A Community of Practice for the Development of Teachers' TEL Skills: A Social Network Analysis Perspective

C. Limongelli[1] and F. Sciarrone[1]and A. Sterbini[2]and M. Temperini[2]

[1] Roma3 University, Rome, Italy
{limongel, sciarro}@ing.uniroma3.it
[2] Sapienza University, Rome, Italy
marte@diag.uniroma1.it, sterbini@di.uniroma1.it

Abstract. Teacher's, at all levels, are confronted daily with the need to acquire, refine, and apply their skills in Technology Enhanced Learning. It is since many years that professional development initiatives for teachers, and adoption of technology-based tools, have been undertaken to foster new ways of teaching; yet much is still needed, as the recent needs for distance learning, in countries where the schools and universities were closed for social health reasons, has revealed quite dramatically. In this paper we describe an experiment of use of a Community of Practice (CoP), where teachers of different disciplines participated, with the aim to 1) get in contact with technologies of relatively easy adoption, and 2) interact with colleagues, to discuss with and learn from them. The experiment was conducted within the framework of a EU project aiming to bridge the gap between teachers and pupils in the use of the Web technologies. The CoP was designed based on the foundational Wenger's concepts of domain, community, and practice. It supported an educational program on Web2.0 educational technologies for Vocational Education teachers. We present a discussion of the social aspects of the CoP dynamics, using evaluation metrics coming from the Social Network Analysis research area.

Keywords: Technology Enhanced Learning; Community of Practice; Vocational Education.

1 Introduction

Teacher's, at all levels, are confronted daily with the need to acquire, refine, and apply, their skills in Technology Enhanced Learning (TEL). It is since many years that professional development initiatives for teachers, and adoption of technology-based tools have been undertaken to foster new ways of teaching; yet much is still needed, as the recent emergency application of distance learning, in countries where the schools and universities were closed for social health reasons, has revealed quite dramatically. In this paper we recall and describe an experiment of use of a Community of Practice (CoP) where teachers of widely different disciplines participated, with the aim to get in

contact with technologies of relatively easy adoption, and to interact with colleagues, with which to discuss, and from which to learn.

CoPs can be interpreted as vertical evolutions of Social Networks (SN), where members share a common interest in a particular domain or area, and exchange practical experiences, to increase knowledge and skills related to that specific field (Wenger, 2010). CoPs are not in principle dependent on the use of the Internet, and yet their usefulness and spread is significantly boosted by the use of network technology and Web-based communication tools. In terms of usefulness, CoPs are known to be effective in supporting the learning and development in professional learning communities. It is generally agreed that a significant part of knowledge, protocols, strategies and rules of a professional activity may remain only partially covered, hidden, or just implicit, in traditional educational activities: the mutual engagement fostered by the participation in a CoP can ease this problem, for instance by the construction and sharing of a "collective meaning in the daily routines in the work place" (Wennergren Blossing, 2017). Other topics in skills development through TEL are broadly discussed in (Visvizi et al., 2019) and (Visvizi et al., 2020).

In this paper we present some evaluation aspects of an experiment carried out within the framework of the European project UnderstandIT[1]. The experiment involved the use of a CoP (UnderstandIT[2]) providing an educational program on Web2.0 Technologies for education, dedicated to Vocational Education and Training (VET) teachers. Technical information and best practices were presented, about how to use some Web 2.0 tools and systems for the development and administering of educational activities pertaining everyday teaching activity. Typical generic tools were discussed (forum, blog, chat and wiki), as the main methods for interaction between participants. Several tools and systems, available through the Web, were also presented and experimented (such as tools to easily develop multimedia resources, systems to manage personal e-portfolio, tools for the self-evaluation of technological skills, web sites on teaching methods and theories). The underlying assumption of the project was that the use of these tools can make teaching more effective, and their knowledge by the "digital immigrants" (the teachers) can let them meet productively the "digital natives" (the students) on the common ground, languages, and services of the modern Web Tools (Prensky, 2001). The UnderstandIT CoP was designed based on the concepts of domain, community and practice (Wenger, 1998). The domain of shared competence addressed here is the teaching activity for VET education; the community members are VET teachers while the practice is the use of the Web 2.0 tools during teaching activities. We used the open source ELGG social network engine[3] as the technological platform.

The evaluation of the UnderstandIT CoP is based on techniques and concepts coming from Social Network Analysis (SNA): we use some centrality measures such as betweeness, centrality, and closeness, in order to gather more information about the network dynamics.

[1] http://aitel.ist.no/understandit/
[2] http://understandit.di.uniroma1.it/
[3] https://elgg.org/

After the description of some related work and background, done in Sec.2, we present the UnderstandIT CoP implementation in Sec. 3, and its actual use (Sec. 4). Sec.5, then, shows the use of SNA means to describe the CoP dynamics. In Sec. 6 we provide some further discussion and concluding remarks.

2 Related Work

The concept of CoP has started developing in the world of enterprises, as a mean to effectively engage senior and junior members into professional development, also by the use of mentoring. CoPs are based on the consideration of Learning as a social activity in the first place, to be fostered in the framework of a social network of individuals, where overlapping personal universes of knowledge, values, and practical experience are communicated, compared, shared, and developed by personal and social exchange (Wenger, 2010).

Initially Lave and Wenger defined a theory of learning based on practice, where the core concept is the Legitimate Peripheral Participation in CoPs (Lave & Wenger, 1991). The novices firstly access the community from the periphery. They acquire experience though the support of more experienced members, and gain reputation also as a consequence of the support that they in turn are able to provide to companions. In this way, they finally achieve full participation and membership. Self-development originates by active participation to the community, and the community develops together with its members. Knowledge is acquired from and applied back to everyday real settings, while discussing it with peers and experts in a rich social system (Wenger, 1998).

CoPs have raised a lot of interest among TEL researchers in the last 2 decades. In (Buysse, 2003) the authors underline *the growing need to integrate educational research and practice* in order to connect what we know with what we do. The risk of failing to promote personal exploration and responsibility by participating must be countered by the CoP, as an entity, and by its members by encouraging and motivating each person to analyse and constructively criticize, so to support the main accomplishment of the network, i.e. allowing mutual complementing of members' experiences and knowledge.

The SEDA project (Nixon & Brown, 2013) proposes a CoP to support members working in higher education institutions. It is an environment where educational developers can highlight their needs and fruitfully share their experiences. The spirit of the SEDA project is the mutual support provided by the members of the community.

The UnderstandIT project is a Leonardo da Vinci - Transfer of Innovation project, supported by the EU under the Lifelong Learning Programme[4]. Its partners were from Germany, Lithuania, Denmark, Italy, Portugal, and Norway. The project aimed to include ICT in the competences of VET teachers, trainers and tutors. The project activities went through the design, implementation and experimentation of a course dedicated to VET and general High School teachers, and directed to the development of abilities regarding the use of Web2.0 tools and methodologies to attract and motivate students,

[4] project number: 2010-1-NO1-LEO05-01839, http://aitel.hist.no/understandit

and to enhance the overall learning experience. Four courses (localized to fur partners' country languages) were provided through dedicated CoPs. Each course was articulated in nine lessons, organized in the structure of a "group" of the UnderstandIT Community of practice. The course activities were designed to provide the teachers with the pedagogic concepts related to the use of technology for education, and with ample opportunities to use tools to implement their course works. This was accompanied by the CoP related activities, related to discussion and exchange of knowledge and opinions. The teachers were also exposed to concepts related to coaching, as they were supposed to spread in their school the proceedings of the course afterwards.

(Kirkby et al., 2018) presents a CoP dedicated to early childhood teachers. Besides the support to development of professional skills, and stakeholders' engagement (such as parents), the benefits of the use of a CoP are shown also in terms of how social interaction allowed to support the teachers each other, elicited self-reflection of one's professional identity, and ultimately allowed to meet with challenging professional occurrences at the workplace with greater success.

In (de Carvalho-Filho et al., 2020) the social, collaborative nature of a CoP is stressed as a factor providing the participants with the opportunity of co-creating solutions to practical problems. The paper provides tips about the implementation of a CoP, that can be of general use, although the focus is on CoP's suitability for the collaborative development of best practices in Health professions.

About SNA, it is useful here to recall that it deals with the analysis of social networks in order to trace the relationships holding among members, learn their meanings and apply such findings to better understand the dynamics of members, and groups interactions.

A Social Network can be rendered as a directed or undirected graph, where 1) the actors are represented by the nodes, 2) the relationships among the actors are indicated by the graph's edges, and 3) weights can be assigned to the edges between nodes, to designate different interactions strengths (Wassermann & Faust, 1994; Zhang, 2010; Marin & Wellman, 2010).

Because of this representability of SN as graph, SNA borrows many concepts and tools from the graph theory. In Sec. 5 we will analyse the dynamics of the UnderstandIT CoP and visualize them by means of the *Gephi* graph tool[5], an open source tool useful for SNA (Bastian et al., 2009). Several metrics and operations are defined to allow for such an analysis (Hussain, 2010; Zhang, 2010), such as *Size* and *Density* (related to the amount of interaction), *Clique detection* (which is essential to see how the members group in *sub-communities*), and several declinations of the concept of *centrality*, which represents the importance, and presence, of a member in the network alongside the others. *Degree* centrality measures the number of interactions that a node (member) has with the others, possibly its popularity; *Betweenness* centrality says how a node is important as a connector for other nodes, so fostering exchanges among members; *Closeness* centrality, based on shortest path computations, provides an evaluation of how information can spread more or less quickly from certain nodes towards the others. Besides these, several other useful information can be extracted from the log files of a

[5] http://www.gephi.org

social network, and of a CoP: They can allow to comprehend the existing ways of interactions, and possibly help acting to make them more fruitful (Slaninova et al., 2010).

3 The CoP Web Application

The design of the system started from the requirement analysis, based on an input coming from a sample of VET teachers to identify a list of useful features to deploy:

- Groups common goals sharing, and shared editing tools;
- Friends, groups, stream of interactions and event calendar and RSS feed import;
- Antispam protection;
- FAQ managing;
- Activities sharing among friends;
- Embedding external contents;
- Tracking changes/hot topics;
- Communication: Sync. (chat) and async. (blog, comment, tweet, forum).

Then we selected the ELGG framework. ELGG is a LAMP (Linux, Apache, MYSQL, Php) web application that provides a basic set of services for a social network system, allowing for a complete interface configuration and extension of the functionalities (by adding plug-ins that are either newly implemented or selected among the many already available from the ELGG development community). Finally, the system was customized and deployed.

Members share and exchange knowledge by operations such as adding a new bookmark, posting a link to a particular video, publishing new pages and so on.

Other members might feel the need to access, comment, modify, spread, the knowledge shared by other members, so, among the several features offered by a social networking platform, the setting of access rights associated to each contributed resource, is relevant. In particular, the author of a contributed resource can specify a group (a class of users) to whom allow either read access or read and write access rights on the resource.

The group is a subset of CoP members. The following group specifications are available: *Everybody*, *Members*, *Group*, *Your friends*, *A subset of your friends*, *Private*. Depending on the write access rights of a post, the contributed contents can be edited asynchronously by different users. Each post in the system can be tagged by the author, i.e., it can be associated with one or more keywords. This allows for searching through the system resources by both full text and tag-based selection.

Another characteristic of the system is that the UnderstandIT CoP was configured in such a way to allow for discussions in several language-specific communities, with a common discussion space in English. This feature was implemented through the concept of *Group* managed in ELGG, where a Group is a subset of all the CoP members that is owned by a member and can be moderated. From an operative viewpoint, each group represents a (sub-)community whose members can interact through:

- Group Blog posts, Group Bookmarks, and files and Group pages;

- Embedding videos/podcasts and RSS feeds in posts, and uploading files (File Tool);
- Embedding external content by reference through the Media Tool;
- Commenting on posted resources (files, media, bookmarks and blogs);
- Sharing interesting resources through the Bookmarks Tool;
- Monitoring (importing) RSS feeds through the Feed Tool;
- Managing and or participating in Forums and Chats.

To increase support to collaboration, a synchronous shared editing plug-in was installed, based on the Etherpad open source project[6]. Through it, Group members can collaborate editing a document, also being supported by a small chat.

Users are kept updated about the CoP activities either through automatic e-mail notifications or through the CoP web interface. Both the former and the latter collect information from many relevant areas of the network, offering notifications such as:

- E-mail, RSS feeds, status tweets;
- Group activities;
- Last changes in 1) the main CoP's page, 2) the user's dashboard, 3) each Group main page, or 4) in each page's history;
- Contextual tag cloud with information about terms used in the CoP and their location.

Members can report occurrences of spamming, eliciting an intervention from the administrator. The discussions can be externally disseminated towards *Twitter*. The interface is in the languages of the UnderstandIT project partners (Lithuanian, Italian, Portuguese, German, Danish, and English). Cooperation among different language groups is supported by a *Google Translate*-based tool.

4 The UnderstandIT CoP at work

The UnderstandIT CoP was used as a container for an online course deployed adopting peer to peer coaching and mentoring strategies. The course was attended by a sample of 77 teachers, coming from different didactic experiences, as shown in Fig. 1.

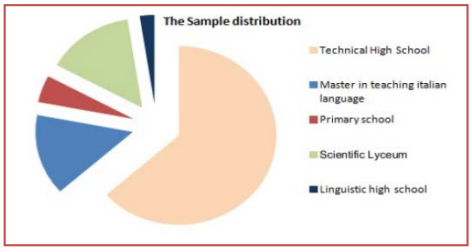

Fig. 1. The sample distribution of the didactic work experiences of the CoP members.

[6] https://etherpad.org/

The course was designed based on 16 Learning Outcomes (LO). The comprehensive LO was: *I can choose relevant resources using the CoP approach for any planned learning activity including ICT-tools where these are the most appropriate and I am able to change my teaching style so to use a more coaching oriented approach.*

The course included several tasks such as:

- Practice with Web 2.0 tools for doing and analyzing one's own teaching;
- Analysis of existing CoPs, SNs, blogs to coach sessions with course tutor and peers;
- Final design of a plan to experiment acquired Los in current teaching activity.

Fig. 2 reports on some data about participation and overall CoP activity in terms of standard metrics. Members have been positively engaged in the CoP life. For instance, about blog activity 90 discussions were managed, with 700 posts.

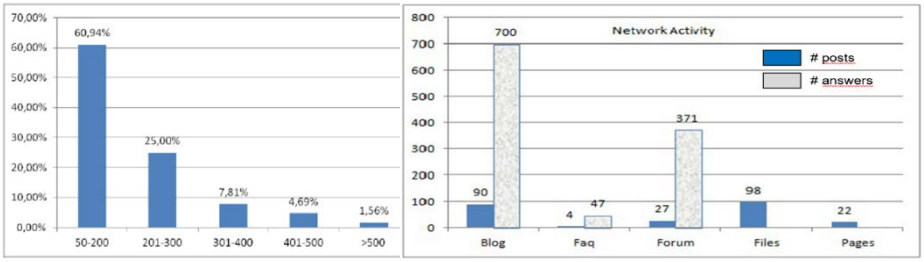

Fig. 2. Member's visits to the web site (left) were about 2000, with an average per member of 31.25. About the overall CoP activity (right), blue bars represent number of posts, while the grey bars represent the number of answers originated by those posts in Forum, Blogs and FAQ.

5 Analysis of the UnderstandIT CoP at work

Among the participants to the experiment, 70% have had already experience in at least one online course, although 71% did not know of CoPs. They had previous experience with some web tools: 79% had been in a Forum, 29% knew of RSS, and blog, chat, podcasting, and wiki, were between the above values. About user satisfaction and perceived success we used a Likert scale, 5 values from lowest assessment to highest, and asked whether 1) the expectations about the course were met, and 2) would the participant feel prepared to be a coach to colleagues on the acquired skills.

To the first question 62% answers were above the neutral (that was 20%): we interpreted this a good result, considering that the members kept participating while continuing to work in their classrooms. The second question had overall 56% of positive answers, with 30% to neutral: we decided to give this question, and not another more generically measuring the personal acquisition of skills, as being a reference point for colleagues seemed the toughest factor to measure the effectiveness of the course, and we interpreted these figures as a good (if not enthusiastic) result.

Then we evaluated the CoP dynamics by means of three main SNA measures in order to appreciate information about the following relationships:

- Friendship relationships (How the members built their list of friends to interact with)
- Participation to group activities;
- Exchange of messages between members, which elicit knowledge sharing.

Fig. 3 presents the Friendship relation extracted by the log data of the CoP. The graph helps seeing how each member builds her/his list of "privileged counterparts". It is easy to spot four sub-communities.

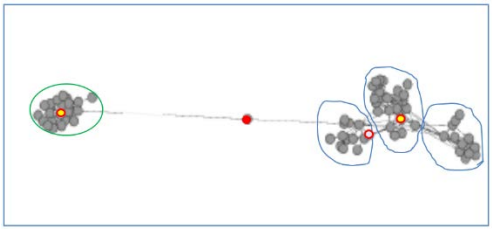

Fig. 3. The Friendship Relationships.

In Fig. 4 the network representing the participation of the community members to social activities is shown. We have again a clear partition in four sub-communities; however, two sub-communities show a good deal on intersection, meaning that several of their members were active in the same groups, and so showing a remarkable commonality of interests.

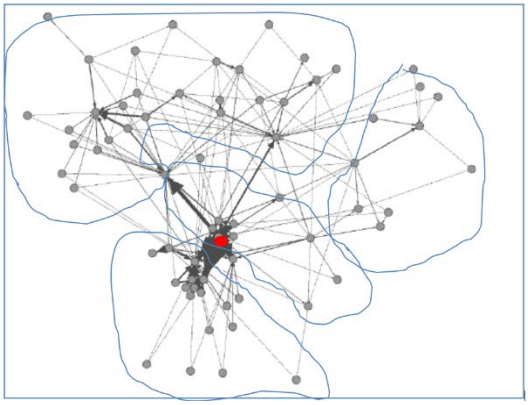

Fig. 4. The development of group activities in the CoP.

Finally, Fig. 5 shows the graph representing the exchange of knowledge among members, after a brief period of the online activities. The graph presents the shape of the message exchanges among members; while it is not surprising, in view of the previous figures, that we see again a partition in four sub-communities, here we can also appreciate how "main" (more "central" in SNA parlance) members are operating in each sub-community, and so how they are in turn relevant with respect to certain topics of interest developed in the whole CoP.

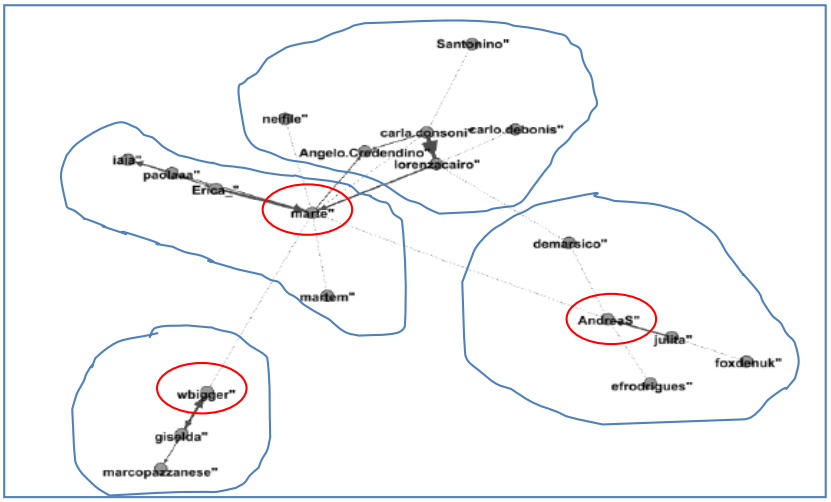

Fig. 5. Knowledge exchange among members.

6 Discussion and Conclusions

TEL studies cover a widespread set of application of information and communication technologies, with educational aims, ranging from more formal and traditional applications (Gasparetti et al. 2018; Limongelli et al. 2012), through less traditional and more social-collaborative instances (De Marsico et al. 2017; Visvizi et al. 2020), to learning experiences making a more wide use of the connecting power of social networks (Limongelli et al. 2015).

In this paper we have presented the design and implementation of the UnderstandIT CoP, the results of using it in an experimental setting, and the application of SNA methods and techniques to this case study.

Through SNA we performed a preliminary structural analysis of the network. We took into consideration the distribution of relationships among all the members involved in the learning process, focussing on the dynamics of such members' relationships.

The analysis of our findings allowed us to evaluate some basic aspects of the interactions occurring through the network. For example, we discovered different sub-communities showing some integrations among all the members in all the activities carried out. We also saw that there are key figures in the information flows between the members.

Our experience showed us that everything, in these communities, happens in the context of a spontaneous flow of information, so, while it is not possible (say, by an administrator of the CoP) to force changes in the pace of communication, several characteristics in the mentioned flow of information can be maintained, in order to make

the members' participation lively and fruitful. An appropriate feeding by the most estimated members (the core of the CoP, i.e., those with higher reputation), a prompt feedback to inquiries, most of all from novice members, and the organization of online events, can maintain the community alive and healthy.

In a worthwhile multi-lingual setting, it would be quite natural that the language dimension should prevail on other aspects, unless appropriate translation services are provided. As a matter of fact, in a future perspective we plan to include keyword translation for multilingual labelling of contents and online translation of pages. On the other hand, a hierarchical inspection of detected clusters and the use of finer measures, or even of the same ones on a restricted set of participants, can help highlighting more covered processes.

References

Bastian M., Heymann S., Jacomy M. (2009). Gephi: an open source software for exploring and manipulating networks. Int. AAAI Conference on Weblogs and Social Media.

Buysse, V., Sparkman, K.L, Wesley, P.W. (2003). Communities of practice: Connecting what we know with what we do. Exceptional Children, 69(3), 263–278.

de Carvalho-Filho, M.A., Tio, R.A., Steinert, I. (2020). Twelve tips for implementing a community of practice for faculty development. Medical Teacher, 42(2), 143-149.

De Marsico, M., Sciarrone, F., Sterbini, A., Temperini, M. (2017). Supporting mediated peer-evaluation to grade answers to open-ended questions. Eurasia Journal of Mathematics, Science and Technology Education 13(4), pp. 1085-1106.

Gasparetti, F., De Medio, C., Limongelli, C., Sciarrone, F., Temperini, M. (2018). Prerequisites between learning objects: Automatic extraction based on a machine learning approach. Telematics and Informatics 35(3), pp. 595-610.

Kirkby, J., Walsh, L., Keary, A. (2018). A case study of the generation and benefits of a community of practice and its impact on the professional identity of early childhood teachers. Professional Development in Education, 45 (2), 264-275.

Lave, J., Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge, England: Cambridge University Press.

Limongelli, C., Mosiello, G., Panzieri, S., Sciarrone, F. (2012). Virtual industrial training: Joining innovative interfaces with plant modeling. Proc. Int. Conf. on Information Technology Based Higher Education and Training, ITHET, IEEE.

Limongelli, C., Sciarrone, F., Temperini, M. (2015). A social network-based teacher model to support course construction. Computers in Human Behavior 51(PartB), pp. 1077-1085, Elsevier.

Marin, A., Wellman, B. (2010). Social network analysis: An introduction. In Peter Carrington and John Scott, editors, Handbook of Social Network Analysis. Sage.

Hussain, D.M.A. (2010). Investigation of key-player problem in terrorist networks using bayes conditional probability. In Borko Furht, ed., Handbook of Social Network Technologies, Springer

Nixon, S., Brown, S. (2013). A community of practice in action: Seda as a learning community for educational developers in higher education. Innovations in Education and Teaching International, 50(4), 357–365.

Prensky, M. (2001). Digital Natives, Digital Immigrants. University Press, 9(5).

Slaninova, K., Martinovic, J., Drazdilova, P., Obadi, G., and Snasel, V. (2010). Analysis of social networks extracted from log files. In Borko Furht, ed., Handbook of Social Network Technologies, Springer.

Visvizi, A., Daniela, L. (2019) Technology-Enhanced Learning and the Pursuit of Sustainability. Sustainability. 2019; 11(15):4022. https://doi.org/10.3390/su11154022

Visvizi, A., Daniela, L., Chen, Ch.W. (2020). Beyond the ICT- and sustainability hypes: a case for quality education, Computers in Human Behavior, Vol. 107, June 2020.

Wasserman, S., Faust, K. (1994). Social Network Analysis: Methods and Applica-tions. Cambridge Un. Press.

Wenger, E. (1998). Communities of practice: Learning as a social system. Systems thinker, 9(5), 2–3.

Wenger, E. (2010). Communities of practice and social learning systems: the career of a concept. In C. Blackmore, ed., Social Learning Systems and Communities of Practice, 179–198. The Open University.

Wennergren, A-C, Blossing, U. (2017). Teachers and students together in a professional learning community. Scandinavian Journal of Educational Research, 61(1), 47-59.

Zhang, M. (2010). Social network analysis: History, concepts, and research. In Borko Furht, ed., Handbook of Social Network Technologies, 3–21, Springer.