Information aggregation in Networked Learning: The Human Factor and Serendipity

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Abstract

The Web is changing and emergent technologies on the Web provide new options for learners to aggregate and engage with information. Learners can take control over their information steam and be proactive in the search for valuable information. The abundance of information makes that choices need to be made about what is valuable and what not, while the low level of teacher presence on open online networks increases the self-directed nature of this task for learners. Learning technologists started the research, design and development of personal learning environments (PLEs) that include predictive technologies to aid learners with the management of their learning in an open networked environment. Designers and developers are working on information recommender systems, using learning analytics and visualization techniques, to present learners with information relevant to their learning. Questions are being raised, however, about the usefulness of these systems for the advancement of learning. The low level of teacher presence on open networked learning networks will influence the level of reflection and critical engagement with information by learners, and is seen as a challenge to depth of learning. It is argued that to counter balance this, critical factors in information gathering would be the level of serendipity and human mediation.

This paper will highlight some challenges and opportunities in the shaping of information streams effective to learning. The aim of our research was to find out how people might position themselves at the centre of their information gathering process and how microblogging tool Twitter, in combination with RSS, shaped by human connections and interactions, might provide them with a reflection-inducing stream of information, in order to at times surprise and challenge them. We will highlight these aspects through the lens of research carried out during a Massive Open Online Course on Personal Learning Environments Networks and Knowledge (PLENK2010) in the fall of 2010. This paper will use a small case-study in the use of Twitter on PLENK2010 to investigate how human interaction might aid the increase of levels of serendipity in open networked learning. Special consideration will be given to serendipity in algorithm-based recommender systems for learning.

Keywords

Serendipity, networked learning, learning analytics, aggregator, predictive analytics, open learning, analytics.

Introduction

The context of learning has changed in recent years. In the past the learning experience was determined by three dimensions: the learner, the educator, and the content, but a fourth aspect has increased in prominence in theories and practice of learning: the learning context (Bouchard, 2011). Especially technology has influenced the learning environment and educators are re-examining their practice in the light of emerging technologies, which have provided learners with an explosion of resources outside educational institutions. This increase of information in combination with a low level of teacher presence and a high level of learner self- direction means that learners have to be adept at critically analysing the information and information sources they use in order to understand how these can be valuable to their learning. It is also argued, that technology can be used to help in this process as it can analyse, represent and visualize learner online activities to improve learning and advance, optimize and personalize their future learning and information aggregation through predictive analytics, in ranking and recommender systems (Duval, 2011, Siemens, 2011).

The options for learning in people's lives have increased, and the learning systems, which used to be controlled by educational institutions, are increasingly Web-based and informal, embedded in everyday activity, work and play. Learners live in a world with an abundance of information, which means that they are left with a scarcity of attention to each piece of information. People have started to make changes to their information behaviour,

and computer scientists are developing new systems to help people cope with data and information challenges caused by the growth of information and communication online. Moreover, researchers use advanced learning analytics applications that allow for quick analysis of data and visualization to make sense of the changed interactions between learners and educators, which now might take place in an open networked environment rather than in a closed class room environment (Duval, 2011).

The educational system has evolved over centuries and interactions by learners and educators as "human beings", not as "cogs in the wheels" of computer systems have been at the centre of the educational paradigm until recently. In educational institutions information and resources would be provided by librarians and validated by educators, and this age old tradition has been extended through Web-based online networks. Broadband and a myriad of new tools make it possible to aggregate human interaction and communication and visualize learner activity, but it seems that the analytics of online transactions moves us one step away from the human and his social interactions. Human activity is shown in a representation through visualizations, rather than that people experience the interactions themselves. Information collection and searches also involve increasingly computational and mathematical manipulation of data. Educationalists might question if these changes will lead to an increase in the quality of the learning process and learning as this changes the relationship between educator and learner and increases the level of responsibility for information gathering, the validation of resources and processes, and requires a high level of self-direction from learners themselves. Some authors have questioned whether all learners display a similar capacity for autonomous learning (Kop & Bouchard, 2011; Candy, 1991). The growth and development of the Web means that learners need to manage a vastly increased network of resources autonomously, which requires critical literacies, such as advanced analytic and synthesis, in order to distil 'really useful' information from the online network (Pegrum, 2011). This is especially relevant, as network research highlights a tendency for homophily by net-users; the congregation and clustering with like-minded people, possibly leading to a reduced level of challenging resources in the information stream that might lead to critical analysis and depth of learning (McPherson, Smith-Lovin & Cook, 200; Bouchard, 2011). Moreover, it is argued that a high level of competency and interest in using web applications is required in order to learn actively, creatively and effectively (Downes, 2009). Garrison and Anderson (2003) argued that deep and meaningful learning results if three forms of presence play a role in education: "cognitive presence", which ensures a certain level of depth in the educational process; "social presence"; and "teacher presence". In open networked learning the teacher presence is low, which implies a challenge to reach the same level of depth in leaning as in more formal learning environments, and a re-consideration of information aggregation and processing strategies to counter-balance this.

This paper will reflect on the mediation by humans and machines in the access, search and use of data and information to advance learning. The role of serendipity and human mediation in a changing learning environment will receive particular consideration.

Learning in a changing environment: information aggregation

As the number of information sources has increased and information has also become more distributed, the need to work with information in a different way in order to evaluate its quality and maintain some coherence has been suggested. The Web is not a power free and hierarchy free environment (Barabasi, 2003, Bouchard, 2011), and people have already made a start with organizing their own streams of information and activities using information hubs, human filters, and through a folksonomy, a classification system not based on library or academic classification systems, but on the ordering of information sources by people, for instance in the form of key words such as tags and #tags as identifiers. This means that information that users value can be organized, stored and retrieved from databases. The semantics of the web and the storage of information in databases are increasingly important in the identification and categorization of information. Google uses their algorithms for instance to crawl the Web and find relevant information related to the search key words. Another possible advantage of the use of semantics and database storage is that they make it possible to personalize information. Computer scientists are using predictive analytics for the development of information recommender and ranking systems for learning that work in a similar fashion as the systems that internet retail firms such as Amazon apply to web-searching and purchasing (Andre, Schraefel, Teevan & Dumais, 2009; Duval, 2011). One would question, however, who decides on the content and the values within the algorithms of these learning recommenders, what the conceptual drivers would be behind the algorithms, and if they would really be any use for learning. Moreover, one might wonder about the possibility and even the desirability of algorithms, being mathematical formulas, for the making of decisions about the resources that will be recommended to learners.

Human mediation and information flows and open networked learning

To a certain extent human beings do edit search engine algorithms (Goldman, 2010), but an important component to a search result is trust in the information provider, and could people ever trust a machine, even though it is tweaked by humans, to find really useful information especially to advance their learning? In the past teachers would be trusted with the decision making over resources, or individuals might browse the library shelves to find what they needed themselves, but in the open networked environment in which people now learn, all that is changing. Pardo and Kloos (2011) analysed the information behaviour of their online university students by using a virtual computer and found that the use of university resources by students was only 28.51%, while the Web was used for the other 71.49% of their searches. This indicates that the online learning process now takes place for a considerable percentage of time outside the institutional realm and that an awareness of positive information aggregation strategies in learners is becoming pressing, also in institutional education.

Learners use other resources than ones provided by educational institutions and instructors to support critical reflection and analysis. They also use information filters and commercial search engines, based on algorithms that make decisions about the information they receive on a daily basis. Search engines are very good at finding "relevant" information to a search, but not so good at information that is of a more capricious nature (Andre et al, 2009). They don't necessarily cater to advanced intellectual inquiry as their top search results merely reflect the general information needs of the population as a whole by bringing up relevant information based on key words. Google and Facebook algorithms provide us 'with the information that they think we want to see, rather than all we can – and should. . . The way algorithms work means that the focus is on what we click on most often, rather than providing us with a "balanced information diet" that also includes things that are uncomfortable and challenging and that include other points of view' (Zetter, 2011, p1.). What is hard to replicate in algorithm-driven searches, is serendipity; the chance of finding a gem of information, unrelated to a focused search, more as a by-product that stimulates creativity and thinking to arrive at a particular insight (Andre et al, 2009; Falconer, 2010).

Serendipity in the information stream

The first use of serendipity stems from the 18th century, where Horace Walpole derived it from the Persian fairy tale 'The Three Princes of Serendip', whose heroes "were always making discoveries, by accidents and sagacity, of things they were not in quest of". An important component of this would be 'sagacity': the ability to connect unconnected facts to come to a valuable conclusion (v.Andel, 1994). Andre et al (2009) researched serendipity to try to understand how it could be introduced in recommender systems and also highlighted that serendipity consists of two components: the finding of some unexpected, surprising, interesting information, and then by making connections to what is already known, perhaps in a particular domain, a creative insight might follow. They argue that the first part, the inclusion of the finding of unexpected information, might be facilitated through recommender systems, but the second part, the insight that would follow, which might advance learning, is much harder to achieve. As highlighted by Falconer: Any automatic "enhancement" of what should be a wander through the park sniffing whichever flower takes our fancy, being told by any external agent what a flower might smell like. No. That's no longer serendipity' (Falconer, 2010, p.4.). The sagacious component of serendipity means it is of a personal nature, related to the self, and hard to guess by a machine.

But we have to balance the abundance of information with the ability to sift through it and find the best pieces for our learning needs. Algorithm-driven computer applications do some of this work for Web-users, but have so far not been able to automate serendipity; only managed to go as far as suggesting content that 'may be perceived to be serendipitous' (Andre, 2009, p.309). Some authors highlight that serendipity is an important aspect in searching for information and in the creation of knowledge (Foster & Ford, 2003; Toms, 2000). Gritton (2007, pg. 6) argues that, 'Serendipitous browsing does have the potential to reveal connections between ideas that may otherwise go unnoticed, to stimulate "out-of-the-box" thinking, and to challenge our mental models so that new learning can take place. Moreover, serendipitous learning is associated with 'gaining new insights, discovering interesting aspects and recognizing new relations, which occur by chance or as by-product of other activities' and are related to people's interest, prior knowledge and the setting of learning goals (Buchem, 2010, p.1.). Furthermore, there are numerous examples in the literature to show that important discoveries were facilitated by serendipity (Andre et al, 2009), and as people's learning and information gathering on networks increases and in formal settings decreases, it seems to be worth pursuing serendipity in a

learning context as it is the unexpectedness that might challenge learners and make them reflect on their beliefs and knowledge, and stimulate their inquiry and learning.

How could serendipity be increased? There are indications that serendipity might be increased if learners are pro-active themselves in shaping their information stream (Ihanainen & Moravec, 2011). One of the challenges for learners in conducting a fruitful serendipitous investigation would be a change in search strategy from looking something up and relying on brokers and search engine algorithms to filter search results and "push" information towards them, to taking personal control and foster more randomness in the information stream by "pulling" information themselves. Ideally, people should find ways of incorporating web-searching into their thinking and reflection processes and integrate it into their own technological system that streams their information, and that is related to their own personal context; an unfiltered but manageable store of resources (Boyd, 2010). Bouchard (2011) believes that this is not enough, and that it would be desirable for the information not only to be filtered by learners themselves, but to also be validated by other human beings. Interaction with human beings is for most people at the heart of a quality learning experience and receiving information from friends, and friends of friends which might still be close in interest to the learner could enhance serendipity. Of course in the era of social media there are a myriad of opportunities to raise social presence and human interaction; one would even argue that the abundance of social networks and contacts makes choosing the right person to listen and talk to problematic. The challenge would be to manage this stream of communications effectively and to choose the best tools for human mediation to avoid being overwhelmed by the volume and dimensions. We carried out some exploratory research in serendipity in information streams on a Massive Open Online Course.

Research on a Massive Open Online Course - methodology

Background of the research and the research setting

The National Research Council (NRC) of Canada investigated the learning experience on a Massive Open Online Course (MOOC) as one phase of the research and development in Personal Learning Environments (PLE). The research was on the PLENK2010 MOOC, an informal, networked learning event with as subject Personal Learning Environments and Networks, that ran over ten weeks and in which 1641 people interested in the subject participated. The course had four facilitators and was based on connectivist principles (Siemens & Downes, 2008, 2009). Downes and Siemens have highlighted on numerous occasions the importance of human agency and the necessity of active participation in connectivist learning. They stress the importance of four types of activity for successful learning: 1) Aggregation of information. 2) Remixing and reflecting on the resources and relating them to what people already know. 3) Repurposing: the creation of a digital artefact themselves 4) Sharing of their work and activities with others.

The central resource on the course was a Daily newsletter that participants could subscribe to if they wished to, which displayed the aggregated resources and artefacts produced by participants in the course. In addition the Moodle Learning Management System with wiki was used to hold discussions and to display course resources and the schedule for speakers of twice weekly Elluminate sessions. Throughout the course Twitter activity and participants' and facilitators' blogs developed around the course subjects, and Facebook Groups, Second Life and other social network environments were developed by participants.

Research methods and ethical considerations related to Big Data

The research team decided to use a mixed methods approach and a variety of research techniques and analysis tools to capture the diverse activities and the learning experiences of participants on PLENK2010. Social Network Analysis was used to clarify activities and relationships between nodes on the PLENK network. This analysis also provided information on the importance of "connectors" on other networks, and the most relevant tools to facilitate this. Three surveys were carried out near the end of the course and after it had finished in order to capture and explore learning experiences during the course: including the End survey (N=63); 'Active producers' survey (N= 32); and 'Lurkers' survey (N=74).

In addition, a virtual ethnography was conducted. A researcher was an observer during the course and also carried out a focus group in the final week of the course. The researchers were interested in the processes taking place, the perspectives and understandings of the people in the setting, as Hammersley (2001) calls it: the "details, context, emotion and the webs of social relationships that join persons to one another" (p. 55). The technology itself and the artefacts that were produced were also taken into consideration in the 'online' ethnography, as these are part of the research setting and might influence the human interactions researched

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(Hine, 2005). As vast amounts of discursive data were generated Nvivo was used to aid with the coding and analyses and interpretation of the qualitative research data.

New research methods mean new ethical considerations for researchers. In the Social Sciences analytics of Web-data is a fairly new field and in an educational context, analytics of Big Data, available freely on the open Web left by traces of learner activity, is only in its infancy. Consequently, researchers should reflect on the kinds of data required for powerful analytics and on the implications of using these data for the invasion of privacy of individuals. Especially on the open network, transparency about the expected use and reuse of Big Data to participants, and clarity on what traces of their participation are being used for research or for future optimization or personalization of learning is not always easy, but vital to have a respectful relationship with participants. (Fournier, Kop & Sitlia, 2011) In our case-study informed consent was sought from participants for the use of all their digital artefacts and contributions to the distributed course learning environment, the Moodle LMS. Contributions distributed on the Web were only used for the research when the course hashtag, #PLENK2010, was being used by participants.
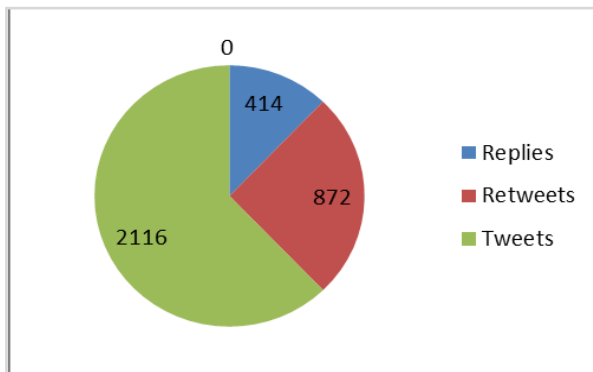
Twitter, RSS and serendipity during PLENK2010

Our study into serendipity on PLENK2010 focused of two collaborative services that stood out in the research on Massive Open Online Courses: micro-blogging tool Twitter that facilitated networking, communication and sharing options with others, and RSS aggregators and RSS readers, which facilitated advanced search options.
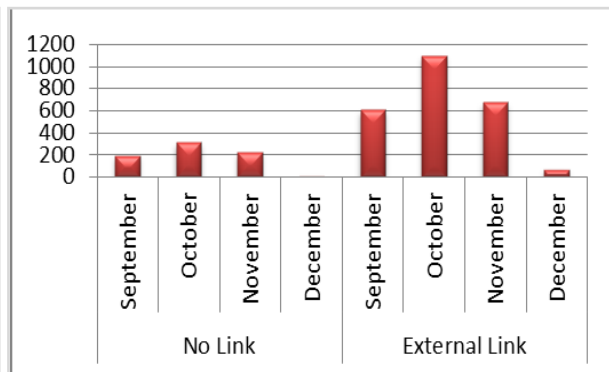
RSS and Twitter offer advanced options for communication, networking, and for receiving and sharing of information. People can us Twitter to quickly write a short message and share a link aggregated through RSS. Human social nature makes that people communicate about what keeps them engaged, thus inducing reflection on activities and information, and what is already known; in the process validating the information and knowledge (Bouchard, 2011). The flow back and forth of information will depend on the number of incoming messages and the balance between messages: if the number of incoming messages is too high for learners to process, it will result in problems distinguishing the 'noise' from the 'signal', but if the number is low the stream will be manageable, but perhaps not bring in too many (serendipitous) messages. Observations on PLENK2010 showed that RSS streams were aggregated and links passed on to others through tweets and re-tweets in Twitter on the course, which helped to provide access to a stream of information. People followed participants on Twitter who introduced pieces of information that they found interesting, and re-tweets provided access to an additional network of people, perhaps with weaker ties to the original contributor than the people that were followed, and consequently with a different angle to information than their own network. Furthermore, access to an even wider network of informants and information through the use of #tags seemed to raise the level for serendipity.

Observations of the learning activities taking place on the PLENK2010 MOOC indicated that RSS and Twitter were heightening the level of serendipity in the information stream and we examined learner use of Twitter in combination with RSS in order to develop a hypothesis related to the 'Degree of Serendipity' and possibly create a 'Serendipity Index' based on serendipity-promoting factors that might aid in predicting how serendipity could be increased in information streams on open learning environments.

On PLENK2010 extensive use was made of RSS and micro-blogging tools such as Twitter. The participants sent 3402 Twitter messages, and Twitter was the communications tool of choice for many participants; one of the tools that increased in use, while the use of others, such as LMS-based discussion forums, decreased over the 10 week progression of the course. Figures 1. and 2. highlight the nature of the Twitter messages and the distribution between textual messages and messages containing links. The combination of a high level of re-tweets, a quarter of all messages, and the high level of external links in the messages showed that participants passed on information and resources to one another, with the possibility of inclusion of unexpectedness. The challenge was to find out if the serendipity was increased through these tools by examining what the links and retweets contained. Qualitative analysis of the tweets showed that most links were related to papers relevant to the course subject, new tools, digital artefacts and participant, facilitator and other blog posts and comments. Some clearly included serendipitous information, for instance a TED talk by Sir Ken Robinson related to creativity in education and an RSA animation of it, which were discussed extensively. The retweets amplified course related events and resources that participants found interesting, but they also contained serendipitous information, in the form of animations and presentations produced by participants and others, which enthused people and made people see particular issues and tools in a new light.

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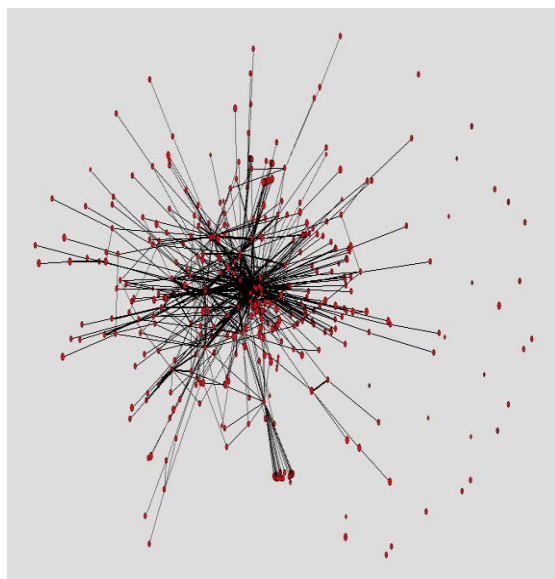
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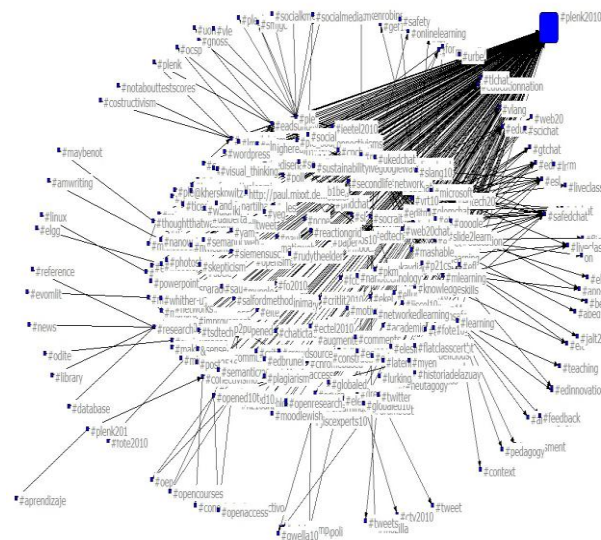**Figure 1 Distribution of tweets, retweets and messages on PLENK2010**

Figure 2 Distribution of tweets with and without links on PLENK2010

Moreover, an important feature of Twitter was that it allowed users full control over persons they followed, which suggested a certain level of trust in the relevance of the information received, otherwise they would not do so. When analysing these hash-tags it became clear that people used hash-tags for a variety of reasons. Some were used as personal identifiers, some were course or conference codes to send links perceived to be interesting to students or fellow conference attendants. Some hash-tags tried to bring together discussions and links related to concepts, such as "knowledge" and "complexity"; or theories, such as "connectivism" and "transformative learning". Codes for tools and resources, such as "secondlife", "OER", "PLE" were also used extensively to make connections between links to particular tools and learning environments. Other hash-tags were related to short-lived emergent actions and ideas, such as "savegooglewave" or "notaboutestscores". Most of the tags were associated with chat related to a particular network, such as education, educational technology, learning, communities of practice. These Twitter chat networks were extensive, long standing and established, and links to particular subjects were exchanged from one to another community and back. Analytics tools such as SNAPP, Pajec and NetDraw were used to show who posted and replied to whom, and how expansive the connections were. They helped to analyse the interactions by visualization them. Figure 3. for instance provides a view of the Twitter connections between participants and shows the high involvement of some, but very isolated involvement of others.

Figure 3. Twitter connections between participants

Figure 4. Twitter Hashtag networks

A high number of PLENK2010 participants were highly connected through their involvement in hash-tag Twitter networks as shown in Figure 4. They participated in multiple #tag networks and introduced new information onto #PLENK2010. The hash-tag networks were one step removed from participants and the distribution of these networks shows that they did not only provide relevant information, but also unexpected information. Participants on the MOOC used 158 #tags. A simultaneous discussion and exchange of links took

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place for instance related to "lurking and passive learning on online learning networks" in the #MOOC, #edchat, and #PLENK2010 networks that carried links to blog posts, comments and course Moodle discussion. An exchange of "relevant" information took place, such as announcements of particular activity, but also of "serendipitous" information as new points of view and links were transferred onto PLENK2010 from other networks.

It seemed that the higher the level of re-tweets, #tags and number and spread of RSS feeds, the higher the likelihood of unexpected and challenging pieces of information and serendipity in the information collector's information stream. The level of serendipity depended on the right level of distance between the aggregator and his contacts or feed/link providers. When the distance was too great, the information became too random and became irrelevant, but when it was short, the level of unexpectedness shrank as well. Receiving re-tweets and cross-fertilization through hash-tag networks heightened serendipity as tweets from these would be provided by contacts of contacts, or through networks of interest, so still be reasonably close to the aggregator.

Conclusion

In a time where linear structures in learning and education are starting to break down, learners are looking for their information online, rather than relying for their resources on educational institutions and instructors. Being in control themselves over their information aggregation, in an increasingly open and self-regulated learning environment means the need on the part of the learners to understand the structure of the Web, the media and information online. Low levels of teacher presence means the need for an awareness of optimal information aggregation strategies. It would be desirable for these to involve not only strategies for collecting relevant, but also of serendipitous information to advance learning. One of the roles of the educator might be to help learners in developing their information literacy and also to aid them in developing information curation strategies. Learners should ideally position themselves at the centre of the information gathering process and be active in creating a kaleidoscope of complex information that allows for colourful and shifting patterns shaped by human connections and interactions, in order to at times surprise and challenge them. One aim in the development of learning recommender systems should be to facilitate this collection of serendipitous information.

In this changing learning environment, some areas for future research would be:
1. How to increase serendipity in information flows. We have just touched upon possible positive indicators related to serendipity on the learning environment, such as human involvement and the distance between actors on the network and we will extend our research to test a 'Serendipity Index' and see if it could help predict the level and increase of serendipity in the information stream.
2. To compare the effectiveness of more traditional information filtering strategies, such as relying on network nodes and hubs, i.e. experts on networks and search engines, for the gathering of serendipitous information, with the effectiveness of collecting information through human networks with multiple participants.
2. The use of learning analytics is only in its infancy, but from our research and use of the tools it seems that they can be powerful in giving meaning to interactions and actions in a learning environment such as on the PLENK2010 MOOC. Further research in their application to clarify learning and provide learners with feedback regarding their progress will be useful.
3. Further research to see how serendipity could be fostered and heightened in information streams through predictive analytics systems, such as recommenders, is required to ensure that these systems will truly help learners in their personal self-directed online learning.

Further qualitative analyses of the PLENK2010 data is in progress to find other factors that might affect the open networked learning experience. Experimentation with analytics tools and educational data mining are also still in progress to come to an understanding of the interactions of a small but representative sample of users during the length of the course. We will elaborate on these findings during the conference in April 2012.

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