

Personal Learning Network Clusters: A Comparison Between Mathematics and Computer Science Students

Ansie Harding¹ and Johann Engelbrecht^{2*}

¹Department of Mathematics and Applied Mathematics, University of Pretoria, South Africa // ²Department of Science, Mathematics and Technology Education, University of Pretoria, South Africa // ansie.harding@up.ac.za // johann.engelbrecht@up.ac.za

*Corresponding author

(Submitted March 11, 2014; Revised October 30, 2014; Accepted January 26, 2015)

ABSTRACT

Personal learning environments (PLEs) and personal learning networks (PLNs) are well-known concepts. A personal learning network cluster is a small group of people who regularly interact academically and whose PLNs have a non-empty intersection that includes all the other members. At university level PLN clusters form spontaneously among students and are known to last over an extended period of time. Little is known regarding the workings of these PLN clusters of students. The claim is that these PLN clusters are at the heart of student learning and are aligned with the current trend of a knowledge-pull community of learning. In this paper we investigate the activities and characteristics of PLN clusters in two different fields of study at a South African university, namely mathematics and computer science. We discuss the benefits that these clusters offer, investigate the mashup of activities and tools and we contrast experiences in the two fields of study. It is the commonalities rather than differences that are striking between the two groups of students. Although computer science students lean more towards digital communication, both groups impress with the pride they take in their PLN clusters and are vocal in describing the benefits that these clusters offer.

Keywords

Personal learning network clusters, Learning management systems, Learning communities, Collaborative learning

Background

This study sets out to investigate the phenomenon of spontaneous formation of small clusters of students, mostly at the onset of their study years, interacting academically as well as on a personal level over an extended period of time. We refer to these groups as personal learning network (PLN) clusters. The setting is in one of the principal universities in South Africa where we investigate and compare two groups of students, mathematics and computer science students, and report on their experiences within their PLN clusters.

Roger and Johnson (1988) surmise that how the students perceive and interact with one another is a neglected aspect of instruction. Although much training time is devoted to helping teachers arrange appropriate interactions between students and materials, and some time is spent on how teachers should interact with students, little or no time is spent on how students should interact with one another. This premise is particularly true for students in PLN clusters and it is in this sparseness of knowledge on how students interact amongst themselves that the main contribution of this paper lies.

We colour the background setting of this paper through a discussion of collaborative learning, and the various faces of technology enhanced learning, and how collaborative and technology-enhanced learning are combined within PLN clusters.

Collaborative learning

A model for collaborative learning that has typically been practised is of assigning small groups of students within a larger group with the purpose of discussion or for completing an assignment. The responsibility of dealing with the smooth running of structured collaborative learning mainly rests on the shoulders of the instructor who is often faced with issues such as fair selection of groups, how to design activities for collaborative learning, how to deal with conflicts within groups and how to fairly evaluate individual work. In a large course, formal group work becomes

increasingly hard to administer. The group itself may experience internal difficulties such as starting tasks late, conflict between team members due to personality clashes, and tasks not being completed on time.

Technology enhanced learning

Technology Enhanced Learning (TEL) is at the order of the day, all learning that involves technology is technology enhanced and collaborative learning dovetails with TEL. TEL has many faces, some of which we proceed to discuss.

Learning management systems (LMS)

LMSs have been adopted by universities all over world at a remarkable rate (Coates, James, & Baldwin, 2005). A case can certainly be made for enhanced learning resulting from utilising the features of an LMS appropriately.

Graf and Kinshuk (2007) analysed students' performance and behaviour in a course in which they provided adaptivity based on students' learning styles in the LMS and found that with this add-on the LMS proved effective. Vovides, Sanchez-Alonso, Mitropoulou, and Nickmans (2007) claim that the powerful features of LMS systems are often underutilized and plead for developing LMS systems that offer new opportunities to personalize instructional support in the form of learning objects with metadata, including features and functionalities such as intelligent learning mentors or tutors.

Inept use of LMSs has led to criticism. Siemens (2004) states:

“Learning Management Systems are often viewed as being the starting point (or critical component) of any e-learning or blended learning program. This perspective is valid from a management and control standpoint, but antithetical to the way in which most people learn today” (p. 1).

Posting static content on an LMS is cautioned. Chatti et al. (2010a) bluntly state that the LMS-centric model of learning has failed to achieve performance improvement and innovation. In most cases an initially paper-based learning resource is simply converted into digital form and a classroom training event is transformed into an online course. The pattern is of modularisation of courses and isolation into discrete units. LMS driven models follow a one-size-fits-all approach and suffer from an inability to satisfy the heterogeneous needs of many learners.

Coates et al. (2005) state:

“It is important that steps are taken to identify how online LMS can be used to augment and complement rather than substitute for an institution's core teaching objectives” (p. 33).

Garcia-Peñalvo, Conde, Alier, & Casany (2011) argue that with LMSs users have reached a plateau of productivity and stability and that this stability and maturity of the LMS may become a resistance factor working against the introduction of innovations. Within the PLE and PLN paradigms, new transformative tools, services and ways of learning are already in use, which cannot be ignored.

The above reasons stated for the “failure” of LMS's in the learning environment may be somewhat misplaced. LMSs can be used productively in a technology-enhanced learning environment if used in a pedagogically sound manner. LMSs have features that enable collaborative learning, such as discussion forums, blogs etc. to be used for TEL and within PLN clusters.

Using technology in collaboration models

Network learning

All learning is situated in practice and all practice is essentially social in nature (Swan & Shea, 2005) and therefore commonly resides in networks. The notion of network learning is supported even stronger by a more social and

connected Web that has arisen over the past years. Web users absorb knowledge very quickly across different channels and they prefer random on-demand access to all kinds of knowledge disseminated over the internet. They are in close contact with their friends using networks to share and create new knowledge. This new Web generation is often termed Web 2.0. (Chatti et al., 2010a).

The concept of an *open network learning environment* was discussed by Tu, Sujo-Montes, Yen, Chan, & Blocher (2012).

“Open network learning environments are digital environments that empower learners to participate in creative endeavours, conduct social networking, organize/reorganize social contents, and manage social acts by connecting people, resources, and tools by integrating Web 2.0 tools to design environments that are totally transparent, or open to public view; the same architecture can be used to design the degree of openness users feel is necessary to the situation” (p. 14).

They report on an online course designed to empower learners to construct their own personal learning environments within open network learning environments. They conclude that effective instructions should prepare “online” learners to become “network” or “open network” learners. We subsequently link our study to this notion.

Personal Learning Environments (PLE) and Personal Learning Networks (PLN)

Personalized learning is linked to the idea that learners do not have control over what is taught but do have control over what is learnt (Tobin, 2000). Learners want to control what they learn and for this purpose create a personal learning environment (PLE). Attwell (2007) defines a PLE as a collection of all the tools we use in everyday life for learning. PLEs enable a learner-controlled integration of different learning tools and services into a personalized space. The space takes a learner-centric approach and is characterized by the use of a set of services and tools that belong to and are controlled by the learners. Rather than integrating different services into a centralized system, the idea is to provide a learner with a plethora of different services and hand over control to the learner to select, use, and mashup the services the way he/she deems fit. A PLE driven approach does not only provide personal spaces, which belong to and are controlled by the user, but also requires a social context by offering means to connect with other personal spaces for effective knowledge sharing and collaborative creation (Chatti et al., 2010a).

Ivanova (2009) describes a blended learning course during which a learning network is formed, following the modified Rogers’ (2003) model for competence development lifecycle in a learning network. She found the main challenges in forming this learning network are to (1) provide sustainable value to students, and (2) stimulate students to contribute their knowledge, insights and experiences on a continuous basis. She found that social networks contribute to the processes by which learners meet and share their competencies. Building a PLE is found to be a core for PLN deployment.

Wilson, Liber, Johnson, Beauvoir, Sharples and Milligan (2007) argue that a PLE should focus on coordinating connections between the user and a wide range of services. It should recognize the need to integrate experiences in a range of environments, including education, work, and leisure activity.

“Unlike the VLE [virtual learning environment], the PLE is concerned with sharing resources, not protecting them, and emphasizes the use of creative commons licenses, enabling editing, modification, and republishing of resources. Rather than pre-packaged learning objects, the resources collected and accessed using the PLE are more typically weblog postings, reviews, comments, and other communication artefacts” (p 32).

Conde, García, Alier and Casany (2011) advise that the problems experienced with LMSs can be solved with the integration of LMSs into PLEs, thus integrating informal learning tools and contexts and formal environments. Similarly, in order to deal with how PLEs interact with institutional LMSs, Derek Morisson in Sclater (2011) ventures the notion of a PLE docking into the “mother ship” (an LMS) every so often, to bring or get content.

Related to the concept of a PLE, and sometimes indistinguishable from, is the idea of a personal learning network (PLN). Whereas PLEs are the tools, artefacts, processes and physical connections that allow learners to control and

manage their learning, PLNs extend this framework to include the human connections that are mediated through PLEs (Couros, 2010). While there is a growing field of research and thinking behind the concept of a PLE, the academic research on personal learning networks (PLNs) is much more anecdotal. Couros (2010) defines a PLN as the sum of all social capital and connections that result in the development of a personal learning environment. PLNs offer an environment where people and tools and communities and resources interact in a very loose kind of way (Wilson, 2008). The longevity of PLNs is one of its most important features. Time-based, course-centric communities die, probably because these communities are based around courses and not around communal learning. PLNs cultivate sustained, long-term learning.

A PLN consists of the people involved with the use of tools only implied - an informal network of the people a learner interacts with and derives knowledge from in a PLE. In a PLN a person makes a connection with another person with the specific intent that some learning will occur because of that connection.

Personal learning network clusters

We define a *personal learning network cluster* as a small group of people who regularly interact academically and whose PLNs have a non-empty intersection that includes all the other members. Where a student's PLN could consist of a number of other students not all doing the same subjects, a PLN cluster would be a subset of the student's PLN, a smaller group of students that are together to address a particular subject or topic. In this paper we focus on PLN clusters that spontaneously form among students and we investigate how they function in two fields of study – mathematics and computer science. These clusters usually stay intact collaboratively over the duration of its members' years of studying and often beyond. Students in a cluster use a number of tools to communicate and learn while using social media, mobile phone technology and learning management systems, among other platforms for learning purposes.

Mashups

The creation of rich learning mashups (normally web applications that integrate complementary elements from more than one source) currently associated with collaborative learning resulted from advances in digital media and data in the early 21st century. Wild, Kalz and Palmér (2010) describe mashups as “the ‘frankensteining’ of software artefacts and data” (p. 3). They describe the development of a technological framework enabling students to build their own personal learning environments by composing web-based tools into a single user experience, getting involved in collaborative activities, sharing their designs with peers and adapting their designs to reflect their experience of the learning process.

There is an opinion that technology enhanced learning (TEL) has not succeeded in revolutionizing education and the learning process. A speculative reason is that most current initiatives take a technology-push approach in which learning content is pushed to a predefined group of learners in a closed environment (Chatti, Agustiawan, Jarke, & Specht, 2010a). A fundamental shift toward a more open and learner-pull model for learning is needed - a shift toward a more personalized, social, open, dynamic, emergent and knowledge-pull model as opposed to the one-size fits all, centralized, static, top-down and knowledge-push models of traditional learning. Chatti et al. (2010b) suggest the 3P learning model as a new approach for addressing the growing complexity and constant change of knowledge required, tailored for the new generation. The 3P learning model encompasses three core elements: personalisation, participation and knowledge-pull. It is in these three core elements that PLN clusters are shown to shine.

User requirements

Students join PLN clusters for reasons that are most likely not explicitly formulated in their own minds. Such implied needs are addressed in successfully functioning PLNs and if not members would leave or become inactive. As these PLN clusters spontaneously form as a natural conglomeration of students through convenience of interaction on a social or academic level, the user requirements are not stipulated at the onset. The common goal of wanting to succeed at university is a draw card for like-minded students to join forces, as is the natural phenomenon

of humans wanting to belong and to function in a social rather than solitary environment. PLN clusters fit into the paradigm of a pull community rather than a push community and shown to offer a more personalized, social, open, dynamic knowledge-pull model for learning that Chatti et al. (2010b) advocate.

Hogg, Hohman, and Rivera (2008) offer three reasons why people join groups. The first of these reasons is that people have a need to belong, and that self-esteem acts as a meter of successful cluster belonging (sociometer model). The second reason is that it is comforting to share our world views with like-minded others because it provides us with a sense of meaningful existence (terror management theory). The third reason is that people have a basic need to reduce uncertainty about themselves and their place in the world, and that group identification can reduce such uncertainty (uncertainty-identity theory).

Benefits of study groups are informally documented via blogs (e.g., Desmond, 2014). Such benefits include counteracting procrastination because of regular meeting times, learning faster through group momentum, getting fresh perspectives on a topic, learning new study skills through observation, breaking the monotony of studying on your own, filling in gaps in your own learning through comparing notes etc., practicing for a career because of experiencing group dynamics.

This study was conducted on existing PLN clusters and we can therefore not determine what the user requirements of these students were for joining these clusters. We can however determine why students stay in these clusters and what they perceive as the positive features so as to post hoc address user requirements.

The study of PLN clusters aims to alert and enlighten educators to this valuable learning model in which both collaboration and TLE are essential features.

Approach

We follow a case study methodology in investigating the phenomenon of PLN clusters, focusing on a single university in South Africa. PLN clusters are studied from two perspectives – one from within the technology rich field of computer science and the other from within mathematics, a field that is less rich technology wise but requiring use of symbolic exposition. By investigating and comparing activities of PLN clusters in mathematics and computer science, commonalities are extracted and differences are reported on to gain a deeper understanding of this phenomenon. The sample space consists, on the one hand, of students enrolled for a second year mathematics course, either studying for an engineering degree or for a science degree, and on the other hand a group of second year computer science students of which a few specialize in multimedia. A simple, voluntary first questionnaire was issued to both groups to determine whether a student was part of a group of close friends who came together informally for study purposes. The term *personal learning network* was not used. Second year groups were chosen as first years were still finding their feet and the possibility of existence of stable study groups was minimal. Another reason for focusing on second year students is because engineering students do mathematics only up to second year level and we wanted to include them in order to address a cross section of students. In order to match the academic level, second year computer science students were included in the sample.

In total 111 mathematics responses were received of which 49 indicated that they were part of a PLN cluster. Of these 22 students indicated willingness to receive a second, follow-up questionnaire via email regarding the functioning of their PLN cluster. A total of 13 students responded to the second questionnaire.

A total of 54 responses were received from computer science students of which 39 indicated that they were part of PLN cluster, all willing to participate in a follow-up questionnaire. A total of 17 students responded to a follow-up email questionnaire.

These numbers should not be seen as a representative sample. The purpose of the study was to investigate the working of PLN clusters in order to gain insight into this phenomenon and to do a comparison between experiences of mathematics and computer science students and for this purpose the samples sufficed. It should be noted that the computer science student response percentage was considerably higher and could point to a difference in attitude, possibly being more prepared to share information.

In the second questionnaire students were asked about the size of their clusters, how long the cluster had been going, how they got together and if the cluster has changed since it started. They had to explain how the cluster functions, how and how often they communicated, what technology was used and what their discussions were about. Lastly they had to mention benefits of the collaboration, what they personally got from belonging to the cluster and whether they preferred a spontaneous cluster to a group formed by the teacher.

Results

Cluster structure

The general trend is for clusters to form at the onset of the first year of study, due to being friends earlier or due to meeting in class. Mathematics clusters seem to consist of 3 – 5 members in general while computer science clusters seem to be slightly bigger with groups of 6 – 8 members not uncommon. Both mathematics and computer science clusters have regular face-to-face meetings, even for a mathematics cluster of nine members. The fact that computer science students have the same schedule and therefore have coinciding spare time makes face-to-face meetings easier to arrange. An interesting single phenomenon recorded is a computer science cluster of 30 members, a cluster that expanded from an initial 15 members to double its original size. This is a WhatsApp group with limited face to face interaction, sharing notes and previous exam papers through a Google drive folder. An advantage of such a large cluster is that when a question is posed someone is bound to have the answer. This cluster is by far the largest and probably more aligned with social media trends but seems to function well in terms of a cluster. Clusters are dynamic and undergo change but not dramatically so. Certain members participate less often from time to time due to work constraints; a member may leave the cluster because he finds that he studies better on his own; here and there a member is added along the way, or a member may quit studying and be replaced by another. The stability of the clusters represented by the responses was noticeable.

Understanding of what a PLN is

The two different group responses to what their understanding of a personal learning network is, is characteristic of the study fields. Mathematics students admit in general to not being familiar with the term personal learning network. Only one student could describe it as a group of people who know each other on a personal level and work together to optimize their learning environment. The majority of computer science students has an understanding of the term and have come across it in their environment. The “people” aspect is mentioned repeatedly.

A bunch of people helping each other to learn and understand the concepts.

It is your group of people that helps you to broaden your knowledge base and better your understanding of certain things.

It is an informal group of people working towards the same educational goal, helping each other.

I would assume it means a network of resources that is not provided by the institution, in our case the university.

Communication and activities

Both face to face and digital communication appear to be integral to all cluster activities. Mobile phone communication, especially via a WhatsApp group seems to be most common, with frequency varying from once a week to multiple times per day until “late hours.” Facebook is also commonly used, as well as Skype and Google Talk. E-mail communication is mentioned as an option, more frequently used by mathematics students due to the “difficulties of using symbols on a phone.” Google docs and Google Drive (or the equivalent Dropbox) are used among computer science students in particular for sharing documents. Face to face sessions are either scheduled for a fixed time(s) per week or on a needs basis, often triggered by a due assignment. Meetings are set up typically via WhatsApp. Clusters are also known to meet informally on campus during free times, often on a daily basis, in the library on campus, at each other’s homes or even in the cafeteria. Among the mathematics cohort face to face

communication seems to be the primary activity with technology often used only for organisational purposes whereas among the more technologically oriented computer science group face to face and digital communication are equally well used, both for learning purposes.

All activities are self-generated and indicative of a knowledge-pull approach. Cluster activities for mathematics students centre on problem solving, mainly preparing for practical sessions or tests and exams. An important component of the technology side of the communication channel is that clusters have access to a helpline at all hours of the day. One student describes it as “using collective knowledge to achieve our goals”. A healthy approach to mastering the work is illustrated by

Each person tries work on their own, if they don't succeed any of the other people in the group are contacted to help the individual.

The practice of collecting exam-type questions for when the cluster gets together and try to solve those problems seems to be common for mathematics students but is not mentioned by computer science students. Computer science students mainly do assignments and projects in their clusters. An interesting approach is that when any member of a group is struggling particularly with certain topics an emergency call is sent and the group meets on campus on request. If no one can solve the problem one member is delegated to contact the lecturer for help. YouTube videos as a learning resource features strongly and PLN clusters often share links to useful videos on a particularly difficult topic. This way of dealing with problems can account for the phenomenon that has been discussed locally among lecturers (informally) of experiencing fewer office visits, especially in mathematics. It is surmised that the umbilical cord of support between lecturer and students is weakening, a premise worth investigating.

Mathematics students experience the added problem of dealing with the symbolic representation of mathematics. Students commonly photograph their notes and problems and communicate these, especially when they need to exchange a significant amount of mathematics. Posing a problem on WhatsApp could include text such as “x to the power of 2,” “x²” or “sin theta” while creativity comes into play with personalized names for symbols such as “pig's tail” and “devil's fork” for sigma and psi. Some mobile phones have a “fancy characters smiley pack” that comes in useful. The odd cluster finds mathematics communication via mobile phones, Facebook and WhatsApp just too cumbersome and use technology only for organisational purposes. Phoning about mathematics problems seems to be something of the past. Computer science students do not experience this type of obstacle.

Role of an LMS

Mathematics students make use of an LMS running on the Blackboard platform, while computer science students make use of a locally developed learning management system. It was clear that an LMS as a tool for learning is not rated highly, especially among mathematics students. Mathematics students exclusively use the LMS for obtaining information, memos, lecture notes and marks.

I try to avoid it as much as possible, the amount of worthwhile notes and discussions posted is disappointing. It makes more sense to personally discuss anything work related if at all possible.

Such negativity could also be a reflection on teachers who do not utilize the learning possibilities of the LMS optimally.

Computer science students are more prone to make use of the discussion tool of the LMS (eight of 17 respondents). They feel that computer science courses are their most difficult and they interact with questions posted on the discussion board, if not by posting then by observing.

It becomes very useful when you have a question to ask and its possibly been answered already on the discussion board.

Benefits

Both groups of students are generous in listing benefits of PLN clusters. Enhanced social skills, better grasping of concepts, motivation, support and understanding are among the frequently mentioned benefits by both mathematics and computer science students.

Motivation

The motivation provided through the cluster interaction is repeatedly mentioned as a benefit of PLN clusters on a personal level as well as knowing there are other people with similar concerns, “knowing that I am not alone in my struggle.” In a cluster you will find

- A person motivating you to complete assignments
- People that know how it feels to study
- More minds to solve the problem

Social support and people skills

One of the main benefits of belonging to a PLN cluster, mentioned by both groups, is getting support from caring friends and most of all a sense of belonging. Working in a cluster is perceived to strengthen friendship ties; it provides social enrichment and a comforting feeling that one has a reliable and trustworthy group of people around you, getting help and giving help. It offers a secure environment where you share what you know and refine your knowledge.

Both groups mention people skills as a gain from PLN interaction. Learning to be patient, to work together with other people, to explain to others, are some of these benefits as well as coming to know that “it is far more pleasant to study with fellow students than to study alone.” It also enhances discipline, as members cannot afford to be distracted.

- I grasp aspects of math faster and it has improved my marks as well as my people skills.
- Working together enhances social skills

Communication opportunities

Another benefit, mentioned by a mathematics student, is being able to speak your mind without the fear of sounding like a fool. This thread also appears among computer science responses. One student feels that his understanding improves because they collectively argue about what a question might mean whilst another says that “bad ideas get weeded out quickly” with no hard feelings experienced. The benefit that clusters offer in terms of immediate feedback on attempts and issues is mentioned, especially by computer science students. They equate the group’s shared experience to better quality of work.

Mathematics students claim that interaction improves your communication skills and helps you acquire problem solving skills. Most clusters require of members to prepare before the meeting and it therefore forces them to keep up to date with the work. In addition, meetings offer more contact time with the subject.

- I am usually the one that explains to the others but I find that this consolidates my own knowledge.

Exposure to different perspectives

Exposure to multiple points of view and different perspectives are mentioned by many respondents as a gain from the cluster interaction. Someone else’s perspective could be the key to finding a solution to a problem. Computer

Science students mention particular benefits regarding programming assignments obtained within a pleasant environment:

It helps a lot to hear other peoples' opinions and see different perspectives. IT has a lot of different ways to do the same thing, thus it is very beneficial to come into contact with different way. IT aims to program in the most efficient way and other people in the group might have a more efficient way than me.

You see the problem you're facing through a different perspective and light heartedness when difficult questions arise (this is very important as it gives you the will to continue).

Mathematics students mention the benefits of exposure to different approaches to problem solving. One member may follow a more algebraic approach whereas another may follow a more visual approach and they can learn from each other. The following quotes illustrate the practical benefits:

Sharing proofs is quite useful; sometimes they require an approach that just doesn't occur to you, but that might to someone else.

I would have had to work much harder in order to pass if I did not work with them.

We learn from how other people think.

Other practical benefits

More practical benefits include access to class notes, study notes, information on dates, explanations from group members and sharing of resources ("even if it is just a useful YouTube video"). Respondents also mention gains such as tips on topics dealt with in practical classes from members who may have attended the practical class earlier in the week as well as a way to catch up on notes, hand-outs and announcements that you may have missed. Tangible benefits are mentioned in terms of improved marks and using meetings as an evaluation of how well you understand the work.

Conclusions

This study set out to investigate the phenomenon of spontaneous PLN clusters among two groups of students, mathematics and computer science students, with the latter being more technology inclined. The overwhelming impression is of how important these groups are in the academic lives of these students. They speak with the pride of the interaction; they take ownership of their clusters and are vocal in describing the benefits that these clusters offer. PLN clusters are truly at the heart of student learning, they are little researched gems in the landscape of learning, and the importance of these should not be underestimated. It is a component of academic life that teaching staff have no input into and yet the functioning thereof realizes the ideals of independent learning within a collaborative, technology enhanced environment, while and stimulating discussion on the work, aspects of learning that lecturers have strived to instill for many years.

Commonalities and differences between the two groups were noted. Computer science students have richer mashups of activities, leaning more towards digital communication as could be expected. Yet the importance of face-to-face communication among these students came as a surprise. There is evidence of face-to-face meetings not just happening by chance but being arranged for a definite purpose. Mathematics clusters are more prone to face-to-face communication. Yet it is the similarities rather than the differences between the two groups that are striking. Both sets of clusters have the academic interest of the members at heart and cluster activities centre around this aspect.

There is no doubt that the main aim of the PLN clusters is to advance learning within a supported environment with the social aspect playing an integral but secondary role. Yet there is strong emphasis on the personal gains resulting from belonging to a PLN cluster. Post hoc user requirements can be formulated from the gains expressed by students in PLN clusters.

- *Sense of belonging.* PLN clusters offer peace of mind on a personal level because of belonging to a circle of caring people who are willing to assist when required, also resulting in motivation, support and understanding

- *Freedom of expression.* It is a protective environment amongst peers where a member can express himself freely and conflicting opinions are dealt with in a mature manner without fear.
- *Exposure to different perspectives.* When mastering a subject different perspectives deepen understanding, an opportunity available in PLN clusters.
- *People skills.* Functioning successfully in a PLN cluster cultivates skills that will be of value both in a work and personal environment.
- *Communication opportunities.* Constant communication is possible and it is noticeable that the almost permanently available helpline is one of the most valued features. It is an effective TEL environment.

PLN clusters are exemplary in answering in the learning requirement needs of the 21st century. It complies to Web 2.0 concepts and encompasses the three core elements of personalisation, participation and knowledge-pull of the 3P model (Chatti et al., 2010b). Learning within these clusters support the notion that "... the most resilient, adaptive, and effective learning involves individual interest as well as social support to overcome adversity and provide recognition" (Ito et al., 2013, p. 4). Collaborative learning has certainly existed for a prolonged period but has gained impetus in the form of PLN clusters with current technology advances. The role of the lecturer with respect to PLN clusters is undefined and his/her support function seems to be diminishing, an aspect that should be viewed positively.

The study has not set out to determine how prevalent PLN clusters are, proposed as a future project, as is expanding the study to other universities. There certainly would be individuals who do prefer to work totally independently and there could be clusters that disintegrate for whatever reasons. Investigation of these phenomena is also left for future studies. The main finding of the paper is that PLN clusters have value for student learning, in both the two fields investigated. The activities within the PLN clusters differ somewhat between the two groups but the structure and way of functioning are essentially the same.

The formation of PLN clusters is evidence of spontaneous formation of knowledge-pull communities, separated from the formal academic programme. Life-long learning is at the order of the day and the longevity of the PLN clusters is testimony to crossing the boundaries of courses and semesters.

The tension between individual independence and collective cooperation has been debated in literature (Wagner, 1995). Paulsen (2003) claims that online education can foster both freedom for the individual and group cooperation and he uses the term collective freedom. The fact that participation in PLN is voluntary, it is initiated by the students themselves and not a forced activity may contribute to a measure of collective freedom for students.

The increasingly large groups that universities are dealing with make structured collaborative learning practices difficult to conduct. Yet the virtues of collaborative learning and the skills that are fostered by it are exactly those observed in the PLN clusters. PLN clusters are part of a larger phenomenon, defined as the "open movement" of which Couros (2010) says:

"The open movement is an informal, worldwide phenomenon characterized by the tendency of individuals and groups to work, collaborate and publish in ways that favour accessibility, sharing, transparency and interoperability" (p. 110).

Our study has shown that the PLN clusters observed also comply with all six elements that Kaufman, Sutow and Dunn (1997) identified for successful collaborative learning namely positive interdependence, social skills, face-to-face verbal interaction, individual accountability, group processing, and appropriate grouping. There is also evidence of the presence of the four key factors that define a sense of community as stated by McMillan and Chavis (1986) namely membership, influence, fulfillment of individuals' needs and shared events and emotional connections.

The study provides a case study example of personal learning environments of which Attwell (2007) says:

"The space takes a learner-centric approach and is characterized by the use of a set of services and tools that belong to and are controlled by the learners. Rather than integrating different services into a centralized system, the idea is to provide a learner with a plethora of different services and hand over control to the learner to select, use, and mashup the services the way he deems fit."

The importance of this study lies in being exposed to the voice of students that function within personal learning network clusters and taking cognisance of the inner workings of these clusters. The benefits of belonging to a PLN cluster are notable and should be advocated to students at the onset of their academic careers.

References

- Attwell, G. (2007). The personal learning environments – the future of e-learning? *eLearning Papers*, 2(1). Retrieved 2013, March 7, from <http://elearningeuropa.info/files/media/media11561.pdf>
- Chatti A. C., Agustiawan M. R., Jarke M., & Specht M. (2010a). Toward a personal learning environment framework. *International Journal of Virtual and Personal Learning Environments*, 1(4), 66-85.
- Chatti A. C., Agustiawan M. R., Jarke M., & Specht M. (2010b). The 3P learning model. *Educational Technology and Society*, 13(4), 74-85.
- Coates, H., James, R., & Baldwin, G. (2005). A critical examination of the effects of learning management systems on university teaching and learning. *Tertiary Education and Management*, 11, 19-36.
- Conde, M. A., García, F. J., Alier, M., & Casany, M. J. (2011, July). *Merging learning management systems and personal learning environments*. Paper presented at Personal Learning Environments Conference 2011, Southampton, UK. Retrieved 2014, October 2, from <http://journal.webscience.org/559/>
- Couros, A. (2010). Developing personal networks for open and social learning, *Emerging Technologies in Distance Education*, 6, 109-128.
- Desmond, N. (2013, November). Seven Benefits of Study Groups [Blog post]. Retrieved 2014, October 23, from <https://www.speedyprep.com/blog/7-benefits-of-study-groups/>
- García-Peñalvo F. J., Conde M. Á., Alier M., & Casany M. J. (2011). Opening learning management systems to personal learning environments. *Journal of Universal Computer Science*, 17(9), 1222-1240.
- Graf, S., & Kinshuk, K. (2007). Providing adaptive courses in learning management systems with respect to learning styles. In T. Bastiaens & S. Carliner (Eds.), *Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2007* (pp. 2576-2583). Chesapeake, VA: AACE. Retrieved 2014, October 25, from <http://www.editlib.org/p/26739>.
- Hogg, M. A., Hohman, Z. P., & Rivera, J. E. (2008). Why do people join groups? Three motivational accounts from social psychology. *Social and Personality Psychology Compass*, 2, 1269-1280.
- Ito, M., Gutiérrez, K., Livingstone, S., Penuel, B., Rhodes, J., Salen, K., Schor, J., Sefton-Green, J., & Watkins, S. C. (2013). *Connected learning: An agenda for research and design*. Irvine, CA: Digital Media and Learning Research Hub.
- Ivanova, M. (2009). From personal learning environment building to professional learning network forming. *Proceedings of the 5th International Scientific Conference “eLearning and Software for Education” (eLSE)*, (No. 01, pp. 27-32). Bucuresti, Romania: Universitatea Nationala de Aparare Carol I. Retrieved 2014, October 5, from www.ceeol.com
- Kaufman, D., Sutow, E., & Dunn, K. (1997). Three approaches to cooperative learning in higher education. *Canadian Journal of Higher Education*, XXVII(2,3), 37-66.
- McMillan, D. W., & Chavis, D. M. (1986). Sense of community: A Definition and theory. *American Journal of Community Psychology*, 14(1), 6-23.
- Paulsen, M. F. (2003). *Online education and learning management systems: Global e-learning in a Scandinavian perspective*. Oslo, Norway: NKI Gørlaget.
- Roger, T., & Johnson, D. W. (1988). Cooperative learning two heads learn better than one. In *Context #18 Transforming Education*, 18, 34. Retrieved 2014, October 13, from <http://www.context.org/iclib/ic18/johnson/>
- Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.
- Sclater, N. (2008). Web 2.0, personal learning environments, and the future of learning management systems. *Research Bulletin*, 13(13), 1-13. Retrieved October, 20, 2014 from <http://net.educause.edu/ir/library/pdf/erb0813.pdf>
- Siemens, G. (2004, November). Learning Management Systems, the wrong place to start learning. Retrieved 2013, March 20, from <http://www.elearnspace.org/Articles/lms.htm>

- Swan, K., & Shea, P. (2005). The development of virtual learning communities. In S. R. Hiltz & R. Goldman, *Asynchronous Learning Networks: The Research Frontier* (pp. 239-260). New York, NY: Hampton Press.
- Tobin, D. R. (2000). *All learning is self-directed: How organizations can support and encourage independent learning*. Alexandria, VA: American Society for Training and Development Press.
- Tu, C. H., Sujo-Montes, L., Yen, C. J., Chan, J. Y., & Blocher, M. (2012). The integration of personal learning environments & open network learning environments. *TechTrends*, 56(3), 13-19.
- Vovides, Y., Sanchez-Alonso, S., Mitropoulou, V., & Nickmans, G. (2007). The use of e-learning course management systems to support learning strategies and to improve self-regulated learning. *Educational Research Review*, 2(1), 64-74.
- Wagner, J. A. (1995). Studies of individualism-collectivism: Effects on cooperation in groups. *Academy of Management Journal*, 38(1), 152-173.
- Wild, F., Kalz, M., & Palmér, M. (2010). Mashup - Personal Learning Environments. In F. Wild, M. Kalz, & M. Palmér, (Eds), *Proceedings of CEUR workshop Proceedings, the 3rd Workshop MUPPLE'10. Barcelona, Spain*. Retrieved February 14, 2014 from <https://sites.google.com/site/muppleworkshop/home/proceedings>
- Wilson, S. (2008). Patterns of personal learning environments, *Interactive Learning Environments*, 16(1), 17-34.
- Wilson, S., Liber, O., Johnson, M. W., Beauvoir, P., Sharples, P., & Milligan, C. D. (2007). Personal learning environments: Challenging the dominant design of educational systems. *Journal of e-Learning and Knowledge Society*, 3(2), 27-38.