Social Tools for Networked Learning: Current and Future Research Directions

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Abstract

Whereas the Web 1.0 was mainly driven by static content and web pages linked by hyperlinks, the social web, or Web 2.0, has opened up new ways of connecting to not just resources, but also to people. The connections that are made through the use of Social Media, contribute to a complex, but also promising network of people and resources. In an educational context, this is called a learning network, and both learning networks by themselves and the Social media by which they are constructed require that we rethink the ways we learn, our view on learners, tutors and learning, and the way we support learners and tutors. Numerous opportunities have emerged with the introduction of social media for learning, but so have numerous problems, ranging from awareness issues via (meta-)cognitive limitations and difficulties to affective and motivational problems.

This paper addresses the above issues by providing an overview of the current research we perform. The research we do is based on three themes: Peer support, Learner support and Online Learner Identity. Peer support describes the way peers may help each other through effective and efficient use of a learning network. It uses 1) natural language processing to, for instance, analyse communication between learners, 2) mine learner profiles to adapt to their individual circumstances and identity and 3) social network analysis extended by game theoretic solution concepts to recommend suitable peers for cooperative learning. Learner support focuses on how we may lead the learner through the jungle of learning resources. It uses recommender techniques to filter out unnecessary learning resources and provides concise sets of candidate resources for learning. Finally, Online Learner Identity focuses on rethinking how we construct our online identity, how to analyse such, and how to profit from the differences with offline learning. It may use multi-agent systems technology to simulate the identity of learners and their interaction in a learning network, but also semantic technology to capture the meaning of online learner identities.

The paper also describes the main techniques that we use in our research efforts to enhance networked learning. Furthermore, an overview of current projects within the themes is provided. We conclude that the results of our current research efforts will provide valuable insights to advance further on research and development of social tools for networked learning.

Keywords

Social Media, learning networks, social network analysis, recommender systems, data, multi-agent simulation, e-Learning 2.0.

Introduction

At the outset, the World Wide Web was mainly an information conduit, it allowed people to store and retrieve information. The web as an information storage device grew rapidly, and ever better search engines allowed people to find ever more accurately the information they were looking for. Soon, web users started to realise that the people behind the information were actually more interesting than the information itself. This marked the birth of the social web (as opposed to the information web) or Web 2.0 (as opposed to Web 1.0). Just as search engine technology drove the growth of the information web, the social web's advent is driven by what

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has become known as social software, roughly any software that supports group interaction. Examples are blogs and wikis but at a more technical level also web services and application programming interfaces. Importantly, it is the large and growing variety of social software tools that allows social media to flourish, also in the context of education. The central argument in favour of the integration of social media into learning experiences is that much learning is a social activity, one that occurs in interaction with others.

The online social interactions that affect education and how learners interconnect in that context are best expressed by what are called Learning Networks. In our view, Learning Networks are on-line social networks through which users share knowledge with each other and jointly develop new knowledge. This way, Learning Networks may enrich the experience of formal, school-based learning and form a viable setting for professional development (Sloep & Berlanga, 2011). Although networked learning enjoys an increasing interest, many issues remain open on how nowadays lifelong learners are dealing with existing online social networks and tools, and how these could contribute to their learning.

A number of problems arise when people use the networked approach to assist them in their learning. First, a learner in a network may not be aware of all the resources that are available. Tools like Delicious and Evernote help organizing the information that you as a learner stumble upon, but this may not be everything that you are interested in. Indeed, some tools may recommend new resources, but there may be other resources (for learning), such as individuals that may teach you (tutors), or support you in learning, decision making or spreading information and knowledge (peer support). Particularly, the notion of one-to-one teaching may be solved by creating awareness of prospective tutors in your network.

Second, the above problems may be solved by creating more awareness, but doing so would merely create more, and possibly an abundance of choices. This may lead to information overload (De Choudhury *et al.*, 2008), especially as the (two-mode) network the learners are in, grows. It is relatively easy to manage your social network if you have ten contacts, but most of us have hundreds or thousands of contacts, be it online or offline. We do not imply that not all of these contacts are useful, but we do need a means to filter out unnecessary contacts when required.

Third, people may encounter decision making problems when they have to choose from a set of peers they can learn from. In networked innovation, for instance, people may have a difficulty choosing whom to cooperate with or learn from, due to their cognitive limitations. This phenomenon in decision making was coined by Herbert Simon as bounded rationality (Simon 1982; Colman, 2003).

Fourth, people are in principle self-interested (Kau and Rubin, 1979; Ratner and Miller, 2001), so why should they help someone other than themselves? It takes reciprocal action to have successful cooperation between people. For instance, early research on joint ventures shows that the stability of joint ventures relies on reciprocal acts (Kogut, 1989). In his seminal book, Robert Axelrod (Axelrod, 1984) showed that people are likely to do unto others as they do unto them (tit-for-tat), because this is the most profitable strategy[1]. Thus, when you want to have successful cooperation between learners in a network, you need to motivate both the learner and the tutor. Defection on either side will result in non-optimal learning. (The argument is actually more complex, but for our present purposes, this suffices.)

Fifth, through social media the learner may be put in the centre of a social, and more personal and flexible learning process (Berlanga, Garcia Peñalvo, Sloep, 2010). However, eLearning 2.0, as the use of Web 2.0 for learning purposes is often called, poses a number of challenges (Sloep, 2011). Learners need to shift away from traditional, teacher-led learning strategies and from individual and non-participative approaches towards working collaboratively in social, situated contexts. And by extension, admitting that social media have the potential to foster these skills, it is also worthwhile to explore their potential for developing higher order skills, such as reflection on action, and critical thinking (Wopereis & Sloep, 2010). Also, learners will increasingly take responsibility over crucial instructional functions, as social media challenges the traditional university model of providing education and seeks to replace it with a flexible and open learning approach. The more personal learning environments that thus evolve provide a single access point to services, tools, people and

[1]This is only true when people meet more than once, like in the *iterated Prisoner's Dilemma*. For unique meetings, so-called *one-shot games*, the best strategy is to defect.

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resources, allowing learners much more control of their own learning processes (Bitter-Rijpkema & Verjans, 2011).

Finally, to improve the computer support we offer the learner in a networked learning environment, we need to evaluate and improve the algorithms that help that learner. To evaluate the algorithm, ideally we would need data about the activities that learners perform and evaluate the functioning of the algorithm against that data. But when we have this data at hand, it would be wise to share this with other researchers for them to test their algorithms on. Initiatives such as the TREC (http://trec.nist.gov/), OAEI (http://oaei.ontologymatching.org/), and the NetFlix competition have proven to take their respective fields to a higher level as they promote the reuse and development of algorithms. Hence, opening up and sharing data and algorithms about learning will boost the development of technology-enhanced learning.

This paper takes a step towards solving these issues by presenting our research on social tools to support networked learning. These tools deal with three main themes: peer support, learner support, and online learner identity. Figure 1 shows that different theories and technologies should be considered to develop such tools. Furthermore, the data learners leave behind when using social network tools, such as YouTube, LinkedIn or Wikipedia, is a valuable source for the envisioned tools.

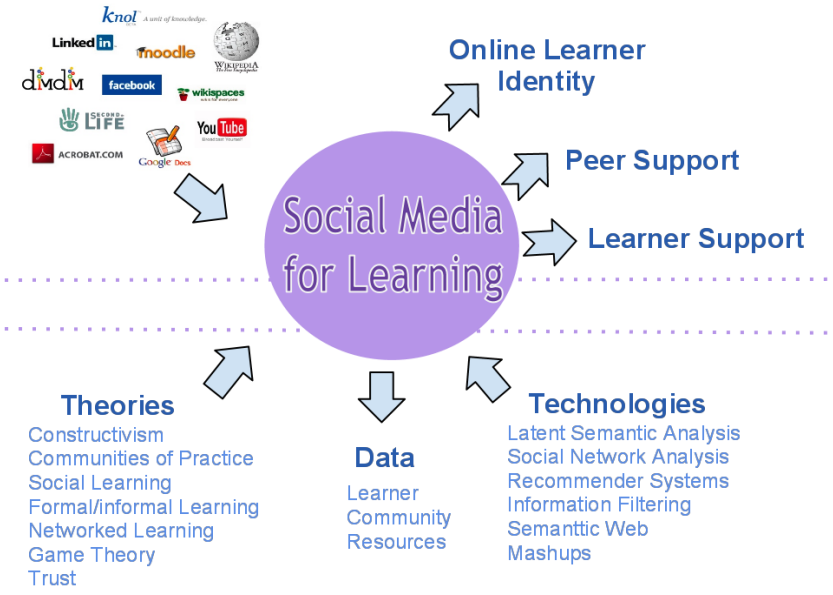

Figure 1: Overview of social tools for networked learning

In the remaining part of this paper, we will describe the theoretical background of these themes. Next, we explain some of the technology that we employ and the problems that we may encounter while using these techniques. Afterwards, we summarize a set of projects that are conducted within these themes. The paper concludes with our final thoughts and outlook.

Peer support

Online learning, e-Learning 2.0, essentially is social learning. This means that peers will often fulfil the needs that arise in the course of their learning, be it the need to have a content question answered, to find relevant learning resources, to discuss a particular topic or indeed to get friendly advice. The number of potential collaborators in online environments is virtually endless, having the important benefit that among those for sure the right person is present. However, this very endlessness brings up the problem of how to find that right person (Sie *et al.*, accepted). Mechanisms that work in the offline world such as your memory of accidental meetings or, more sophisticatedly, your address book do not suffice. Using only people to which you already are strongly linked will ensure that you miss the potentially valuable contributions that people may make to which

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you are only weakly linked or not linked at all (Granovetter, 1973). Software tools are therefore needed that match your specific needs to the people in your learning network who could potentially fulfil those needs.

To be able to make such a match, tools first need to analyse the content of the request for help; second, they need to mine profiles of network users (but see online learner identities); third, they should use efficient and effective rules to make the match to recommend the most suitable peers. All three elements are the subject of ongoing research (De Bakker *et al.*, 2010; Fetter *et al*., 2011; Rajagopal *et al.*, 2011; Sie *et al.*, accepted; Van Rosmalen, 2008).

The main assumptions behind this research are that: (a) when a learner understands her networked learning behaviour, she will adapt her personal learning network into a more supportive environment for her learning, (b) engaging social interactions are triggers for lifelong learners to reflect on their behaviour and practice, and (c) Tools based on network analytics can support learners in monitoring their behaviour and roles in a network.

Learner support

Online learning is no different than offline learning in that it to a significant extent depends on media. Some are more social than others. Books that have been digitized and 'put on the web' are a direct translation of the ordinary books we know and therefore lack a social dimension. However, blog posts, which allow comments and track backs, already are a much more social medium. And finally, synchronous chats the results of which are stored for later use are of course thoroughly social in nature.

To be able to use such media, they need to be accessible. In terms of transaction costs it would be optimal if those media were freely accessible, under some creative commons license (open educational resources or OERs). That way, a learner can access them immediately, without further ado. However, before resources can be accessed at all, they need to be found and retrieved. Finding them is a matter of making a proper match between the learner's learning needs and the content of the resources. This requires the ability to search for and catalogue (on the fly) resources, to analyse learner needs, and match the two to provide recommendations and guidance over resources that best suit learner's needs and preferences. All of this is the topic of ongoing research (Drachsler, 2009; Drachsler et al., 2010, Sie *et al*., 2011).

The main assumptions behind this line of research are that (a) giving insight into the prospective value of peers in a network will enhance learners' performance; (b) personalised recommendations of learning resources will boost learners' performance; and (c) standardised, open datasets will boost the development of algorithms for the learning domain.

Online Learner Identity

Our identity is a complex characteristic, which comprises our beliefs (what we hold true), desires (what we want) and dispositions (what we are capable of). We discover, perform and negotiate this identity through dialogue and in interaction with others (Taylor, 1991; Swan & Bosson, 2008). Interaction through social media and networks provides new possibilities to construct and negotiate these identities (Merchant, 2006). The proliferation of social software has provoked an escalation of online dialogue that translates into tagging, rating, blogging, commenting, liking, connecting or disconnecting, which in turn results in strengthening or weakening of our ties with others (Granovetter, 1973).

Online identities are essential for networked learning, in which people actively and jointly construct their understanding of the world through their interaction with others. Christakis and Fowler (2009) claim that to know *who* we are, we must know *to whom* we are connected in our social network. The influence social networks have on our identity works in two ways: through the structure of the network (connections), and the information, behaviour that it is disseminated throughout the network (social contagion). Unfortunately, fragmentation of online identities occurs, due the large influence that commercial social media sites such as Facebook, Twitter and Google have. These issues are not easily resolved, in spite of ongoing research on them (e.g., Berlanga & Sloep, 2011; Tandukar & Vassileva, 2011; Abel et al., 2010). To tackle this problem we aim to consider those footprints learners leave online that are conducive to their learning. These footprints represent their Online Learner Identity: the desires and beliefs they harbour, the dispositions they have. Through them,

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once provided with the right learning tools, learners would become conscious of how they can best learn online (Berlanga & Sloep, 2011). The assumption is that an Online Learner Identity will (a) foster learner's self-reflection; (b) allow learners to profit from the online realm; and (c) enhance online lifelong learning.

Technologies

This section briefly introduces some of the technology that is used to develop tools and platforms that support the three themes described above.

Social Network Analysis (SNA)

Social network analysis originated in psychology in the 1930s, when Gestalt psychologists such as Moreno made a shift from Freudian psychology to behavioural psychology by trying to model interactions between individuals (Moreno, 1934). In 1973, Mark Granovetter found that people who found a new job, got it through mere acquaintances, rather than family and close friends (Granovetter, 1973). This led him to believe there is strength in weak ties.

Ties in a network can be analysed by mathematical models such as the 'centrality' of an individual. It may tell us how people learn from peers in a network. Whom do they learn from, and why did they choose these people to learn from? Does their position lead to a certain status in the network, or is it the other way around?

Several practical problems may be encountered when we want to apply SNA. First, before we start analysing data, we need to collect the data. Data can be gathered by observing learner interactions in the network. One method is the construction of ego networks: ask the learner for his or her contacts. If we ask for a learner's contacts, whether they are connected, we have an ego network with alters. Another method is the snowball method, in which case we ask learners for their contacts, akin to the ego network, but now we also ask the contacts for their contacts. This process is repeated until a stopping criterion is met (say, no more than three hops away). Finally, we can observe 'real' data (rather than self-reported data), such as Twitter followers, interactions in an online learning environment or email exchange.
We can make sense of learner's network by giving meaning to the relationships between learners, adding semantics. Recent developments suggest the use of semantic web technology in combination with the SNA, to distinguish between several types of networks learners are in, such as friendship networks, work-related networks and family networks (Erétéo *et al.*, 2008).

Recommender Systems (RS)

The invention of the Internet also brought us some unexpected problems. For instance, email spam required appropriate measures to get rid of these unwanted email messages. A collaborative approach to identifying spam, and combining the findings to filter out new spam, a technique called *collaborative filtering* (Goldberg *et al.*, 1992), became the start of a new area of research: Recommender Systems (Resnick & Varian, 1997). Recommender systems advise people about new content that is presented to them, be it movies, web pages, news or indeed spam, based on 1) their previous preferences and 2) people that are similar to them. A good example of a recommender system is the website Amazon.com. At Amazon.com, someone that viewed a book receives recommendations about other books, based on what other viewers of that book viewed. Such recommendation techniques can in principle also be used to filter out unnecessary learning resources that contribute to information overload. Since 2000, there has been extensive research on Recommender Systems in the domain of Technology-Enhanced Learning. Manouselis *et al* provide a comprehensive overview for the TEL domain. (Manouselis *et al.*, 2011).

Multi-Agent Systems (MAS)

In Multi-Agent Systems (MAS), distinct software agents are used to solve problems in a distributed way. Each of the agents has its distinct purpose, and together, they form a collective that can solve problems efficiently and effectively, in a distributed way. Agents are characterized by autonomy, pro-activeness, reactiveness, and social ability (Wooldridge, 1995). Thus, each of the agents has its own way of reasoning and behaving. The added value of having multiple agents is best explained by the proverbs "Two heads are better than one" and "The whole is greater than the sum of its parts". When we combine the reasoning and behaviour of multiple agents, we can exhibit more complex, well-wrought behaviour. We can simulate the behaviour of such agents and use

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the simulation to study social phenomena. Also, we can let agents interact with people, like *intelligent virtual agents* that try to grasp human emotions (Pontier *et al.*, 2010).

In learning sciences, we may use MAS to analyse the behaviour of and interaction among a group of learners. Every individual is unique, and so are learners. If we model each and every learner as a single agent with unique characteristics, we can simulate their interactions and study them without the costs, time, and effort that it takes to study them in real life. Based on such a simulation, we could even model and test a proposed intervention within the simulation before testing it with the learners.

From a practical perspective, we first need to choose the right environment before we can actually model the learner. Some simulation environments may be more useful for modelling interactions between individuals (e.g. Netlogo) (Sie *et al.*, 2010), or others may be more suited to model the reasoning (cognition) of the learner, such as Brahms (Seah *et al.*, 2005) and LEADSTO (Bosse *et al.*, 2005).

More generally, we face the risk of remaining in simulations, rather than putting them to practice, be it running the simulation in real-time, or putting its results to practice. Especially in the domain of learning, a lot can be gained by transforming simulations of learning networks into real-world applications (Van Rosmalen *et al.*, 2008; Vassileva *et al.*, 2003).

Current projects

Table 1 shows an overview of current research projects we do in the themes discussed earlier.

Table 1: overview of current research projects in the themes

Project	Description
CEFcult (peer support)	The CEFcult project aims to promote intercultural professional communication with foreign language users by means of an open source web 2.0 assessment tool. The principal outcome of the project will be an online environment for the assessment of speaking skills and intercultural competence in professional communication (Rajagopal et al., 2011).
TeLLNet (peer support)	The TeLLNet project is to study the eTwinning network (86,000+ teachers) through visualisation techniques, SNA and prospective scenario building exercises. It aims to identify the structures, actors, networks and Communities of practice that are effective in sharing practices, encouraging innovation and creativity at schools (Vuorikari et al., 2011).
Biebkracht (peer support)	Biebkracht is a learning network for librarians. It is intended for staff members of the public libraries in Gelderland, The Netherlands. It strives to create a learning network that (a) will foster knowledge sharing and organizational learning, (b) will enhance creativity, and (c) will foster a common understanding of the issues and developments at hand.
ReMashed (learner support)	ReMashed enables learners to integrate their Web2.0 sources, allowing them to personalise emerging information of a community to their preferences. Learners can rate information of the Web2.0 sources in order to define which contributions of other members they prefer. ReMashed takes the preferences into account to offer tailored recommendations (Drachsler, 2009).
Wikiwijs (learner support)	Wikiwijs is a platform for teachers to search, use, make and share learning materials for primary, secondary and college education. The main aim is to stimulate the use of Open Educational Resources (OER) in the Dutch education.
dataTEL (learner support)	In the educational world, only a very limited amount of datasets is publicly available and no agreed quality standards exist on the personalization of learning. The dataTEL Theme Team (funded by the EU STELLAR Network of Excellence) aims to gain verifiable and valid results and to develop a body of knowledge about the personalization of learning with recommender systems (Verbert et al., 2011). See http://bit.ly/datatel for more info.

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CoCooN (online learner identity)	Coalitions in Cooperation Networks (CoCooN) aims to collect data about learners and their networks in order to help them make more effective and efficient use of their social network. It uses SNA to generate profiles of key individuals, Communities of practice, groups. Next, it recommends valuable peers based on coalition theory and similarities between users.

Conclusions

In this paper, we have delineated our current work on social tools for networked learning. We have presented the theoretical background of three themes: peer support, learner support and online learner identity. We have argued why social tools are needed in these three themes. Also, we introduced some of the technology that could be used to develop such tools and practical problems that one may encounter. An overview was provided of the social tools we are currently investigating and developing. We believe that the results of our current research efforts will provide valuable insights to advance further on research and development of social tools for networked learning. Particularly, we would like to consider different angles and explore, for instance, how meta-cognitive skills are developed in networked learning, what is the new set of social networking literacy needed to perform better in networked learning, how to provide learners with automatic support on affective, motivational and meta-cognitive matters, and how analysis of learners behaviour could be used to support learner engagement in networked learning environments.

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