact or to learn.

We think several reasons may have contributed to the students perceptions:

• Lack of previous experience using *Moodle* may have led students to oversee some of the LMS potential and not really understand what was expected of them in the forums and even in the online courses in general;

• Lack of previous experience in DE. This different teaching/ learning system was a novelty for most of the students and required of them different skills and more autonomy. Being the first contact for most of them we can considerer that they were still in a trial period;

- The fact that most of the students were in the first college year may have been an additional factor of inexperience;

- Little or no training from almost half of the participants may have contributed to a lower capacity to engage and take full advantage of *Moodle*;

- The large number of students enrolled in the courses may have inhibited a fuller and more engaged participation;

- Work overload. The students had to attend to six different courses in each semester. For each course there were assignments, tests, and several other activities;

According to Michael Wesch (Blees & Rittberger, 2009) one of the main challenges to learning is creating platforms in which students realize and leverage the emerging media environment. We believe that despite *Moodle* features that help promote participation it takes a period of adjustment, experimentation and learning for its full potential to be tapped. And most participants were still in an early stage of that process which may have contributed to their perceptions.

Lewis et al. (2005) say that students who take online courses tend to be more self-directed learners that can set and maintain an appropriate pace for learning. That could not be confirmed by this study. From the content analysis of the forums and the teachers' interviews, we have observed that students still showed some dependency seeking often 'guidance' from the teachers.

We did not find evidence in the literature about a consensual 'ideal' number of students for online courses, and we did not find references about pedagogical advantages of working with groups of hundreds of students. Although *Moodle* can be used with classes of hundreds of thousands (Moodle Trust, 2012) we believe that with exception of C1 (with 27 participants) the courses sizes may have been a factor that has influenced the participants' perceptions and also their behaviour. As stated by Wasserman & Faust (1994) networks environment can be an enhancer or inhibitor of the actions of the individuals. These two authors also explain that network models conceptualize the notion of social structure as enduring patterns of relationship. And that seem to have happened regarding the network patterns. Students reproduced online a usual classroom behaviour: talking in small groups or talking mainly with the teacher. Students also perceived being a part of a learning network. They did belong. But perhaps not because of the online courses but because of the face-to-face courses they attended every day together. Part of the study and the tasks for the online courses may even have been made together at school.

On the other hand perceptions about *Moodle* among the teachers were different. C1 and C4 teacher had a more positive opinion about *Moodle* and was the only one who felt motivated by it to teach. C2 and C3 teachers said they did not prefer to teach online and that they felt

overwhelmed with the workload they had preparing the courses contents and grading the students. We think teachers different perceptions may have been due to:

- C1 and C4 teacher had voluntary accepted to be in the initial team that has implemented the *Online Project* in the institution and that is more likely predisposed to see the positive characteristics of *Moodle* and DE. This teacher was also the most experienced one and because of that could take more advantage of *Moodle* features;
- C2 teacher did not want to teach his course online and resisted the process. Although he thinks DE can be an advantage for universities he did not agree with the *Online Project* of the institution because he thought it was not clear and well implemented. This may help explain his perceptions and general attitude towards the all process;
- C3 teacher was among the first teachers in the institution to be trained to use *Moodle* but still did not felt very able to take more advantage of *Moodle* features and potential. This may have contributed for him not having yet fully formed an opinion about the platform and about DE;
- Courses size were large which may have add difficulty to the online teaching process and contributed to the general feeling of the teachers that they did not do a 'great work';
- The fact that the institution changed its online project, rather quickly, the original plan of the *Online Project* may have let the participants a bit confused and helpless.

5.4 Teaching and learning process

Another dimension we intend to study was the teaching and learning process. Again we are triangulating all the data sources but focusing especially in the content analysis.

Table 46 summarize the information gathered to answer our third research question.

Table 46 Summary of the resulting triangulation of data collected and analysed to answer the third research question

General objectives		Q3 - How can the LMS, as a support environment for social learning networks, contribute to the organizational design and strategy of an institution of higher education in supporting the process of communication, sharing, knowledge building and management at distance?
Social Learning Networks	**Specific objectives**	*Moodle* is an open source system that allows the development of new modules tailored to the needs of the users and the institutions
		Moodle features allow it to be used by both a large number of students (in the hundreds of thousands) or by a small school with just a few students
		Moodle enables the connection to other information systems and external e-mail accounts. This features allows a school to link different information/ communication systems making the access and management of those systems more effective
		Moodle allows the sharing of almost every type of file
		Moodle has different tools for communication, sharing, and knowledge building
		Moodle setup is relatively easy and a low cost process although its maintenance requires some investment
Participants' perceptions		*Moodle* allows schools to diversify teaching and learning methodologies as well as the courses offered
		Among the most useful features of *Moodle* are the ones that allow and/or promote asynchronous communication/ interaction (e.g. forums, group messages, and individual/ private messages)
		Moodle it is user friendly and easy to learn. *Moodle* training does not take a long time and resources needed are only a computer with internet connection
		Teachers said that *Moodle* has few tools for collaborative work
		Teachers feel not all types of courses are suitable for DE
		Participants must have adequate training for the use of *Moodle* and for DE model
		The institution changed very quickly to a DE model (even that for strategic and legal reasons the expressions DE and DT were never used) without giving teachers and students much time for training and adjustments
		Large courses size made the management of forums very difficult and contributed to challenge the intended objectives
Teaching and learning process		*Moodle* can be used for B-Learning and DE as well as a support tool for classroom courses
		Moodle was initially implemented as a support tool for classroom courses but after one year and a half teachers were informed they would start almost immediately a blended model (which actually turned out to be DE model)
		The DE (and blended) model was adopted by the institution for several courses within a time period of two years
		The teaching process of the majority of teachers was mainly a transposition of the classroom model to the online environment
		There was an initial resistance from the students and some of the teachers to this educational model
		The strategy behind the implementation of *Moodle* was not always clear and was changed midway through the first stage of the process
		Course size seemed to have been a determinant factor in the adoption of an LMS as well as in the outcome of the courses

This study also provided some information that could give us an insight of what happened with the learning process of the four courses and that could, in the future, help the institution in its strategy for implementing *Moodle* and online courses.

We believe one major finding of this study is related to the process chosen by the institution to implement *Moodle* and the online educational model. The initial online strategy was interrupted and a new strategy was adopted without the process being clear and without consulting and involving all participants. This may have led to much resistance from the participants as well as many of the results obtained in the courses. The reasons which led to this decision by the institution do not seem to have taken into account all the needs that a DE system requires to be successful. The formation of very large classes only for the purpose of saving resources has led teachers to situations too difficult to effectively manage. Also, national classes (with students from different campuses) meant that teachers had to schedule trips around the country. Some students never met the teachers because not all the teachers could carry out all the traveling scheduled. This ended up corrupting the original intention of having a blended system. For many participants their experience was a DE one. And they did not felt prepared for that.

The initial project for implementing *Moodle* and the new educational model anticipated a period of transition, training, and adaptation of all involved as all technology adoption is supposed to have. That did not happen. The great potential of the LMS seem to have led the institution to precipitate and to try to get as much of that potential as it could in a too short period of time.

And although many of *Moodle* features may have been taken into account when it was chosen (such as its potential for building learning collaborative communities) sometime during the process those features did not seemed to have guided the posterior development. The learning and teaching processes were subsequent to other factors of concerns.

Teachers had some guidelines for preparing the online courses as well as a support office. Training was also foreseen in each school campus but not all teachers (or students) have participated. Most of that training was provided just one week before the beginning of the school year (sometimes even after the beginning) and addressed mainly technical issues related to the use of *Moodle* (how to upload files, send messages, participate in a forum, create/ answer a test, etc.). Pedagogical issues were very briefly mentioned although in some campuses the local *Moodle* team have, during the school year, done some workshops about pedagogical use of the LMS. Teachers were required to submit their class plans[101] to the schools boards in the beginning of each semester. There were mainly two reasons for this: to check their level of preparation and to be able to provide that information to students (so they would know in advance the objectives of the course, the tasks to be undertaken and the assessment methodology). Some teachers did their classes planning from a model provided to them and without training. Although Haguenauer & Bechara (2009) said that *Moodle* favours the development of environments that promote

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[101] Classes plan for online courses was called '*Semester teaching guide*'.

learning through its framework that potential might have not been fully explored in teachers' training. All three teachers have tried to promote a student-centred pedagogy in the online courses but students did not respond as much as hoped. *Moodle* can represent a milestone in changing attitudes in education and in the pedagogical model of transmission of information for the construction of the knowledge (Flores & Flores, 2007) but that process takes time, vision, effort, and this study caught it in a very early stage.

Another important aspect of the implementation of *Moodle* and the *Online Project* was the non-systematic information collection over the entire process. According to the responsible of the process data provided by *Moodle* statistics module was never gathered or used (except by a few users who might have done it individually) by the institution. Even the team responsible for the *Online Project* has not gathered any information about *Moodle* use such as the number of users and/or participants, the number of courses using it, pedagogical models used, participants' perceptions and opinions. Only recently some master students showed interest in some aspects of the *Online Project* and started collecting information for their dissertations. We believe that valuable sources of information were overlooked and not used. The redirection of the project shortly after its inception and the fact that it involved a course of action substantially different from what was planned by the initial team may have led to the situation of non-use of available information and some lack of organizational design and strategy behind the second phase of the project. Baepler & Murdoch (2010) stressed how academic analytics can contributed to the decision making practices for operational purposes at the universities. That was not observed in our study because no data was collected form *Moodle* by the institution. The potential of academic analytics for improving teaching, learning and students success is yet to be exploited by the institution.

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6. Conclusions

LMSs have been rapidly adopted by a growing number of institutions in higher education. However this process of adoption and implementation of technological tools has been experienced by some in a very unsystematic and unguided way. This has led to less positive experiences that have affected its successful implementation and adoption.

Technical issues are an important aspect when considering the use of ICTs but learning environments give emphasis to the pedagogical use of those technologies. How can we take full advantage of the characteristics of these systems for the benefit of better teaching and learning? Academic curricula, learning methodologies and even the participants are changing. How can we incorporate those changes in the implementation, management and use of such technologies?

Much can be learned from the experience of other institutions already have. Nevertheless each one has to travel its own path. The specific characteristics of each institution as well as their individuals, and their environment make each one a unique situation and it is sometimes difficult to apply to them generalizations obtained through the analysis of other cases. However some lessons can be learned from others and general conclusions can be drawn from this research.

6.1 Information on the major topics

Although this research is a case study whose results cannot be generalized or extrapolated it helped us to better understand how the main areas of the literature review were experienced by a particular institution.

The literature review of this study has focused on five major topics: *DE, E-learning, Online Interaction, LMS* and *Academic Analytics*.

Regarding DE what was witnessed in this study does not meet the strict definitions that are given on this type of education especially with regard to the planning and the existence of pre-produced learning materials. The speed with which the project was initiated did not allowed many of the DE common features to be present. However a certain type of DE was experienced in the courses that were analyzed. This allowed us to strengthen the idea that a common definition for DE is difficult to achieve and even when it is not planned and fully prepared DE may occur.

Another issue related to DE is that it is a process that can have several stages. What happen in the school were this study was carried out was an early stage of the process of implementation of a DE model which has resulted in the transposition of the classroom model to the online environment. And that is something that occurs frequently. This study has reinforced that information as well as the need for a design of instruction when developing DE.

The fact that DE can often be confused with e-learning has led us to propose the designation of DEL. The interviews carried out in this study confirmed that It is not always clear to the participants of such processes is what they really are and what are their constituents and consequences. This study as also confirmed what is now called *e-learning 2.0*. An open source application was used by an educational institution for promoting a more collaborative and student centered type of learning.

Regarding online interaction this study could not confirm a definition of online effective instructional interaction and that there is as increasing interactivity between learners, instructors and contents. What could be witnessed is that participants in an educational context search for guidance in online interaction as well as a clear/ meaningful purpose for doing it. There seems to be a need for reward to interact and communicate in such contexts.

Although it was not a purpose of this study to research on meaningful learning it has allow us to confirm that further studies on this area are needed. We were focused on online learning networks and issues about community and collaborative learning and its importance for the educational process emerged several times.

Concerning online participation we think this study reflected in a small manner some of the levels of researchers' perceptions of the complexity if online participation mainly the 2nd, 4th and 6th levels proposed by Hrastinski (2008)[102]

Online discussion forums are one of the most common tools used in DEL and this research has confirmed that, as well as some of its the strengths and weaknesses. We believe that it was also exposed the difficulty to take full advantage of the forums features which has

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[102] See also sub chapter 2.3.3.

revealed the need for further research. The SNA performed confirmed that the most important characteristic of the forums is social interaction. It was also confirmed that students' engagement is not always automatic and it is not clear yet what is the ideal role of the instructors. Results from this study seem to point to a relation between the presence of the teacher and a bigger participation rate from the students. But that has been refuted by some studies and confirmed by others. A deeper research is also needed regarding this subject.

LMSs are being increasingly adopted by higher education institutions. Their features and potential are, for many reasons, attractive for schools boards as well as for teachers and students. Some of those reasons were present in the online educational project of the institution and confirmed by the participants in the questionnaires and interviews. *Moodle* seems to have been a milestone in the institution education project history and sparked a debate on the same.

But most of the information produced by LMSs is not being harnessed. And that is what was concluded in this study. We hope that researches like this one help promote some awareness about the potential use that can be done of such data through academic analytics.

Academic analytics broadly refer the decision making field and can improve decision making with its predictive modeling. That idea was also reinforced by this study. If that kind of information was available, participants, especially teachers, could use it in order to adjust their online teaching models and promote a better learning experience. SNA can be considered as one field of academic analytics and the one made in this study was an example of the potential of this research area. The need to make this type of information available to everyday practitioners and to integrate it into the teaching and learning plans was exposed in this study.

6.2 The Online Project

"We started very well, very committed, convinced we were going to change much. But then we had to go back ..." (Person responsible for the online educational project, personal communication, June 2011)

The institution we have studied accepted from one of his teachers a project to implement and use *Moodle* as a new tool for teaching and learning in a blended model. This project had, initially, a three years' time phase that was not met. After a year and a half the administration of

the institution decided to change what they had agreed to initially. Suddenly several courses were being taught using a full DE model which was not foreseen nor prepared.

The early good outcomes seemed to have triggered the need to hasten the return on the initial investment made by the institution and at some point enterprise logic took over with very little time for the participants to adjust.

The results from this study concluded that most of the participants in the online course did not have previous experience which may account for the opinion they had not only about *Moodle* but also about online learning. That inexperience may also help explain their behaviour in the forums. A longer period of learning and adaptation could have caused more positive results. If the project is expected to continue in the future a better use of *Moodle* may be done to promote the necessary interactivity for the creation of learning social networks.

Another major factor that contributed to the outcomes of the *Online Project* was that participation was not voluntary for many of the teachers and students. Several reasons were stated for their reticence but overall they felt they were not prepared. A project with an anticipated big impact needed more cooperation from all involved. In the year following the collection of data most of the participants already had some experience and had more training hours. The reflex on the reaction of these participants was visible with a sharp decrease of complaints and resistance to *Online Education Project*.

Because of the sudden change in the original project many felt lost and although training was provided, each campus was left on their own to prepare and provided it. There was no general strategy for all campuses of the institution across the country. But classes had students from different schools and they had different levels of digital literacy and different levels of *Moodle* training. The same solution cannot be fit to such heterogeneous audience. We believe that even when implementing a single project different strategies are needed able to adequately address the different contextual realities.

In this study the resistance from the participants seemed not to be related to the use of *Moodle* but to the new online learning model. Although both aspects are related we believed they should have been addressed in different moments (according to the original plan). Without deep reflection, clearly defined objectives and above all significant involvement and participation of those who will be affected all can be placed at risk.

We have witnessed developments that require additional efforts by institutions and individuals working within them. Among these challenges are the major developments in ICT that have altered not only the learning processes but also the way schools are managed. The

compatibility of enterprise logic with the logic of educational processes occupied the centre of many debates and is the source of much that was observed in this case study.

6.3 Online Learning Networks

"Creating communities is not easy or simple. With large classes it is impossible. The stimulus was not what we had dreamed. The stimulus sometimes has to be another besides the enthusiasm that they will feel." (Person responsible for the online educational project, personal communication, June 2011)

ICTs do not, by themselves, assure interactivity or collaboration. Nor do they create communities. ICT users must feel motivated (and many times rewarded) to use them and to participate in a network.

The literature review on online participation stresses that assessment is a major factor leading students to participate in online networks. When students are being evaluated for their online participation they do participate more. The question that arises is: but what kind of participation are they having? A quantitative approach to this issue does not provide enough information. Online interaction phenomena cannot be fully understood with a simple count of the number of messages or words. Messages need to be 'heard' as well as the participants. And that is why a qualitative approach provides us with the other missing half of the comprehension process.

One other central question of this study was related to online learning networks. Several students enrolled in a course do not form a network. If they do not interact and participate nothing happens. Connections are needed to form a network. And a specific kind of connections is needed to form a learning network: cooperative and collaborative connections. Because their main purpose is to achieve educational goals.

The number of participants in a network was also an issue. Although there is no 'right' number of students for online classes, nowhere in the literature did we found examples of successful courses with a very large number of members (above forty students). Participation requires commitment, time, attention, availability, feedback and a sense of belonging. The larger the groups the more difficult that is for teachers but also for students.

Faculty experience in DEL was also something that arose from this research. In general teachers with more experience tend to have a more positive perception about the potential of this learning model. Beginners can be overwhelmed with all the changes that the model implies and the sense of lost (and even loneliness) is usual. Not only new technical skills are required but also a new approach to the pedagogical model. Building new and different teaching materials for the online environment is time consuming and can be very challenging. The first impulse is to transpose the classroom teaching model to online classes and many times the results are disappointing to all participants. Students and teachers' roles in DEL may be even more difficult to set in an environment in which most of the subjects continue to be taught face-to-face. The constant change that players have to make between online courses and classroom courses can cause confusion about what are the roles expected in each learning model. And that is a new challenge for schools that are now beginning to provide some online courses without changing completely to a DEL model. Because of all the changes that are happening and due to market competition we believe that studies like this can provide clues and models of action for schools that are now venturing into the online experience.

6.4   Social Network Analysis

SNA is one of the many approaches we can use to analyze data produced by LMSs. However one of its biggest advantages is the combination of quantitative and qualitative methods. Because of its numeric nature[103] it provides us a quantitative basis on which to build graphical representations of networks structures that allows us a qualitative analysis.

The visual results obtainable by SNA go even further by allowing non researchers (like students or school managers) to access and easily interpret a substantial part of the interaction process. Providing this kind of information to participants can contribute to a greater understanding and involvement of them in the learning processes.

LMSs have made SNA task more easy[104] by storing huge amounts data about users' interactions. However most of the times data stays still without being used in a structured and systematic way. Teachers do not use it to make adjustments to their teaching model allowing it to evolve and find creative and adjusted solutions for the learning process. Students do not use it in

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[103] See also *Social Network Analysis Developments* chapter.
[104] As long as SNA software is built into the LMSs (for accessibility).

order to understand and adjust their behavior in classes. Schools do not use it in order to understand the educational process which they are also responsible for, neither take greater advantage of the potential that human networks can have in business terms.

It is true that the SNA appears to be in fashion, especially when we consider major online networks like *Facebook*, *Twitter* or *Linkedin*. But the same it is not true when we think about academic learning networks. It is still a new field for researchers.

6.5   Implications for Practice

One aim of this study was to provide information that could be useful not only for the institution but also for the teachers and students involved in the online teaching model.

A crucial part of learning is based on the interactions between the stakeholders (e.g. teachers/ instructors and students/ learners). The interaction done online has different characteristics of the communication done in person. So, different approaches are needed to study this phenomenon. SNA it is one of those approaches.

One of the most used tools by teachers in LMSs for asynchronous communication is the forum/ discussion board. But teachers feel often disappointed with the results obtained in those forums. Participation can be weak, sometimes the quality of the posts is not good, and many times students do not interact between themselves. The management of these spaces of communication assumed then a great importance.

How are you doing in the discussion board? The answer to this question can reveal the perception of the forums participants and does not always correspond to SNA results. SNA provides an almost immediate access to the visualization and statistics of interactions in online learning networks and often surprises the participants of those social networks.

This type of information allows teachers to adapt / change their own use of the forums and also the use made by the students. The teachers that have participate in this study think that if they have had access to SNA results they could have tried to improve the use of the forums. We agree with them and think that the integration in the LMSs of tools that help analyze interactions will allow the rapid collection and processing of data produced by those systems. The ultimate

goal would be to integrate this type of information in the process of teaching and learning to allow participants to have a clearer and accurate view on how they interact in social networks.

SNA provides information about the outcome that specific behaviors can have in online networks. From this information one can set the rules of participation in the forums according to the goals and type of results expected. The use of this type of information can then be done in order to think/ plan/ adapt the forums or other types of asynchronous communication tools for a more effective use in the educational process.

However this type of information needs to be collected and processed. And if on one hand tools like *SNAPP* are easy to use and enable a rapid analysis and visualization of interactions on the forums, on the other hand a deeper and consistent analysis requires tools whose use involves more advanced skills. The integration of these tools on schools LMSs can help promote research from faculty staff which in turn can contribute to a better use of the large amounts of data (which are often ignored) produced by these systems with the aim of improving both the use of technological systems and its pedagogical use. Research in this area would also contribute to increase the literature available on the subject with the purpose of improving both the pedagogical practice of teachers and the learning process in general.

On the other hand, and regarding the perceptions of users about the use of technological tools, this study was particularly useful to highlight the importance of research in this area. And that was especially true with regard to students' perceptions that still had a distorted picture of how their online relational behavior really was. The idea that the generation of young students who currently attend the university is composed of digital natives with a high degree of technological competence is often refuted by the experience that teachers have with these students and by the results they get when using technological tools. But although that is witness every day in schools across the world research is necessary to confirm that. Research that can help understand the phenomenon, to improve the pedagogical models adopted by the schools and the teachers, to improve the curricula of courses (e.g. with more and better introduction of soft skills in curriculum particularly technological skills) and to help students more effectively in their academic journey.

From the perspective of educational institutions this type of research can also have several advantages. Increasingly, schools use their LMSs (or similar) or their web pages to provide information and communicate with students. The way that communication takes place and the results obtained could benefit greatly with SNA and other types of statistical analysis (e.g. perceptions analysis about the use). Research is important to adjust and improve the use of those technological systems and even to promote new types of usage, broaden its scope of use,

encourage greater feedback, have more commitment from the users, and have more positive results in line with the goals that institutions intend. This would involve some investment by institutions but would allow a more effective use of those systems and by that ensure a quick return of the investment.

Regarding to who should be responsible for this type of analysis in schools we believe that they benefited in being made by researchers that would made available their results to the teachers, the students and the school boards. Thanks to free access to some software for relational analysis any user can try to study that type of data. This, however, could lead to decontextualized, incomplete, inadequate and even erroneous analysis. For a better research and understanding of the results of this type of analysis, qualified persons are needed so that an effective contribution is made to really improve the practices related with the use of this type of technological systems. And so that knowledge could be more easily and quickly shared.

6.6   Future Research

Data is everywhere and the technological development has provided us with tools capable to access, store and analyse even greater amounts of data. Nevertheless much is left undone and unknown.

Regarding academic analytics in Portuguese higher education institutions there is still a long way to go. It is a research area very little explored with large quantities of data that are not being used. It is a field with many interesting aspects that may arouse the interest of researchers. One of those aspects concerns the use, perceptions and adoption of ICT tools in educational contexts. Hargreaves (2003) argues that a common framework should be developed for evaluating ICT and it should serve the needs of schools, teachers and learners, as well as policy-makers and researchers. Based on that Dix (2007) proposed a *Design-Based Research in Innovative Education Framework* (DBRIEF). It attempts to provide an instrument that finds applicability, currency, and promote the sharing of knowledge within the educational research community. Assumes that the understanding of how and why an innovation works within and across settings over time depends on research framed in an appropriate paradigm. This framework "(…) attempts to provide a visual representation of a research paradigm that embodies what is currently considered good research design" (p. 120) and aims to promote complex interventions through improved information and empirical study.

We have adapted Dix's proposal to create a new framework for researching the relational aspects of learning networks which uses SNA as an academic analytics strategy for improving the online learning process. We believe that the analysis of data provided by LMSs can be crucial for its implementation and use as well as for DEL. This type of research could offer valuable information to guide the future development of such systems making them more suited to the needs of users and of learning.

Teachers' confidence and competence have increased resulting from a continuous use of ICT by schools to enhance learning. On the other hand students ICT capability has also improved although an effective use of it is still not the norm (Hargreaves, 2003). Despite all the research that is being done on this subject by many researchers from all over the world there is still much to learn about online learning networks and the ICT tools that promote them.

SNA main goal is the study of networks because assumes that the understanding of these is vital for knowing the behavior of societies and their individuals. SNA is a recent research field which boosted just a few decades ago especially with growth of the Internet which aroused the interest of researchers for the phenomenon of formation and operation of online social networks. In the education field new ICT tools like the LMSs opened the online learning process to new challenges which can benefit much from the information and understanding provided by SNA.

Because of the reasons stated above we decided to adapt Dix' s framework (2007). We have called it *Academic Analytics Designed-Based Research Framework for Networks Relational Aspects* (figure 25). It is an attempt to combine educational research on educational networks with the development of an adapted and innovative online learning. The desirable outcome is to provide an instrument more refined and specific that allows:

- Identification of potential areas where the research of relational aspects is needed within the different factors that contribute to and constitute the reality of an educational institution;
- Collection and provision of relational data resulting from SNA to all participants / stakeholders in the educational process;
- Promote academic analytics through the collection and analysis of data gathered by a LMS in educational institutions that which are often undervalued and even unused;
- Help promote the technological factors within the educational process

Extended Evaluation

Subject → Research → Outcome

Educational Paradigms

Social Network Analysis

Environmental Factors

LMS or similar

Academic Analytics

Intervention Cycle

Technological Factors

Context Identification

Intervention Development

Adapted and Innovative online learning and DEL processes

Intervention Evaluation

Theory

Review of literature

Intentional and Informed Exploration

Goal

Reflection

Conjecture

Relational aspects of learning networks

Teachers

Participants' factors

Students

School

Unstructured Exploratory

Structured Confirmatory

Figure 25 Academic Analytics Designed-Based Research Framework for Networks Relational Aspects

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- Provide useful information and output measures for the creation and support of a cycle of intervention that allows to adapt and innovate online learning and DEL;
- Contribute to an extended evaluation of the DEL intervention cycle;
- Help promote an effective use and a better provision of ICT tools and academic networking;
- Promote awareness, reflection and research about the relational aspects of the learning networks;
- Enhanced the understanding about online learning networks;
- Help develop further theory about the use of technological tools to create and/or promote learning networks.

This framework attempts to incorporate the major elements that should be present when doing research on the relational aspects of learning networks. We describe it as follows:

- All frameworks elements are connected (directly or through indirect relations);
- The context identification is a detailed description of the institution where the online education takes place. In other words is a description of the school, its material and human resources, and educational project. It is an attempt to get to know as much as possible about the place and the persons that are going to be studied and to identify potential areas where the research of relational aspects is needed;
- The conjecture is the main purpose of the research. In this case it is the relational aspects of learning networks[105]. We wanted to provide a structure that would allow the pursuit of the research initiated with this dissertation and that could also provide a guideline for future studies;
- The literature review is naturally related to previous theoretical and empirical research done on the same subject (or related areas). It aims to anchor the work to theoretical references, to meet new lines of research and to know what else is been done in this area by the scientific community;
- Context, conjecture and theory are at the beginning of an intentional and informed exploration which is a standard format for educational research and is, at the this stage, in an unstructured and exploratory phase;
- In the environmental factors and among several technological ICT tools that exist we have left just the LMS due to our main purpose of research and not because all the others lack importance. This framework attempts to provide an operational guideline for researching a very specific aspect of an also very specific ICT tool;

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[105] We believe this framework can also be adapted to the research of other ICT tools used in schools.

- The data provided by the LMS about user's interactions is then analysed using SNA techniques contributing for academic analytics to be incorporated in the routines of the school as a procedure that helps improvement and accountability The aim is to provide information that can improve decision making with its predictive modelling and which allows faculty members to intervene improving the success of teaching and learning;

- Because schools are affected by policies which reflect the current educational paradigms we have consider it a major environmental factor. The adoption of ICT tools often depends on those factors and they must be taken into account when researching on this area;

- The participants are the teachers, the students (and the relation they establish in the learning process) but also the school. We view the school here as the responsible for managing material and human resources as well as responsible for pedagogical issues and others related to the learning process;

- In this framework students and teachers are more identified with the pedagogical aspect of the learning process while the school relates more directly with the enterprise logic;

- Both factors, environmental and participants, contributed to the development of an intervention cycle through a deepest analysis of one technological tool using SNA;

- On the other hand the intervention cycle is also a self-feeding process where development and evaluation provide information to each other to promote adapted (to the specific characteristics of the educational context) and innovative (creative and adjusted to current demands) online learning processes;

- At this stage the outcomes of the research allow a structured and confirmatory phase to be achieved. A context assessment has been done, data has been gathered and analysed and information about the relational aspects of networks is finally available to be used in the intervention cycle;

- The exploration and intervention phases feed a larger and on-going process of analysis/ action/ evaluation that allows the development of further theory, adaptation and intervention actions, readjustment or more structural changes if and when needed.

This framework is a resulting proposal from the reflection on the research carried out within this thesis and attempts to systematize and provide a basis for further development of the research initiated with this study.

According to Dix (2007) there is an "unusable knowledge" resulting from the fact that educational research is often divorced from the problems and issues of everyday teaching practice.

Historically, research has not been used effectively to improve practice for a broad and complex set of reasons, including the nature of research, the local and situated nature of practice,

the training and expected roles of researchers and practitioners, and limited use of intermediaries between research and practice. (Stein & Coburn, 2003, p. 3)

The framework we have proposed aims to contribute to closer research and educational practice regarding the relational aspects associated not only to the learning process but also to the use of ICT in schools in general.

In addition to the possible use of this structure for future research we believe that there are various other possibilities to the pursuit of this study or similar studies. It would be important to know and understand how other higher education institutions have deal with the implementation of technological tools such as LMSs. A comparison between them could be useful not only for adjustments that would allow for a more effective use of those systems but also to provide useful information to other schools that have not yet undertake the same path.

Regarding SNA there is still a lot that can be done. Comparative studies between courses within the same school and between different schools could help us research and understand online relational patterns and their underlying causes. A more effective use of LMSs communication tools depend on that. Adjustments to the pedagogical models used in the online environments could be done from this type of information.

SNA could also be used to study online interactions 'outside' the courses in the universities web pages. The research about relational data could help institutions to understand how the users of those pages communicate and interact and use that information to promote contents and activities.

Another important research area is the perceptions that users have about technological tools. Often these perceptions do not match the behavior that users have when using those tools. It would be important to deepen the knowledge about the reasons that lead to this discrepancy. This type of study could provide results that could be used to help students and teachers as well as to adjust the courses curricula.

This research started from a problem (*What types of social learning networks supported by the LMS Moodle are created within higher education and training?*) and intend to answer to several major and minor research questions. Tables 47 and 48 attempt to provide a synthesis of the responses obtained with this study to those questions:

Table 47 Major and minor research questions and summary of the information provided by this study

Research Questions	Information provided by this study
MRQ1 - What types of social learning networks are formed in LMS *Moodle*, in a Portuguese Higher education institution, as a mediated, on-line teaching and learning environment?	Formal networks and with very few interactivity among the participants, especially between the students.
MRQ2 - What are the patterns of relationships established between users of the LMS, and what features, activities influence the formation of these patterns in the context of distance education at an institution of higher education in Portugal?	The most prominent pattern is the one centred in the teacher (star pattern). The students interact mostly with the instructor although in some sub regions of networks few examples of other patterns can also be found. Assessment activities were mainly responsible for the formation of the patterns found. We also found that more informal themes of discussion can trigger higher participation and more interaction.
MRQ3 - How can the LMS, as a support environment for social learning networks, contribute to the organizational design and strategy of an institution of higher education in supporting the process of communication, sharing, knowledge building and management at distance?	*Moodle* can be tailored to support the needs of an educational institution regarding online and distance communication, knowledge building and sharing. *Moodle* enables the connection to other communication systems that schools may have allowing a more effective management of those systems.
mrq - Study the *Moodle* platform as it supports the development of social learning networks (its elements and characteristics);	*Moodle* has good features for asynchronous communication and interaction. Nevertheless the expected outcomes rely on the experience and the type of use that users do of these characteristics. The little experience of the participants seem to have led to a poor use of the forums and somewhat disappointing results.
mrq - Determine the relationship, representation, distribution and distance between the users of the forums of the analysed courses find patterns of relationship in this type of social networks;	Low connectivity relations with large distances between the actors of the networks. Also some isolated actors. Above all, students distributed around the teachers forming a star pattern.
mrq - Analyse the relationships and flow of communication in the learning forums among the users individually and in groups;	Relationships were mainly established with the teacher or in very small groups. Communication flow was most often unidirectional and information was mainly on the subjects of forums and there was a lot of redundancy.

Legend 2 MRQ = major research question / mrq = minor research question

Table 48 Major and minor research questions and summary of the information provided by this study (continuation)

Research Questions	Information provided by this study
mrq - Determine the type(s) of network(s) present in the learning forums of the courses studied and their relationship with the participants and their representativeness;	Formal and small networks (with exception of C2) focus on teachers who were in most cases the most representative actor.
mrq - Compare the different types of social networks created in the forums of the courses;	There were no significant differences between the forums networks of the four courses despite the differences between the students and the teachers (e.g. previous experience in online learning environment).
mrq - Analyse the formation of subgroups within learning networks (moment of creation, participants and their representativeness, characteristics and types of subgroups);	Very small subgroups were created. The sub groups were created especially when approaching assessment deadlines. Most time the teacher was a part of those small sub groups and the prominent role.
mrq - Identify the moments of formation of the networks within the courses and the possible causes of formation and closure through characterization of the activities undertaken by participants;	Networks were formed whenever the teachers initiated a forum and activity ceased whenever the assessment or the course was completed. The most active moments in the networks coincided with the assessment schedule.
mrq - Evaluate the relationship between the network(s) pattern(s) present in courses studied and the possible causes and processes behind the formation of that model(s);	Possible causes behind the most common network pattern are likely to be related to the forums purposes (formal debates about the courses content and assessment), and to lack of previous experience of most actors in using *Moodle* and in participating in online courses.
mrq - Analyse the participants' perceptions of the features, interaction/collaboration (social and learning networks), learning/ teaching process and skills acquisition developed in the LMS context;	Teachers' perceptions about *Moodle* were different and ranged from very positive to very negative regarding some features
mrq - Characterize the teaching / learning processes used in the courses;	Two of the three teachers transposed the teaching classroom model for the online environment. The third teacher tried a model more focus on students and less on the knowledge transmission.
mrq - Characterize the strategy for the adoption / use of the LMS *Moodle* by the Higher education institution;	A technological upgrade strategy to increase and improve the resources available for teachers and students in order to make the courses more updated and competitive.
mrq - Characterize the strategy of the institution that drives the adoption of the particular model of distance education (process, characteristics and evolution);	The strategy was to move slowly to the online learning model. First in a blended model and then a review of the experience would take place for possible adoption of DEL. This strategy was interrupted, the blended model eventually became inadvertently in distance learning and now the process is interrupted.

Legend 3MRQ = major research question / mrq = minor research question

We believe our main goals with this research were achieved. We wanted to know the process of implementing a new technological tool by an educational institution and see the reflection of that adoption in the establishment of online leaning networks. We achieved a thorough understanding of the entire process and we have watched some of the same

consequences for both the teaching and learning process and for the institution itself. As any case study it had an exploratory nature and the findings can be useful especially to the school were the study was conducted. And even if these results cannot be extrapolated each research can be a step towards a best understanding of educational phenomena and can allow us to discover particularities, possible ways of data analysis and clues for future developments.

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8. Appendices

Appendix A – Research Schedule

Academic year 2009/10	S	O	N	D	J	F	M	A	M	J	J
Doctoral Program of Seminars	▓	▓	▓	▓	▓	▓					
Seminar on Development of the Research Project						░	░	░	░	░	
Exploratory readings on the research theme	▓	▓	▓	▓	▓	▓	▓				
Preparation of pre-**doctoral** project				░	░	░	░	░			
Selection of methods of data collection and identification of participants				▓	▓	▓	▓	▓	▓	▓	▓
Test of data collection methods (possible settings)								░	░		
Theoretical basis of the research (research, readings, bibliography updating)	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓
Writing of the Ph.D. Project											
Presentation of the Ph.D. Project											▓
Realization of the exploratory study to investigate the methods of collecting and processing data and selection of courses to be studied										░	░

Academic year 2010/11	S	O	N	D	J	F	M	A	M	J	J
Completion of the exploratory study	▓	▓									
Continuation of theoretical research (research, reading, bibliography updating)	░	░	░	░	░	░	░	░	░	░	░
Data collection	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓
Drafting of the theoretical basis of the Ph.D. Dissertation	░	░	░	░	░	░	░	░	░	░	░

Academic year 2011/12	S	O	N	D	J	F	M	A	M	J	J
Data processing - reading, interpretation and analysis of results	▓	▓	▓	▓	▓						
Conclusion of the writing of the Ph.D. dissertation						░	░	░	░	░	░

Teachers' initial questionnaire

This questionnaire is part of an investigation being conducted by Patricia Fidalgo, Ph.D. student at the Faculty of Sciences and Technology, New University of Lisbon, about social learning networks created in online courses using the LMS Moodle, in a private institution of Higher Education in Portugal. The study involves teachers who will use the Moodle platform as a pedagogical tool in their courses during the academic year of 2010/2011.
Thank you for your participation.

* Required

1. How many courses and their ECTS will you teach online using Moodle platform, in the academic year of 2010/2011? * [   ]

1.1 How many face-to-face moments will you have in this course? * [   ]

2. How many courses will you teach, in total, in 2010/2011? * [   ]

3. Which of the following Moodle features you plan to use in your course? * *You can select more than one option

- ☐ Book
- ☐ Labels
- ☐ Write text page
- ☐ Write a Web page
- ☐ Add files or links
- ☐ Display a directory
- ☐ Add IMS package
- ☐ Other: [   ]

3.1 Develop, if you want, the answer to the previous question

```
[                                                    ]
[                                                    ]
[                                                    ]
[                                                    ]
```

4. Which of the following Moodle activities you plan to use in your course? * You can select more than one option

- ☐ Chat
- ☐ Student's diary
- ☐ Forum
- ☐ FLV Player
- ☐ Glossary
- ☐ Inquiry
- ☐ Lesson
- ☐ Questionnaire
- ☐ Referendum
- ☐ SCORM/AICC
- ☐ Table
- ☐ Test
- ☐ Assignment
- ☐ Wiki
- ☐ Other: [   ]

5. Rate in order of importance the following uses of Moodle.. * 1 = less important and 5 = very important

	1	2	3	4	5
To make contents available (e.g. files)	☐	☐	☐	☐	☐
To assess students through the platform	☐	☐	☐	☐	☐
To receive student assignments	☐	☐	☐	☐	☐
To keep the content of the course organized and available for student access	☐	☐	☐	☐	☐
To refer to external sites relevant to students (e.g. links to web pages)	☐	☐	☐	☐	☐
To schedule events (e.g. calendar)	☐	☐	☐	☐	☐

	1	2	3	4	5
To obtain the opinion of the students	☐	☐	☐	☐	☐
For collaborative construction of content by students	☐	☐	☐	☐	☐
For publication for informational purposes (e.g. web page)	☐	☐	☐	☐	☐
To send messages to all students (e.g. news)	☐	☐	☐	☐	☐
For topics discussion by students (e.g. forums)	☐	☐	☐	☐	☐
To send private messages to students	☐	☐	☐	☐	☐
For online synchronous communication (e.g. through chat)	☐	☐	☐	☐	☐
To provide direct support to classes (e.g. PPT, PDF, etc.)	☐	☐	☐	☐	☐
To perform tests to assess students	☐	☐	☐	☐	☐
To publish the results of students evaluations	☐	☐	☐	☐	☐
To manage the moments of evaluation and their results	☐	☐	☐	☐	☐
To inform students about the tasks they should perform at home and make its reception	☐	☐	☐	☐	☐

6. Regarding the organization of your course in Moodle you intend to: *

- ☐ Segment the content according the different days of classes (e.g. each section corresponds to a class and the respective subject)
- ☐ Segment content according to the themes of the course (each section corresponds to a topic regardless of the number of classes that are occupy the same)
- ☐ Do not intend to segment the content of my course and I will use Moodle primarily as a social forum
- ☐ Do not intend to segment the content, but present it all in the same initial section
- ☐ Other: [____]

7. What kind of scripto resources you plan to use in Moodle? * You can select more than one option

- ☐ Books and / or book chapters
- ☐ Articles
- ☐ Journals
- ☐ Maps
- ☐ Drawings / Paintings
- ☐ Graphs / charts
- ☐ Photos
- ☐ I do not intend to use any scripto features
- ☐ Other: [____]

8. What kind of audio resources do you plan to use Moodle? * You can select more than one option

- ☐ Music
- ☐ Podcasts
- ☐ Do not intend to use audio features
- ☐ Other: [____]

9. What kind of video resources you plan to use in Moodle? * You can select more than one option

- ☐ Videos
- ☐ Webcasts

- ☐ FLV Videos
- ☐ Screencasts
- ☐ Video Podcast
- ☐ Do not want to use video features
- ☐ Other: _____

10. What kind of inform resources you plan to use in Moodle? * You can select more than one option

- ☐ About Basic Software
- ☐ About Management and Operating Systems
- ☐ About Application Software
- ☐ Other: _____

11. Do you have previous experience in using Moodle (before 2010/2011)? *

- ☐ Yes, as student
- ☐ Yes, as teacher
- ☐ Yes, as student and teacher
- ☐ Did not had prior experience

11.1 If you used Moodle before in this institution in the any of the last three academic years, check on which. You can select more than one option

- ☐ Yes, in the academic year of 2007/2008
- ☐ Yes, in the academic year of 2008/ 2009
- ☐ Yes, in the academic year of 2009/2010

12. How do you rate your level of proficiency in the use of Moodle? *

- ☐ Weak
- ☐ Elementary
- ☐ Good
- ☐ Very good

13. How did you get the skills you currently have to use Moodle? * You can select more than one option

- ☐ Through internal training

- ☐ Through external training
- ☐ Taught myself using training materials
- ☐ Through colleagues / acquaintances
- ☐ Other: [＿＿＿＿]

13.1 Explain in more detail how you have obtained your skills *

[text area]

14. Read the following statements about the process of teaching and learning through the use of Moodle and rank your level of agreement with them. *

	1 Fully disagree	2 Disagree	3 Neither agree or disagree	4 Agree	5 Fully agree
Moodle allows me to better organize the contents of my course	☐	☐	☐	☐	☐
Moodle allows me to improve the presentation of the contents of my course	☐	☐	☐	☐	☐
Working on Moodle from any location will facilitate my work as a teacher	☐	☐	☐	☐	☐
Working on Moodle at any time that is convenient to me will help me in the teaching process	☐	☐	☐	☐	☐
The Moodle is an innovation for teaching and learning	☐	☐	☐	☐	☐
Moodle motivates me to the teach my	☐	☐	☐	☐	☐

	1 Fully disagree	2 Disagree	3 Neither agree or disagree	4 Agree	5 Fully agree
course					
Moodle facilitates collaborative work between students and of between the students and me	☐	☐	☐	☐	☐
Moodle facilitates interaction between students and between the students and the teacher	☐	☐	☐	☐	☐
Moodle will save me time in preparing lessons	☐	☐	☐	☐	☐
Moodle will facilitate the acquisition of skills for autonomous work by students	☐	☐	☐	☐	☐
Moodle will facilitate the diagnosis of knowledge and skills of students	☐	☐	☐	☐	☐
Moodle will facilitate the process of students' assessment	☐	☐	☐	☐	☐
Moodle will facilitate the deepening of knowledge by students	☐	☐	☐	☐	☐
Moodle will make the relationship between the teacher and the students impersonal	☐	☐	☐	☐	☐
Moodle is very useful pedagogical tool	☐	☐	☐	☐	☐
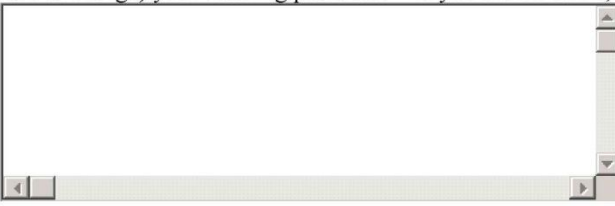
	1 Fully disagree	2 Disagree	3 Neither agree or disagree	4 Agree	5 Fully agree
The little face-to-face interaction between teachers and students will not harm the quality of teaching and learning	☐	☐	☐	☐	☐
Moodle will facilitate the information and resources exchange between students and between the students and the teacher	☐	☐	☐	☐	☐
Moodle will increase student's motivation for the learning process	☐	☐	☐	☐	☐
Moodle creates a social learning network	☐	☐	☐	☐	☐
Moodle will increase the number of interactions between students and between the students and the teacher	☐	☐	☐	☐	☐
The social networks created through Moodle are similar to the social networks created in the context of classroom teaching	☐	☐	☐	☐	☐

15. Have you changed (or want to change) your teaching practices since you have started using Moodle for online courses? *

- ☐ Yes, completely
- ☐ Yes, most teaching practices

- ☐ Yes, some of the teaching practices
- ☐ Almost nothing
- ☐ No

15.1 If you answered yes to the previous question, please indicate to what extent you have changed (or want to change) your teaching practices? * If you answered no, please

state the reasons *

C1. What is your age *

- ☐ Between 20 e 30 years
- ☐ Between 31 e 40 years
- ☐ Between 41 e 50 years
- ☐ Between 51 e 60 years
- ☐ Over 60 years

C2. Sex *

- ☐ Male
- ☐ Female

C3. What is your degree? *

- ☐ Graduate
- ☐ Master
- ☐ Ph.D.
- ☐ Other:

C4. What is your work relation with the institution? *

- ☐ Full time
- ☐ Part-time
- ☐ Special Covenant
- ☐ Other:

C5. For how many years have you taught in higher education? *

- ☐ Less than 5 years
- ☐ Between 5 and 10 years
- ☐ Between 10 and 15 years
- ☐ Between 15 and 20 years
- ☐ Over 20 years

C6. For how long have you been using the Internet? * ☐

C7. What is your scientific area of training? * You can select more than one option

- ☐ Management Sciences
- ☐ Education Sciences
- ☐ Social and Behavioural Sciences
- ☐ Engineering
- ☐ Health
- ☐ Humanities
- ☐ Arts
- ☐ Physical Sciences
- ☐ Life Sciences
- ☐ Computers
- ☐ Law
- ☐ Journalism and information
- ☐ Mathematics and Statistics
- ☐ Technologies
- ☐ Other: ☐

C8. What scientific areas do you teach? * You can select more than one option

- ☐ Management Sciences
- ☐ Education Sciences
- ☐ Social and Behavioural Sciences
- ☐ Engineering
- ☐ Health
- ☐ Humanities

- ☐ Arts
- ☐ Physical Sciences
- ☐ Life Sciences
- ☐ Computers
- ☐ Law
- ☐ Journalism and information
- ☐ Mathematics and Statistics
- ☐ Technologies
- ☐ Other: [   ]

Students' questionnaire

This questionnaire is part of an investigation being conducted by Patricia Fidalgo, Ph.D. student at the Faculty of Sciences and Technology, New University of Lisbon, about social learning networks created in online courses using the LMS Moodle, in a private institution of Higher Education in Portugal. The study involves teachers and students who will use the Moodle platform as a pedagogical tool in their courses during the academic year of 2010/2011.

This questionnaire is confidential and anonymous.
Thank you for your participation.

* Required

1. Did you have previous experience in using Moodle? *

	1	2	3	4	
None	○	○	○	○	Much

2. If you had previous experience with Moodle identify where you got that experience *
You can select more than one option

- ○ Here at the Institute in previous academic years
- ○ In another institution of higher education
- ○ In primary / secondary school
- ○ In an institution of vocational education
- ○ In the workplace
- ○ Not applicable
- ○ Other: _____

3. If you had previous experience identify the academic year(s) in which you used the Moodle * You can select more than one option

- ☐ Academic year of 2004/2005
- ☐ Academic year of 2005/2006
- ☐ Academic year of 2006/2007
- ☐ Academic year of 2007/2008
- ☐ Academic year of 2008/ 2009
- ☐ Academic year of 2009/2010
- ☐ Not applicable

4. Identify how you learned to work in Moodle * You can select more than one option

- ☐ Through training provided by the Faculty
- ☐ Through training outside the Faculty
- ☐ Through colleagues / acquaintances
- ☐ I taught himself

5. As for the ease of use how do you rate Moodle *

	1	2	3	4	5	
Very hard	○	○	○	○	○	Very easy

6. How do you rate your skills / master of Moodle? *

- ○ Weak
- ○ Elementary
- ○ Good
- ○ Very good

7. Read the following statements about the process of teaching and learning through the use of Moodle and rank your level of agreement with those *

	Fully disagree	Disagree	Neither agree or disagree	Agree	Fully agree
Work on Moodle platform from any location will facilitates my work as a student	○	○	○	○	○
Working in Moodle at any time that is convenient to me facilitates my work as a student	○	○	○	○	○
Moodle is an innovation for teaching and learning	○	○	○	○	○
Moodle facilitates collaborative work	○	○	○	○	○

	Fully disagree	Disagree	Neither agree or disagree	Agree	Fully agree
with my colleagues and with the teacher					
Moodle platform facilitates interaction with my colleagues and from colleagues with me	○	○	○	○	○
Moodle will save me time in study	○	○	○	○	○
I am more independent in my learning thanks to Moodle	○	○	○	○	○
I have acquire more skills thanks to Moodle	○	○	○	○	○
I am assessed more quickly thanks to Moodle	○	○	○	○	○
The lower face-to-face interaction between teachers and students will not harm the quality of teaching and learning	○	○	○	○	○
Moodle will facilitate the exchange of information and resources between students and between the students and the teacher	○	○	○	○	○
Moodle will increase my motivation to the learning process	○	○	○	○	○
Moodle has created a social learning network	○	○	○	○	○

	Fully disagree	Disagree	Neither agree or disagree	Agree	Fully agree
Thanks to Moodle I interact more often with my colleagues	○	○	○	○	○
Thanks to Moodle I interact more often with the teacher	○	○	○	○	○
In Moodle I have more information / resources (texts, videos, etc..) available for study than in face-to-face courses	○	○	○	○	○
Through Moodle I can perform more activities than in face-to-face courses	○	○	○	○	○
I learn more easily through Moodle	○	○	○	○	○
I feel more motivated to learn thanks to Moodle	○	○	○	○	○
The Moodle platform makes the learning process more flexible	○	○	○	○	○
The Moodle platform makes the learning process more effective	○	○	○	○	○
Moodle allows me to better schedule my activities as a student	○	○	○	○	○

8. In which of the following features of Moodle you like more to participate? * You can select more than one option

- ☐ Chat
- ☐ Student's diary

- ☐ Forums
- ☐ View audio-visual resources
- ☐ Inquiry
- ☐ Assignments
- ☐ Tests
- ☐ Glossary
- ☐ Wikis
- ☐ Referendum
- ☐ reading of texts
- ☐ Other: [　　　]

9. In this Course, which of the following features do you use more to interact with your colleagues? * You can select more than one option

- ☐ Moodle chat
- ☐ Direct messages through the platform
- ☐ Forums
- ☐ E-mail
- ☐ Other: [　　　]

10. Which learning routine did you changed, in this Course, due to the use of Moodle? * You can select more than one option

- ☐ I changed my readings (amount and type of texts)
- ☐ I changed the type / amount of text abstracts that I do
- ☐ I changed my study schedule
- ☐ I changed my place of study
- ☐ I study alone more often
- ☐ I contact more of my colleagues so they collaborate in my study
- ☐ I put more questions to the teacher
- ☐ I go less to the library
- ☐ I use more resources made available by the teacher (e.g. summaries, hand-outs) than other features surveyed by me
- ☐ I have not changed any of my routines
- ☐ Other: [　　　]

11. Your learning experience with Moodle, in this course, has changed the way you study for the face-to-face courses? *

	1	2	3	4	
Nothing	○	○	○	○	Much

11. 1 If you answered 3 or 4 to the previous question specify how

12. Do you participate in any of these social networks? * You can select more than one option

- ☐ Hi5
- ☐ Facebook
- ☐ Linkedin
- ☐ Flickr
- ☐ Friendster
- ☐ MySpace
- ☐ Netlog
- ☐ Ning
- ☐ Orkut
- ☐ Twitter
- ☐ Other: _____

13. Did you used Moodle to invite your colleagues in this course to be part of a social network you belonged (e.g. Facebook)? *

- ○ Yes, to invite them all
- ○ Yes, to invite most of them
- ○ Yes, to invite some of them
- ○ Did not invite any of my colleagues
- ○ I do not participate in any social network

14. Do you consider that you modify your behaviour when using Moodle social network, compared to your behaviour in other social networks (e.g. Facebook, Hi5)? *
You can select more than one option

- ☐ I change my behaviour because Moodle's environment is more formal
- ☐ I change my behaviour because of the presence of the teacher
- ☐ I change my behaviour because the reasons to use Moodle (e.g. learning) are different from the reasons which lead me to use other social networks
- ☐ Do not change my behaviour
- ☐ Other: ☐

15. How often do you use the Internet? *

- ○ Once a week
- ○ Two to three times per week
- ○ Every day of the week
- ○ Other: ☐

16. Which of the following resources do you use more for contacting your friends / colleagues? * You can select more than one option

- ☐ E-mail
- ☐ Chat Roorms (IRC)
- ☐ Chat programs (e.g. Messenger, Skype, Facebook)
- ☐ Mobile phone calls
- ☐ Mobile phone messages
- ☐ Blogs / Personal Web Pages
- ☐ The contacts with my friends / acquaintances are face-to-face
- ☐ Other: ☐

A. Which undergraduate course are you attending? *

- ○ Clinical Analysis and Public Health
- ○ Sociocultural Animation
- ○ Art Show
- ○ Visual Arts

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- ○ Communication Sciences and Marketing
- ○ Dietetics
- ○ Basic Education
- ○ Physical Education and Sports
- ○ Music Education
- ○ Social Education
- ○ Socioprofessional education
- ○ Nursing
- ○ Food Engineering
- ○ Civil Engineering
- ○ Engineering and Computer
- ○ Petroleum Engineering
- ○ Safety at Work Engineering
- ○ Pharmacy
- ○ Physiotherapy
- ○ Management
- ○ Hotel and Tourism Management
- ○ Human Resource Management
- ○ English and Spanish
- ○ Human Motricity
- ○ Music
- ○ Human and School Nutrition
- ○ Psychology
- ○ Radiology
- ○ Sociology

B. What year of your degree are you registered? *

- ○ 1st Year
- ○ 2nd Year
- ○ 3rd Year
- ○ 4th Year

C. If you have already attended Higher Education which degree you have? *

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- ○ Graduated
- ○ Postgraduate
- ○ Master
- ○ Ph.D.
- ○ Have attended Higher Education but did not get any degree
- ○ It is the first time I attend Higher Education

D. What is your age? * [   ]

E. Sex *

- ○ Female
- ○ Male

F. Are you a working student? *

- ○ Yes
- ○ No

1) *Moodle* **use**

• Generally as a teacher what is your opinion about Moodle?

• What difficulties have you encountered (features / characteristics less positive) in the use of Moodle?

• In your opinion, what are the features / characteristics more positive of Moodle?

• Have used more or less resources and / or activities of *Moodle* than you had originally planned? Why?

2) Opinion on the experience of DE

• In educational terms how would you describe your style of teaching online?

• Have you adapted the classroom teaching model to the online environment or is it a new model?

• Regarding the forums what did you intended when you implemented them? Were the goals achieved?

• The pedagogical model that you have implemented in the online environment to what extent depended on the students' interactions with each other? And with you? And with the resources provided on Moodle?

• How was the students' assessment process done in your course?

• What stresses as more positive and negative about this experience?

• Do you think your Course has features that make it a better or worse candidate for this type of teaching?

3) Interaction networks in the Course

• About the interaction process, do you think that it was more encouraged more and / or more inhibited by use of *Moodle* (there were more or fewer interactions)?

• How does the quality of these interactions? Why? And compared to face-to-face courses?

• What do you think have been the most widely used tool by students to interact (forums, direct messages, e-mail ...)? And by you?

• Do you think students have created a learning network (or other type of network - which one) in your course? Why?

• Have you had access to data on the amount and type of online interactions in your Course?

• What do you think about having access to information that will provide data on the quantity and type of interactions? Could it be useful to you?

• (I show him a picture of SNAPP of the most common network pattern on the forums of his course) If I show you this picture of one of your course forums does it contains information that interests you? Do you find it useful? How and why?

• What do you think about the network pattern presented in this picture?

• Do you think that you would change the dynamics of the interaction spaces of your course if you had this information timely?

• Would you alter the type of activities conducted on *Moodle* with the students on the basis of this type of information about social networks? Why?

• Would you require a qualitative analysis of the interactions? Why? Who should do that analysis?

• The information provided by the picture is enough for you? Do you need more?

• Do you think that the analysis of social networks created on *Moodle* in the courses may be an important management element of the teachers' participation in the course? And by the School managers of the *Online Education Project*?

• Do you think students should have access to this type of information? Why?

• What is your general opinion about the interactions between students and teachers on *Moodle* and in on DE?

4) DE process

• In general what is your opinion about Distance Education?

• Specifically, in relation to the model of online education that your school has adopted, what is your opinion? Why?

• If the institution to proceed with the *Online Education Project* which you think should be the way to do it? Why?

• Would like to participate in that model?

Appendix E – Interview Guide for proponent and main responsible for the implementation of the LMS Moodle and the Online Education Project

Purposes:

Background of our research object.

Knowing the strategy and organizational design, behind the process of implementation of the Moodle, and its use for teaching purposes by the Institution.

Interview:

1. In terms of project implementation:
   How was the decision to opt for Moodle? Why?
   People who were originally involved are the same that continue now?

2. What progress has been made of the training of the pivots (the first invited to be responsible for *Moodle* implementation in each campuses of the Institution) and of the pioneers (the first teachers to be involved in the process)? And of their performance afterwards?

3. For results of the questionnaires (questionnaires were administered at the end of training to assess participants' perceptions) to the pivots and the pioneers do you believe that the potential of distance education and the use of *Moodle* shown in the responses was fulfilled?

4. How was the disclosure of the project done to the whole school community?

5. The implementation of the initiative meant, necessarily, strategic planning in collaboration with the governing bodies of the different campuses - how was this done?

6. What was the initial reaction of teachers and students?

7. How were overcome the resistances to this model?

8. «For the implementation of the project was considered imperative to ensure that the courses would resorting to the platform would be characterized by its quality of teaching" (quote from an article about the *Online Project* of the institution) - What does this mean? Why? How was it granted?

9. The pedagogical model advocated worked? Why?

10. The educational and competitive offering of other schools was one of the reasons that led to the implementation of the project. This still maintains?

11. "The online education is related to the use of the Internet as a medium for the publication of teaching materials, teaching for the courses, communication with (and between) students, etc.." (another quote from an article about the *Online Project* of the institution) The online educational project of the Institution was thought for b-learning or distance learning? Why?

12. "The pedagogical model used was essentially as an active complement of classroom training." (another quote from an article about the *Online Project* of the institution) Although it may have been thought to b-learning many of the courses were taught, in practice, under the DE model since the face-to-face meetings were scarce… what do you think about this?

13. 'The use of content management platforms is consistent with the guidelines of the Bologna declaration." (another quote from an article about the *Online Project* of the institution) How so?

14. *Moodle* produces and records a lot of information. As the same been used for research purposes, model validation or other?

15. "The online education also allows the construction of Virtual Learning Communities that can facilitate the construction of knowledge through the integration of teachers and students in discussions and interactive activities" (another quote from an article about the *Online Project* of the institution) What was done to promote the construction of virtual learning communities?

16. *Moodle* is a good tool for building these virtual communities? Why?

17. Have you ever done an analysis of virtual learning communities on Moodle?

18. That analysis could be an asset for the institution? In what way?

19. This type of information could be relevant to any adjustments to the pedagogical model? In what way?

20. Who should do this kind of analysis?

21. Who should have access to the results?

22. "The analysis of the target audience and existing courses do not allow the validation, even from a legal standpoint, other solutions at the moment. There is a desire that can happen at a later stage." (another quote from an article about the *Online Project* of the institution) It still remains?

23. An analysis and / or evaluation of the use made of *Moodle* in all campuses of the country was made? How and why?

24. Sometime after the beginning of this project what is your opinion about Moodle?

25. What's your opinion on Distance Education? Does it have a future within this institution? How?

26. What is your assessment of this entire experience (implementation of the *Online Project*)?

9. Attachments

Attachment 1- Forum Guide from Course 2

Teacher's instructions to students of C2 for participation in the forums (translated).

Purpose of the Forum

This is a space for **reflection** and **debate** on the issue of gender relations, more precisely on the fact that 1) human societies in general and in particular of the Portuguese society, are structured by gender relations with a clear male dominance, both material and symbolic, and 2) that male domination is due to anthropological and historical factors rather than natural or biological facts. For this, at first will be discussed the following **theoretical aspects** (see bibliography):

1. Sex / Gender
2. Socialization and differentiation of Male and Female
3. The universality of male dominance
4. Material domination / symbolic domination
5. The "Differential valence between the sexes" (F. Héritier)

Secondly, we will try to discuss the **situation in Portugal in particular**.

Practical organization of the Forum

- The Forum will take place in two phases, 1st the Forum 1 will be devoted to a discussion of the theoretical aspects mentioned above. In the 2nd stage (Fórum2), in light of the theoretical aspects discussed in Forum 1, we will reflect / discuss the situation in Portugal. The Fórum1 will begin on Wednesday, 15/12/2010 at 14h and end on 21-12-2010 at 24h. The Fórum2 will begin on Wednesday, 01/05/2011 at 9am and close at 1/11/2011 at 24h.

- Both in the 1st and in the 2nd Forum, each student may intervene a maximum of 3 times.

- Any intervention that does not respect the rules of the Forum, both in terms of general ethics and in terms of the specificity of the issues discussed will lead to its immediate deletion of the Forum and therefore a negative evaluation.

- Interventions should be personal. Any information used without mentioning clearly the source will result in the immediate exclusion of the Forum and therefore a negative evaluation.

Dynamics of the Forum

In Forum 1, what is being requested is that on the basis of specific Bibliography and personal search, students share with colleagues a theoretical clarification of the items discussed, namely:

1 - Distinction between Sex and Gender;

2 - The role of culture (socialization) in the construction of the identity of Gender;

3 - Universality of male domination;

4 - The two strands of male domination: material domination and symbolic domination;

5 - Understand the thesis of "Differential valence between the sexes" according to F. Héritier.

Assessment of Participation

Both the 1st and the 2nd Forum, the interventions will be evaluated.

In the 1st Forum, the valued aspects in interventions are: 1) **consistency**, 2) **relevance**, 3) **clarity and cohesion,** 4) **personal position concerning assistance from other participants in the Forum**.

In the 2nd Forum, valued aspects are 1) **Relevance and consistency of personal reflection** 2) **Relevance of comments regarding the reflections of other participants**.

In the 1st Forum, interventions must be:

1) **Brief** (where possible) and **not repetitive**
2) a) **Focus on one of the items listed in *Dynamics of the Forum*** or b) a **particular aspect** of it, or c) **make connections** between different items, or specific aspects of it or d) **bring new contribution**s, but always referring duly sources

In the 2nd Forum, interventions should seek to **present and defend by argument, the personal positions, and / or discuss the positions of other participants**.

PS The operating rules of practice and organization of the Forum may be modified if circumstances change.

Of course the students will be advised in advance.

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In order to give a timely feed-back, the quotation system will be as follows:

E: Negative Intervention negative

D: Intervention not relevant

C: Intervention relevant

B: Intervention very relevant

A: Excellent Intervention

Only the intervention of type A, B, C, and E are indicated. The D type interventions are marked by default, this is, for lack of any indication.

At the end of the forum, on the basis of the qualitative quotation, quantitative assessment will be made on a scale of 20.

</div>

Print screen of software *SNAPP* used for extracting matrices from the courses forums for SNA.
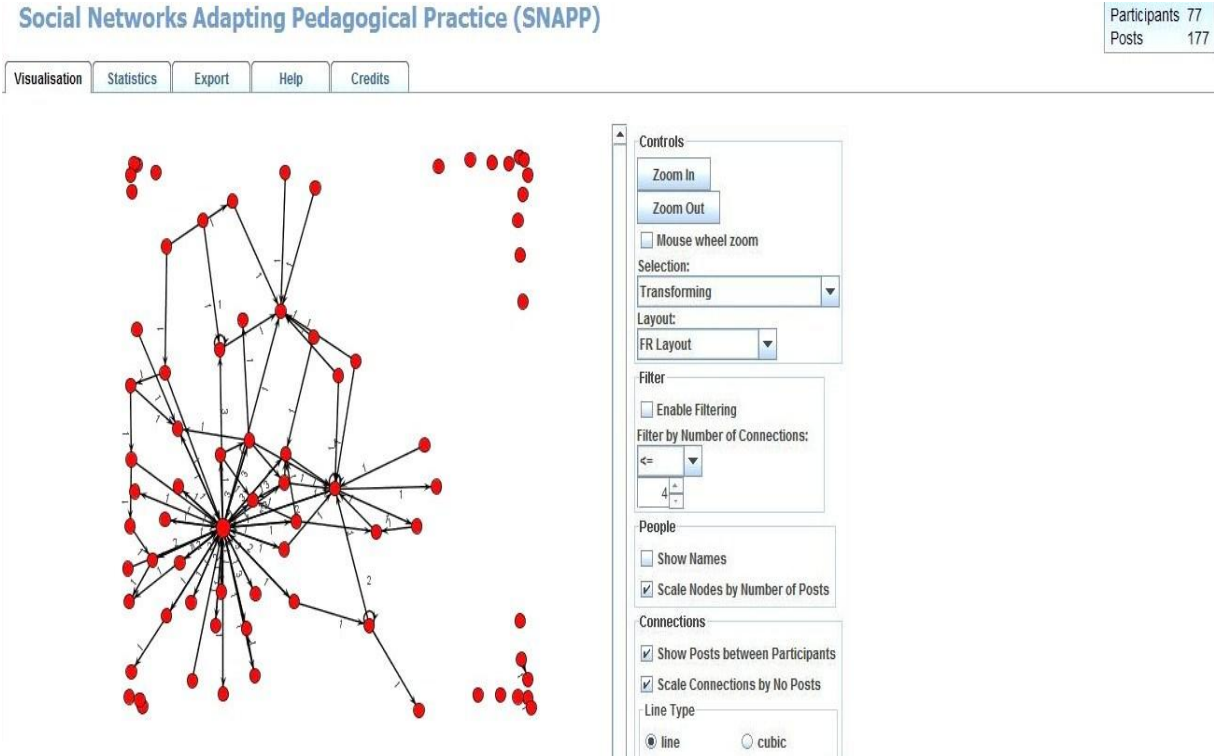
Print screen of software *UCINET* used for SNA.
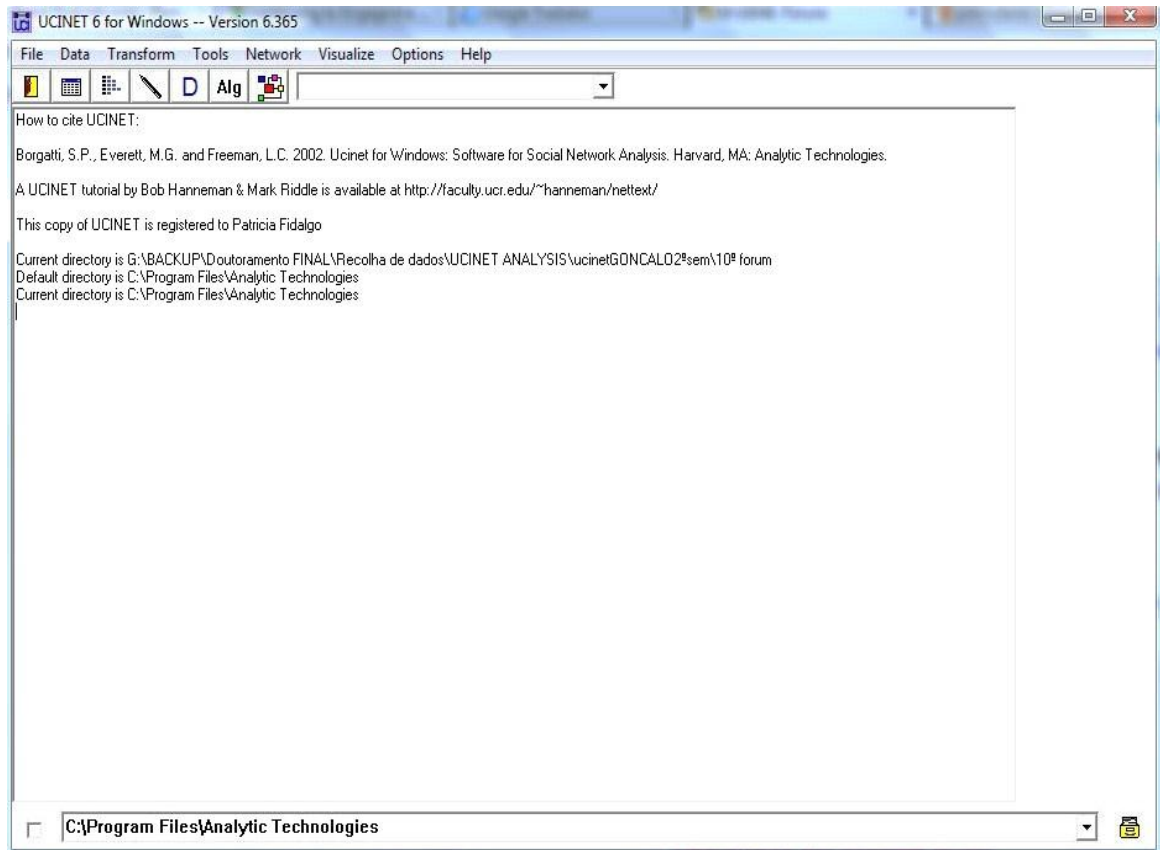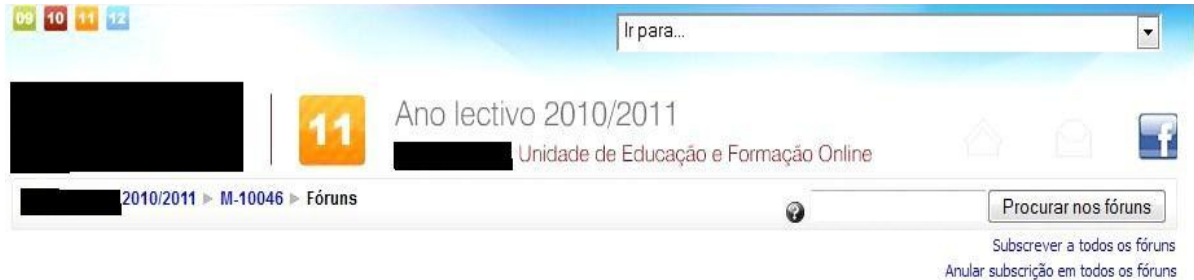
Print screen of software *NetDraw* used to make the networks graphs.
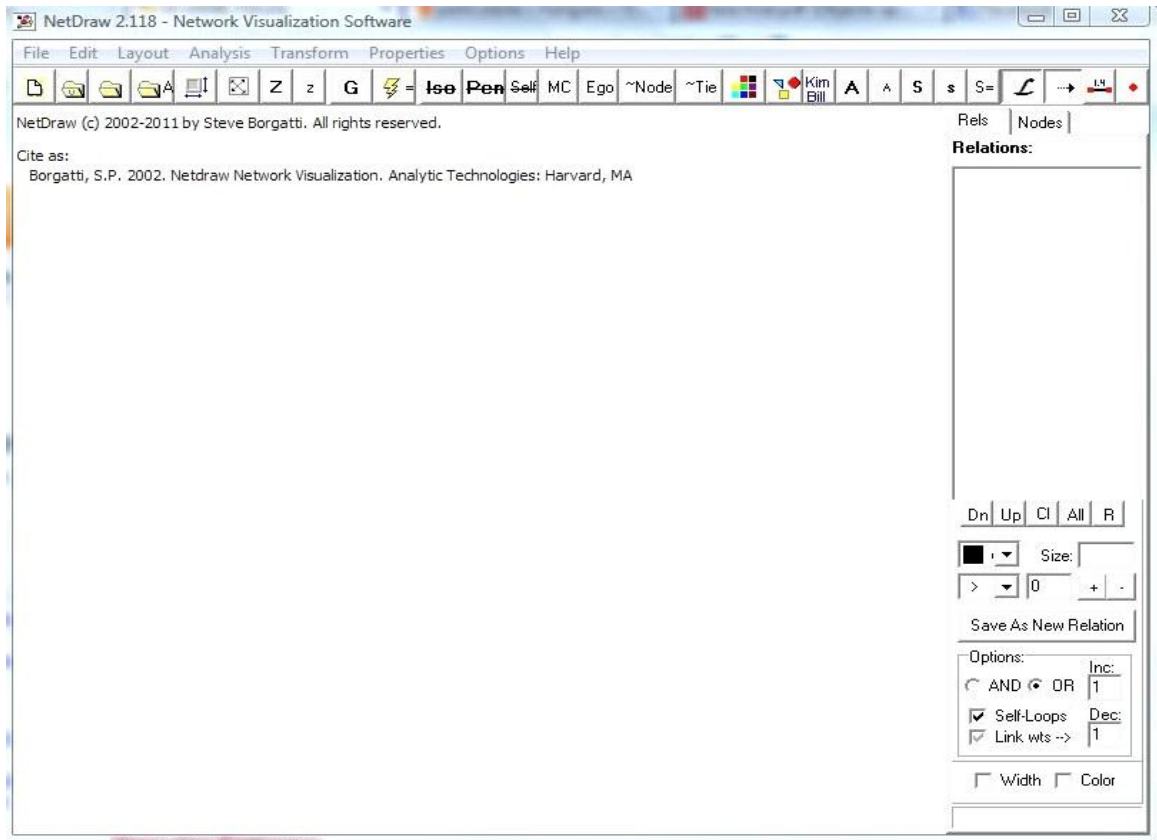
Print screen of an example of the forums page from one of the courses (all elements which were likely to identify the institution have been hidden).