Impact of Social Network Analysis In E-Learning

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Abstract: *E-learning occupies an increasingly prominent place in education. It provides the learner with a rich virtual network where he or she can exchange ideas and information and create synergies through interactions with other members of the network, whether fellow learners or teachers. Social network analysis (SNA) has proven extremely powerful at describing and analysing network behaviours in business, economics and medicine, but its application to e-learning has been relatively limited. This thesis presents a case study on analyzing students' participation level within modules from a Learning Management System (LMS) by inspecting the discussion forums . It studies levels of participation of students as well as the patterns of interactions formed by students, teachers, and tutors. These are investigated from a Social Network Analysis (SNA) viewpoint .This systematic review of the literature on SNA in e-learning aimed to assess the evidence for using SNA as a way to understand and improve e-learning systems. Most of the courses by higher learning institutions use LMSs. LMSs provide a number of communication services such as discussion forums, wikis, messages, and chats. These can enhance the interactive social nature of learning by communication and collaboration between students.*

Keywords - *SNA ,E-learning SNA measures for E-Learning.*

Objectives of the Study

1.To assess whether the application of SNA to e-learning is increasing and explore how these studies have been cited.

2. To identify what research questions about e-learning have been addressed using SNA,
What SNA measures and network characteristics have been studied most often and what insights we have gained.

3. To identify gaps in the SNA literature on e-learning and suggest directions for future research.

4. How useful is SNA as an analytical tool for studying relations within learning environments?

RESEARCH METHODOLOGY

The research was planned and developed according to the following steps: state the problem, review the literature, develop study objectives , develop study methodology, collect the data and analyse the data. First the literature on e-learning was systematically reviewed, identifying 37 studies. The result from this phase of research were published in Cela et al.(2015).

Methods of Data Collection:

The most suitable method to collect data for analysis in a learning context is the learning systems themselves. These systems capture a wide range of students' information, from personal information, to their interactions within the course, as well as their data such as grades, forums posts, and wikis entries. The present study was based on Secondary Data.

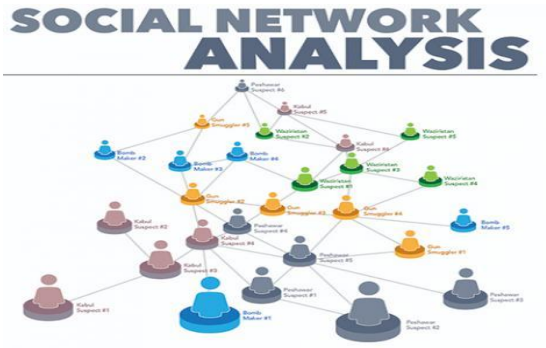
Data was collected with the help of:

- **LMS**
- **Moodle**

INTRODUCTION

Social network analysis [SNA] is the mapping and measuring of relationships and flows between people, groups, organizations, computers, URLs, and other connected information/knowledge entities. The nodes in the network are the people and groups while the links show relationships or flows between the nodes. SNA provides both a visual and a mathematical analysis of human relationships. It has generated graphic and mathematical methods of representing human interactions in a social network .Relationships between nodes, which can be persons, communities, countries, agencies and companies, are represented graphically, while interactions between actors are represented as paths between nodes (Scott 2000). These relationships can be of many types, such as economic, relational, motivational, communicational, emotional and

family based. SNA has been applied to a variety of fields in order to examine the number and characteristics of relationships between actors or elements. One such field is education. SNA may be particularly well-suited to studying e-learning.

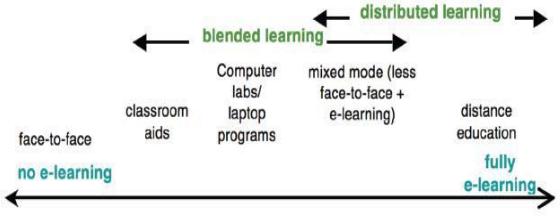


Social network analysis approach allow understanding the dynamics between students in the classroom or environment through studying the extracted social networks. The idea is to represent the social network of specific courses within the LMS where the course is represented as a social network of students and their connections. This could answer questions such as: how active are students within the course? How students tend to work collaboratively in smaller groups i.e. communities? The social network approach provides a tool to extract useful and meaningful information from large volumes of data produced from students' interactions within the LMS.

This thesis focuses on studying the social relations in courses within LMS. Morespecifically studying students' participation level within courses and the interaction
levels among learning activities within the courses. Studying and analyzing participation level within learning activities influence many aspects in learning process such as learning outcomes, knowledge acquiring levels among students in the course.

I. E-learning

E-learning encloses all the educational scenarios based on the applications of Information. Communication Technology (ICT). One definition of e-learning is to describe a number of technologies and methods that can be applied to deliver courses and exercises in an electronic format The new definition of the Web, marked by the introduction of Web 2.0 applications, has a great effect on learning and educational uses. Web 2.0 has integrated social software applications, i.e. blogs, wikis, and online sharing applications into learning environments. This encourages the collaboration, cooperation, and interaction among learners. Since 2004, Web 2.0 has brought a new perception of the use of web, which highly empowers learners through giving them more possibilities of online services. This changed the role of learners and stopped being passive, only receiving learning material, but being more active and creators for learning material that are compatible with their own learning styles .As stated previously, these technological development have greatly affecting teaching approaches. Especially, these new approaches represent new relation between teachers and their students, characterized by high interactions and sharing ideas. In the literature, several learning approaches were defined, including: traditional learning (i.e. face-to-face), e-learning, blended learning, mobile learning, and personalized learning.



II. Collaborative Learning

Modern education aims to prepare citizens able to live in diverse, multicultural and connected world(Lehtinen,Hakkaaraeinen,1999). The constant interaction of persons and technology has made collaboration a core competency(Laal & Ghodsi,2012), leading to prominent role for collaborative in current educational trends. Collaborative learning is defined as an educational approach that involves groups of learners working together in order to accomplish a task or activity. It is based on idea that learning is a social act and occurs as a result of learner interactions.

Defining the Focus of the Review

Our review of SNA approaches to e-learning was motivated by the widespread use of e-learning because of its advantages for learners and teachers, including global access, self-paced learning, multimedia learning and enhancement of Internet and computer skills (Nichols 2003; Mason and Rennie 2006; Keegan 2002). At the same time, SNA shows potential for advancing e-learning in the same way that it has advanced fields as diverse as computer science (Pham et al. 2011), behavioural science (Hurd et al. 1981; Brenner et al. 1989; Haines et al. 2010), biomedical and life sciences (Kasper and Voelkl 2009; Lusseau 2006; James et al. 2009), business and economics (Prell et al. 2008; TerWal and Boschma 2008; Retzer et al. 2012), and face-to-face learning (Carolan and Natriello 2005; Pittinsky and Carolan 2008)

Main Ideas of Web 2.0
The main ideas behind Web 2.0 is summarized by six items in the study by Anderson
(Anderson, 2007). They are:
(1) "user generated content,
(2) the wisdom of the crowds,
(3) the long tail in learning
(4) architecture of participation,
(5) network effects, and
(6) openness."

The older static websites do not depend in their success on the largest number of users accessing them. These websites offer the same material since they are static websites. On the other hand, Web 2.0 sites take advantage from users feedback and frequent access to the website. These websites use the previously mentioned information to modify and update their content and the presented information. For example: Amazon5 and Wikipedia6 (Anderson, 2007).

1. www.facebook.com
2. http://del.icio.us
3. www.youtube.com
4. www.flicker.com
5. www.amazon.com
6. www.wikipedia.org.

One of the objectives of this systematic review was to assess whether the application of SNA to e-learning is increasing and to explore how such studies have been cited. Based on our final sample of 37 articles, it appears that such studies are being published with increasing frequency (Fig. 2). During the 7-year period of 1999– 2005, only 9 studies were published, whereas 13 were published during the 4-year period of 2006–2009, followed by 15 during the 3-year period of 2010–2012. Although the number of studies published per year has fallen over the last 3 years, with seven studies in 2010 giving way to three in 2011 and five in 2012, the overall trend seems to be that the number of studies applying SNA to e-learning is increasing

Table 1 Key characteristics of selected papers presented in full in the Appendix

ID	ID number assigned to paper
Bibliographic reference	Authors and year of publication.
Theoretical approach	The theory or theories on which the study was based
Method of analysis	Methodologies applied together with SNA in the study
Sample Size	The number of participants (nodes) in the study.

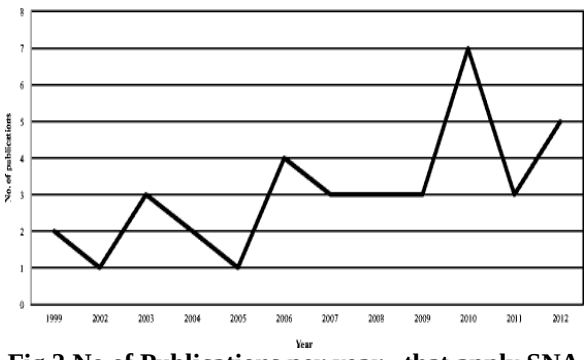


Fig.2 No of Publications per year that apply SNA to e-learning

III. E-Learning Research Topics Analysed by SNA

Analysis of the research topics in the included studies can help us understand the range of e-learning problems to which SNA has been applied. We identified three major topics: (1)evaluation and/or implementation of SNA software tools, (2) identification and analysis of interaction patterns and (3) improvement of e -learning design.

1. Evaluation and/or implementation of SNA software tools: studies in this group focused on implementation of software tools to analyse networks using SNA methods. Studies in this category: [S8], [S26], [S30], [S32], [S34].

2. Analysis of interaction patterns: studies in this group examined patterns of interaction between nodes. This category included several subtopics:
2.1 Patterns of interaction in information sharing [S3].
2.2 Patterns of communication in collaborative learning [S2, S5, S12, S16, S23, S37].
2.3 Patterns of interaction in communicational activities: micro blogging [S33], wiki
[S21], chat [S29] and forum discussions [S7, S9, S25, S28, S31].
2.4 Patterns of interaction in construction of knowledge [S1, S13, S36].
2.5 Patterns of interaction during activity or task completion [S19].
3. Improvement of learning design. This category included the following subtopics:
3.1 Learning environment [S17].
3.2 Social learning [S24].
3.3 Design of discussions [S35].
3.4 Roles of students [S4, S6, S10, S11, S15, S20, S22] and teachers [S18].
3.5 Identifying motivations for contributing to the network [S27].
3.6 Learning performance [S14].

IV. Network Characteristics and SNA Measures Applied to E-Learning

Database and Data Collection Approaches

This study is taking place within the LMS at TU Berlin, a Moodle is called ISIS. Moodle is a good example for studying activities taking place within learning environments. Moodle keeps a detailed logs of all activities that students participate in. Moodle usually stores its log data in a relational database. LMS log files are the most promising source of automatically gathered online learning data. These logs consist of information of all events performed by Moodle's users, such as communicating in forums and chats, reading study materials or blogs, taking tests or quizzes etc. The users of this LMS are students, tutors, teachers, and administrators which interact among each other and with the learning materials under course boundaries (Romero et al., 2008). The objective of this study is to investigate students' activities in ISIS and to discover the hidden social network created from groups of students with similar patterns of behavior.

Study Selection To be included in this systematic review, studies had to fulfil the following inclusion criteria:
(1) they used SNA method(s) to analyse e-learning environment(s), (2) they were published in English and (3) they were published in an electronic format. Our insistence on the electronic format was based on the assumption that information distributed electronically is likely to be more up- to-date and more widely distributed than print information. We included not only journal articles but also conference reports. The latter are useful because they can give a preliminary overview of research presented in journals (Rosmarakis et al. 2005).
Studies were selected through the following steps:
1. Search literature databases using the search terms.
2. Filter out results based on reading titles and abstracts.
3. Retrieve full text of potentially eligible studies.
4. Filter out results based on reading the full text.

Forum's Network

A discussion forum is an activity module in Moodle (ISIS) where students and teachers can exchange messages/information/messages. Every single post along with who posted it, time of creation, time modified, and message content, is saved in the ISIS database. After forums' information have been extracted through SQL queries, it is inserted into an adjacency matrix that can be further analyzed through UCINET software. Similarly, the generated matrices are imported into NetDraw software to generate the required network sociograms. In order to analyze a forum's network, basic statistics are extracted first, which help to understand the whole basic idea behind the studied courses. Table 6.1 lists the studied courses, the number of students in each course and the semester in which
the course was offered.

Course	Course Name	Students
C-1	Algorithmische und Funktionale Lösung diskreter Probleme [WS 10/11]	231
C-2	Blue Engineering	87
C-3	Methodische und Praktische Grundlagen der Informatik 2 [SS 12]	270
C-4	Algorithmische und Funktionale Lösung diskreter Probleme [WS 10/11]	231
C-5	Semantik und Kalküle	27
C-6	Einführung in die Informatik 1 [WS 12/13]	1176
C-7	HTA Online 2012/2	20
C-8	Agententechnologien in der Forschung [SS 12]	40
C-9	MPGI 5: Datenbanksysteme[SS 12]	300
C-10	Berechenbarkeit und Komplexität [SS 2011]	202
C-11	Berechenbarkeit und Komplexität [SS 2009]	116

Table 6.1: Courses used for analyzing forum's network

SNA Measures

SNA often relies on well-defined measures to provide an important overview of network characteristics (Scott and Carrington 2011; Carolan 2013). For example, power is a fundamental property of networks; generally, actors with more connections enjoy greater power in a relationship network and therefore see a greater proportion of the information flowing through the network (Hanneman and Riddle 2005). The higher a node's centrality degree, the greater its access to information resources or peers in the network, i.e. the greater its power and popularity. Degree centrality computes and identifies the node's importance and influence within the network. Degree centrality measures is divided into two types based on the type relations of the network. For directed networks, there are two degree centrality types in-degree and out-degree. In-degree centrality represents the incoming connections and measures the node's importance or popularity in the network. On the other hand, out-degree centrality represents the outgoing connections and it measures the node's influence or power in the network .

Closeness is a centrality measure of how quickly one actor can access another. Closeness varies inversely with centrality: small closeness values indicate greater proximity to other nodes, whereas larger values indicate greater distances from other nodes This type of centrality is related to the distance measure where it computes the distance of one specific node to the rest of nodes within the network. It points out the importance of the node in the network as a whole or in small regions. For example, a node may be central but only in small region where the node has many connections but only in smaller region.. Another SNA measure is density, which indicates the number of relationships actually observed in a network divided by the total number of possible relationships. Density is a quantitative way to capture important sociological characteristics such as cohesion, solidarity
and membership (Wasserman and Faust 1994).

SNA Software

In order to understand how researchers have applied SNA to problems in e-learning, we examined which software programs they have used. Our intention was simply to examine trends in software usage, not to promote particular software packages. Of the 37 studies, 23 used existing software tools: UCINET (S3, S4, S11, S15, S16, S17, S18, S20, S21, S23, S24, S27, S35 and S36), GEPHI (S9), GRAPHVIZ (S5), Krackplot (S12), NETMINER (S1, S10 and S13), PAJEK (S28), SAMSA (S22) and SIENA (S32). In another five studies, researchers created their own tools to allow fully customised analysis (S8, S26, S30, S32 and S34). The remaining nine studies did not describe the software systems used (S14, S19, S31, S6, S7, S29, S37, S2 and S25). The custom-designed programs used in the studies in our systematic review rely on a variety of tools, yet all are based on SNA methods. Lin and Chen (2004), for instance, prototyped a system for analysing virtual tasks performed by teams. The system identifies the relationships among the members and quantifies their strength. Rabbany et al. (2012) developed SNA software that assesses the participation of students in asynchronous discussion
forums in online courses. Teplovs et al. (2011) proposed an SNA software tool that assesses user activity in the network, as well as extracts terms used in learner discussions and quantifies their frequency of use. Saltz et al. (2004) created a software tool that visualises a network and analyses its characteristics. Spadavecchia and Giovannella (2010) described a software tool for evaluating and monitoring learning processes using a combination of SNA and CA.

V. CONCLUSIONS

This Study Investigated The Potential Of Using Social Network Analysis In Monitoring Online Collaborative Learning, Finding Gaps And Pitfalls In Application, And The Possibility Of Guiding An Informed Intervention. The Objective Of This Study Was To Present Information That Could Be Useful For The Teachers About The Students' Performance, Actions, And Interactions Within The Course. Sna-based Visualization Helped To Analyze Thousands Of Discussion Posts. The Automated Sna Visual Analysis Was Quick To Produce, Updated In Instantly, And Was Easy To Interpret. The Combination Of Visual Analysis And Quantitative Analysis Enabled Us To Using Social Network Analysis To Monitor And Guide Improvement In Online Collaborative Learning Plos One | Https://doi.org/10.1371/journal.pone.0194777 March 22,2018 18 / 22 Identify A Non-collaborative Teacher-centered Pattern Of Interactions In The Three Courses Studied, Very Few Interactions Among Students, And Limited Information Exchange Or Negotiation. Students' Network Of Information Exchange Was Very Limited And Dominated By The Teacher. The Information Derived From The Monitoring Enabled Us To Design A Relevant Data-driven Intervention, And Assess Its Efficacy Using Experimental, Observational, Repeated-measurement Design. The Intervention Was Able To Significantly Enhance Student-student Interactions And Teacher-student Interactions, Improve Information Exchange, Group Cohesion As Well As Achieve A Collaborative Pattern Of Interactions Among Students And Teachers. Since Efficient, Communicative Activities Are An Essential Prerequisite For Successful Content Discussion And The Realization Of The Goals Of Collaboration, We Assume That Our Sna-based Approach Can

Positively Affect Teaching And Learning In Many Educational Domains.

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