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Conceptual design and empirical study of a personal learning environment and network (PLE&N) to support peer-based social and lifelong learning [1]

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Abstract

Purpose – This paper describes a conceptual design of PLE&N (Personal Learning Environment & Network) and a learning model developed in support of peer-based social and lifelong learning in higher education, which collaborate with classroom learning.

Design/methodology/approach – The model consists of students, instructors and external parties interacting synergistically in learning in PLE&N-enabled courses based on the collaborative designs of instructor-led pedagogical approach and external parties-assisted lifelong learning "first-mover" development. The research constructs, tests and assesses this model in courses of twelve subjects in nearly two years.

Findings – The practicality of the designs is evidenced in post-course surveys and reflected by students' ability in productively using collaborative resources over the Internet to create an ever-expanding personal learning space stretching from home to campus and beyond, oriented towards individuality, universality, ubiquity, interactivity, and connectivity.

Originality/value – The research contributes to PLE&N, social and lifelong learning seamless integration in theory and practice to dramatically enhance students' virtual learning skills.

Keywords

Personal Learning Environment and Network (PLE&N), Interactive learning environment, Social learning, Lifelong learning, Higher education, Social media

1. Introduction

Around the clock and around the world, lectures and tutorials are delivered in campuses to connect teaching professionals with learning students in higher education institutes. This brick and mortar synchronous teaching/learning is still the norm today as it was in the past centuries. However, when low-cost, convenient person-to-person connectivity by text, voice and pictures happens almost spontaneously and universally, stakeholders in higher education – administrators, teaching staff and students, have already started to find ways to take advantage of this ubiquitous connectivity in students' learning, a connectivity enabled by information technology, the Internet and advanced personal communication devices and services. They may have already participated in online forums over the Internet to discuss or share views on certain topics with peers resident locally or in other countries or accessed learning materials available in the cyber-space for self-learning. They envision that existing technologies can provide a new, effective way for learning and teaching to take place asynchronously in different locations, making face-to-face classroom teaching only one of the popular methods of transferring knowledge from teachers to students. They also expect that students can learn from many sources by many means anywhere any time.

The myriad technology-enabled new learning sources and means not restricted by time and space necessitate good management and training so that students can get maximum benefits out of them to develop their potential to the fullest. Teachers or educators, therefore, are expected to provide guidance on setting up and expanding a responsive personal learning environment to effectively leverage on and then optimize the use of existing or emerging learning resources and technologies. This environment is often referred to as PLE&N (Personal Learning Environment and Network) (Valtonen *et al.*, 2012). In general, a PLE&N consists of computing/communication devices, networks connecting a vast number of people and electronic learning resources, software for various learning activities and large-scale repositories of knowledge and information. In a typical PLE&N which is student-centered, a student develops deep cognitive skills for problem solving and collaborative work with others as well as acquires those qualities or attributes (e.g. self-regulated learning attitudes) required for lifelong learning after graduation. As information and communication technologies are progressing rapidly, new/enhanced incarnations of hardware and software tools are the market trends and students need to evolve their learning skills over time with the assistance of their teachers. In parallel, researchers and practitioners in the educational technology field also need to advance the theory and practice at a fast enough pace in the expanding universe of PLE&N. Because of these efforts, some even suggest that PLE&N would be the next big step forward in educational technology development to meet the demands of knowledge society (Mott, 2010).

Today, some forward-thinking researchers, instructors and students gather together informally in the ubiquitous social media to discuss course materials and express views or comments in an attempt to learn and progress collaboratively. However, many of the efforts are small scale trial or pilot runs with experimental results to be analyzed or validated. This situation would be explained by the fact that PLE&N is still in the early stage of development without solid established frameworks to describe its purposes, functions and impacts on students constructing their new learning environments (Kop and Fournier, 2013). Going forward, what is needed is to put theory into practice and formally include this new learning mode in a university course and students are systematically trained and guided to participate in it as an integral part of the curriculum. In this way, human progress will no longer be slowed down by traditional learning.

1.1 Objectives of the research

With consideration of the learning challenges faced by higher education stakeholders discussed above, the research aims to put the paradigms of PLE&N (Personal Learning Environment and Network), peer-based social learning, and lifelong learning in students' learning space and minds while they are in university for their benefits inside and outside a classroom.

Based on a sound, solid theoretical foundation, the first objective is to develop a conceptual framework of study which logically links the infrastructure components (hardware, software and network), learning activities/interactions, learning resources and learners together structurally and functionally in the whole learning space of students, instructors and other participating parties. In so doing, a learning model of three interacting layers is developed. Seeing that nearly all university students were brought up in traditional classrooms (they still are today and hopefully less so in the future), the next objective is to integrate the peer-based social learning theory into the conceptual

design and introduce it to them and lead, encourage and motivate them to practice this new method of learning on the PLE&N platform. Resistance to change, feeling of loss, confusion and frustration (in some cases) which may happen among students are overcome by another objective. It is the objective to propose and adopt a detailed, theoretical pedagogical approach to put PLE&N learning into practice among the students to increase learning effectiveness in a well-planned, organized, guided, assisted (online and offline) and engaged manner. The last objective, which is often overlooked by many researchers but very crucial to students' long-term learning interest, is to theoretically link the new learning mode and its physical context with the lifelong learning needs of students in university, later work, social or private life, in a knowledge-intensive and technologically-oriented world they face now and more in the future.

The learning outcomes of these objectives will be assessed by end-of-course surveys of participating students for review and improvement opportunities.

2. Theoretical background and relevant work

2.1 Development of learning modes leading to PLE&N

Face-to-face communications and interactions in all possible forms including voice, eye contact, facial expression and movement or gesture of different parts of a body have long been used together with teaching aids and course materials in traditional teaching-learning activities in higher education for hundreds of years. This is enabled by the presence of teaching staff and students in a place, typically a lecture room or a laboratory in campus, for a pre-determined period. Because of advances in teaching methodology and technology, other forms of teaching or learning have emerged to complement the traditional mode of learning which still remain the most dominant and important vehicle for knowledge transfer and acquisition. Online education is one example where students learn a subject by using electronic course materials delivered to them over a network to their computers and the software allows some form of interactions with the course content also through their computers. This newer form of learning, sometimes called e-learning, is supported by the development of a LMS (Learning Management System). A LMS serves a number of functions. It facilitates the organization, retrieval and delivery of course materials, storage, updating and reporting of student learning records and administration of schools or universities. However, online learning and LMS provide very limited interactivity and collaboration with peer students or instructors, which was considered important in learning effectively (García-Peñalvo *et al.*, 2011; McCombs, 1991). The use of the now popular social media was suggested as a potential solution to address the need to communicate and interact with other learners or instructors to continue learning after the formal classroom teaching or discussion session (García-Peñalvo *et al.*, 2011; Milligan *et al.*, 2006). Social media becomes the platform for learners to practice social learning which in simple words is to learn together with peers in a social group such as a class or a project in the physical or virtual space.

To be an effective learner, students have the need to organize learning materials and collected information to allow for later quick retrieval in doing their assignments and assimilating knowledge. They want to store their views, comments, alternative ideas, insights or other learning outcomes all in a single place to extend or enhance knowledge (García-Peñalvo *et al.*, 2011; Milligan *et al.*, 2006). LMS is very far from providing this preferred learning environment.

Therefore, the concept of PKM (Personal Knowledge Management) emerges in response to this learning need (Jefferson, 2006). PKM provides a framework for a learner to efficiently enrich his/her personal knowledge repository so as to apply his/her knowledge to solve old and new problems and possibly create new knowledge (Cheong and Tsui, 2012). On the other hand, because of the proliferation of free and features-rich Web 2.0 tools on the Internet for PCs (followed by tablets and smartphones recently), learners start to use a set of such tools chosen according to personal preferences and integrate them to do their own versions of PKM to manage personal knowledge database. The use of social media and Web 2.0 tools together leads to the concept of Personal Learning Environment and Network (PLE&N) whose objective is to provide a strong framework within which a learner connects to others, share information, collaborate and effectively manage stored knowledge all in one environment without going through separate systems like LMS or separate tools for PKM. In recent years, the use of PLE&N in education has begun to gain traction (Dabbagh and Kitsantas, 2012). The use of social learning is gaining popularity too. A survey conducted in 2011 found that about two thirds of 2,000 professors contacted made use of some forms of social learning to a certain degree (Wolf *et al.*, 2012).

2.2 Manifestation of PLE&N

Attwell (2007) offers a definition of PLE&N more independently of where the software tools come from or reside and can be generally adopted. PLE&N is a space of personal computing devices, networked computer systems storing system programs, databases and information/knowledge for shared access, communications network infrastructure, software tools running locally or remotely and traditional everyday's learning tools or aids. These components and learners themselves are all connected over the network as to share, acquire, update and create knowledge. The learner can easily adapt these components to suit his/her learning goals, style and needs. Social software is the predominant software tool to use for learning.

Sclater (2008) offers three visions of PLE&N based mainly on the physical locations of the software tools used in learning. In the first vision, the software is resident in the learners' computers and can be used offline as well as online. During online mode, the software interacts with other networked learners and networked information storages. Information or knowledge can be viewed instantly on screen or shared by upload and download of files. In the second, the software tools are located in the host computers for shared use by connected learners. Social software is a common example. In the last vision, it simply refers to the existing computing devices, software tools (resident locally or hosted remotely) and online learning resources, all of which are already in active use. However, the breathtaking speed of IT advances since Sclater (2008) has made the applicability of these three visions quite irrelevant in today's terms. For example, the popularity of apps in smartphones and tablets have blurred the distinction of the three visions. Typically, many apps from apps stores are downloaded in local computing or functions and can interact with software applications hosted on servers to access information or learning resources stored remotely. In fact, most apps combine the functionalities of local software and remotely hosted software seamlessly as an integrated whole to provide the necessary functions useful to learning.

(See also Appendix A for additional theoretical background.)

3. Conceptual research design of PLE&N study

The conceptual research design of the PLE&N study consists of two parts: virtual learning space design and learning model design. The latter is further sub-divided into pedagogical approach design and lifelong learning development design. The objective of the whole design is to create a framework to study peer-based social and lifelong learning of students in higher education.

3.1 Virtual learning space design

Conceptually, the components of virtual learning space to support peer-based social and lifelong learning in higher education is as shown in Fig. 1. Basically, the conceptual design consists of two main sets of components: the set of concentric circles at the center and the set of rectangles joined by arrows on the periphery. It is essentially an entity-activity diagram where an entity is a group of related physical objects (e.g. students, PCs and servers) or virtual objects (e.g. videos and knowledge) and an activity is an action performed between entities. In the diagram, the circles represent layers of hardware, software and data stored which a student can go through transparently to perform learning activities at the center and the rectangles represent entities and arrows show how the actions are performed. For example, the learner entity (the rectangle at the bottom center) consists of persons participating in learning: students, instructors, professionals and past students, and the posts (read/write) and files upload and download (on the right) are activities both of which are represented by two bi-directional arrows.

The three concentric circles represent the hardware, software and data stored making up the platform of PLE&N on which social, peer-based learning takes place. The innermost circle, cloud repository, consists of host computers, servers, storage devices, databases and data management software to provide update and retrieval services of knowledge and learning resources to entities on the outermost boundary. The next circle, Internet connectivity, on the other hand, consists of communication hardware and software for network connectivity which together provide the ubiquitous global Internet services. The third circle, the outermost, presents the user-friendly interface of collaborative software tools running on desktop or mobile computing devices for learners to access the cloud repository through the Internet connectivity circle. The two bi-directional arrows (bottom center and bottom right) between the innermost circle and the two concerned entities illustrate such multi-layer connection which in fact applies to all entities on the periphery. Furthermore, the three-layer PLE&N infrastructure also enables object to object, entity to entity or learner to learner communication (only partially shown in the diagram). On the outermost boundary, the social, peer-based learning is represented by the main cycle starting from the learner community entity, going in an anti-clockwise direction through “connect, engage, reflect, collaborate”, “text, image, video, hyperlink”, “categorize, store, retrieve, aggregate’’ and “knowledge domains”, and finally being back to the learner community. There are sub-cycles between entities like ‘uploading and downloading of files’.

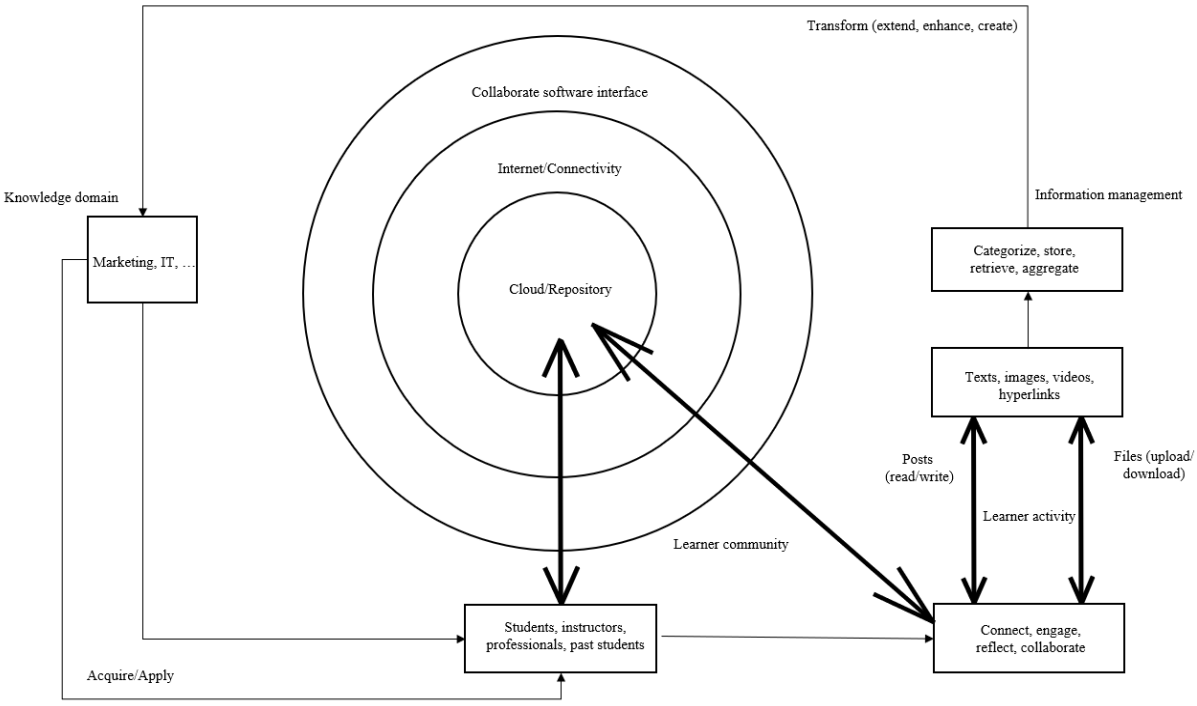

Fig.1. Virtual Learning Space

3.2 Learning model design

Based on the virtual learning space, a learning model is designed for use by students in peer-based social and lifelong learning. The model consists of three layers: instructors layer, students layer and external parties layer, which together resemble a hamburger and hence its another name is the hamburger model. The whole design is centered on students, making the middle layer compose of students. The three layers correspond to the three most important groups participating in the PLE&N study. Any two layers will not make a complete hamburger without the third. As shown in Fig. 2, there is intra-layer communication and interaction in each layer and inter-layer communication and interaction between any two layers as well. While the layers represent the model structurally, it is the loops of bi-directional information flow (as shown by bi-directional arrows in the diagram) that make up the functional representation. The focus of the instructor layer is the adoption of a pedagogical approach design to train students to learn socially. The bottom layer, the external parties layer, adopts a lifelong learning design to help students understand and develop lifelong learning in university and seamlessly transition to post-graduation lifelong learning. Members in the middle layer will be guided, instructed, directed or influenced by members in layers above and below, making the middle layer be peppered with various learning ingredients which are tools, methods, skills, experiences, attitudes, behaviors and a lot of others.

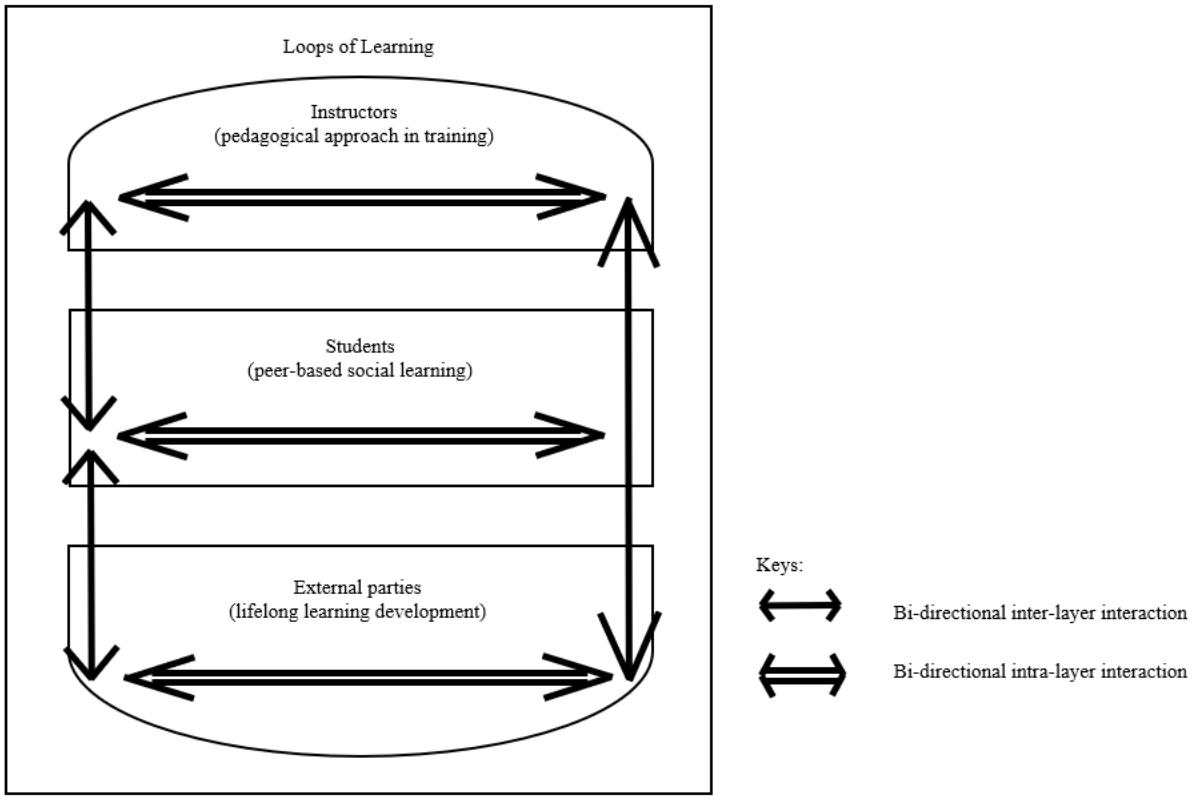

Fig. 2. The Learning Model

3.2.1 Pedagogical approach design

The design of the pedagogical approach to help students practise peer-based social learning is described along side with its comparison with a pedagogical framework proposed by Dabbagh and Kitsantas (2012). In this way, the new, more effective design features are better explained.

At level 1 of the said framework, the instructor encourages students to use social media to create a personal learning network to get into contact with others in the self-regulated learning process. In this study, all the collaborative software tools required will be set up and customized for students according to their needs (to be identified in interviews) and a fully usable PLE&N will be available to them right at the beginning of a course. Students are then introduced to the components of the PLE&N and trained how to best use them. The PLE&N support team can also be contacted when necessary. The instructor encourages them to use the collaborative software as much as required in their learning after attending the lectures.

At level 2 of the same framework, the instructor encourages students to use social media for sharing information and collaborative work. In the current design, during the classroom lecture hours, the instructor promotes the active use of collaborative software for communication and co-study with other students. Not limited to this, the instructor while online is also a very active member of the learning group, making frequent uploads of articles for sharing and responding regularly to many posts from other participants. The active participation not only promotes the new form of learning but also has the effect of stimulating interest and motivating students to be

more active and reflect more on information or knowledge obtained from the online social learning.

At level 3 of the framework, Dabbagh and Kitsantas (2012) encouratge the learners to annotate, combine, and summarize knowledge obtained at Levels 1 and 2 and reflect on them. Valtonen *et al.* (2012) also finds that PLE&N contibutes to knowledge assimilation and reflection in their trials. In the pedagogical approach of this study, more learning activities are planned and their scopes are greater. Throughout the course, the importance of relevancy of shared contents to the subject studied is emphasized constantly by the instructor. Such high relevancy applies to views, comments, and articles (self-written or not) and even shared resource hyper-links. Participants will be encouraged to put required efforts to search, select and do some level of aggregation before uploading files or after downloading them. They will be assisted in how to assimilate and reflect on information coming to and leaving them during the whole learning process in order to have a reasonable relevant content output. To help achieve the high content relevancy goal, two methods will be adopted. The first one is the role model approach in which students could learn the filtering, searching aggregating and reflecting skills from the posts or files transferred by their instructors who in this particular instance are experts in knowledge management and learning. In the second, an assessment grade at the end of a course is 'designed into' the approach to evaluate activities of individual students in the new mode of learning. The motivation to get a better grade has the positive effect of particularly influencing student to actively participate and reflect on their experiences, knowledge gained and learning skill level achieved during the full length of the course.

PLE&N is not a technological application but a new and significant attempt in learning. Successful assembly of hardware, software and network to build a personal learning environment infrastructure is only the prerequisite. It is the pedagogical learning approach adopted afterwards that matters most – assisting students in understanding, compiling and synthesizing contents. The work by Attwell (2007) and Drexler (2010) shows earlier signs of this situation.

3.2.2 Lifelong learning development design

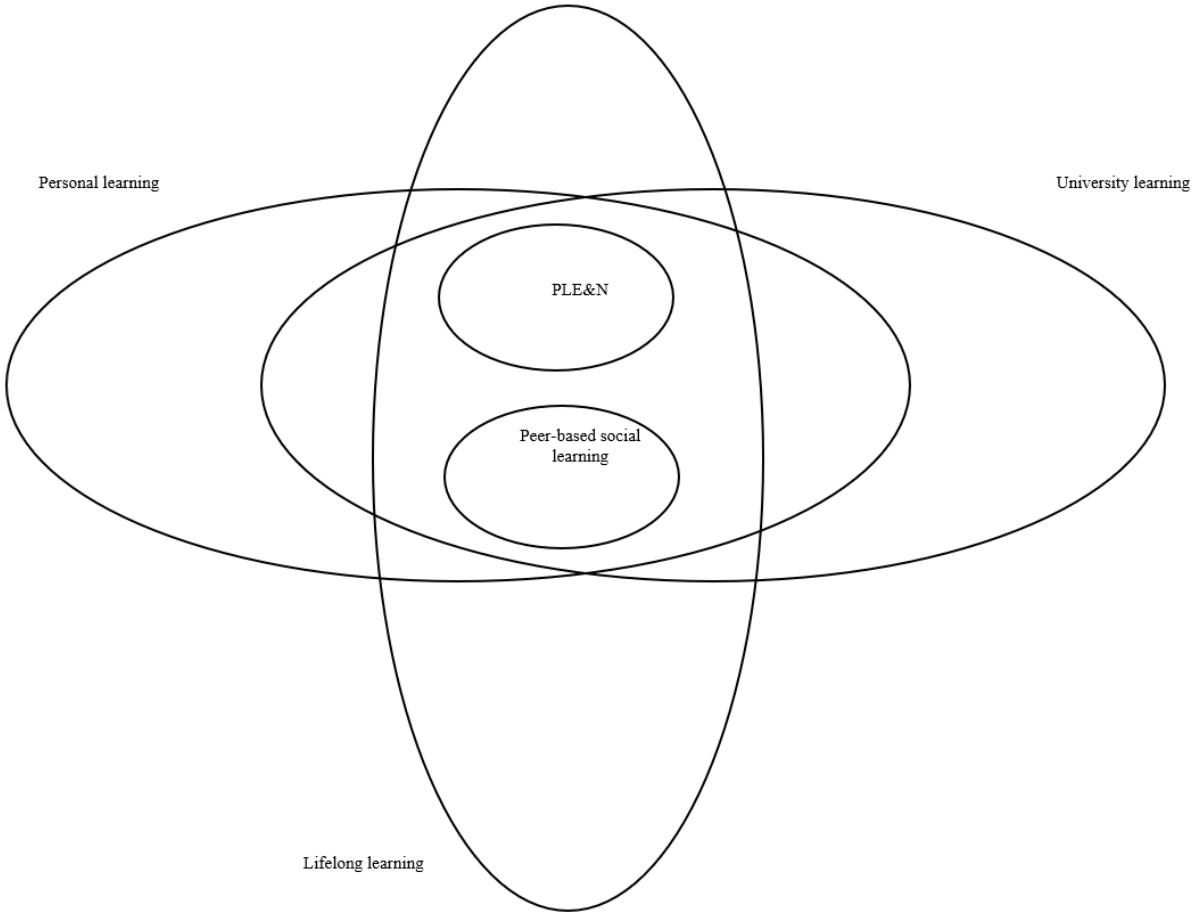

Fig. 3. Conceptual overlapping lifelong and other learning in higher education

It is quite uncommon that lifelong learning is taken into consideration in the higher education context as students are still young learners by most measures. However, globalized knowledge-intensive economy demands that higher education should take care of students' learning needs while they are in campus as well as prepare them well for post-graduation learning. This learning is necessarily lifelong in nature because students need continuous self-improvements and knowledge acquisition to meet and adapt to fast or big advances in workplace or society. Therefore, the lifelong learning element is incorporated into the whole design of peer-based social learning in student courses in the current study. In earlier PLE&N investigations, Attwell (2007) mentions off-campus access advantage of PLE&N, and Väljataga and Laanpere (2010) describe other advantages like communication, socialization, team work, and class-independent time and space. Even so, they and other scholars stop short of linking these advantages found with lifelong learning, which is important in fact.

A very critical component in the design of lifelong learning part of the study is the invited or volunteered participation of past students, outside professionals, and other interested external parties in the learning course activities over the Internet. As these external joiners are also knowledgeable in the subject being taught, their interactions with students tend to be contributive

to the students' learning. In addition, such mixing with parties outside campus who have more expertise is a situation closer to the likely lifelong social environment they would work or live in after graduation. Students are thus exposed to and practice a certain mode of lifelong learning on an assisted, stimulated and directed platform in university in preparation for a more demanding but similar learning in the future.

With the participation of enthusiastic external parties from enterprises taking the advisory roles, students will be convinced that the new, information technology-enabled learning environment they use in courses is in fact also for the future and that they can continue to refine, enhance, expand and change throughout life as they wish according to their needs and personal preferences. At the same time, they will be advised by the instructors or external parties like past students to take responsibility and ownership of their learning activities, benefiting from the good results and learning from the bad ones of what they have done. Self-ownership and related ones such as self-control, self-initiative and self-help are all typical basic characteristics which lifelong learning promotes and supports. Students may learn examples of such learning attributes by observing the learning behaviors of professionals they come to know or admire when interacting with the external parties. Ndongfack (2016) and Attwell (2007) have also identified personalization, self-control and continuous improvement in learning in PLE&N in their studies.

Learning from peers, superiors, experts or anyone for that matter is desirable if not mandatory in students' long learning life after finishing higher education. This is not limited to the knowledge or a subject's contents. Students will also acquire and practice the methods of learning by seeing and getting involved in how these methods are applied by more experienced people – the participants of PLE&N in the lower layer of the hamburger model. The methods include basic ones like reading, searching, selecting, filtering and sorting and more advanced ones like commenting, consolidating, summarizing, brain storming, analyzing, evaluating, reflecting, extending/creating contents, and a host of others. The close and frequent interactions during the course with the external parties layer, encouraged by the virtual, friendly atmosphere created as a result of the design, will speed up the transformation of these methods into personal skills or permanent habits in cyberspace. Students will be more convinced of the lifelong concept of learning by seeing it done by trusted and mature parties and believing it will then quickly follow.

Furthermore, in fostering technology-friendly attitude among students in the courses employing PLE&N, the external parties can contribute in ways more effectively than course instructors. When an external party expresses his/her views about a topic or comments on ideas, he/she may draw examples from technological applications he/she comes across in the past or in their current job and explains how technology enables or facilitates a task to be done. As these external parties may come from different industries or business sectors, students may get valuable exposure to real world examples of technological applications of various types which may stimulate students' quests for more information. The style of learning and practice of skills in PLE&N itself is already technology-oriented. The external technology examples will further enhance technology-friendly attitude of students who very likely perform their future jobs in increasingly knowledge-intensive, technology-enabled enterprises. The technology-oriented skill set of peer-based social learning acquired will become even more relevant in their lifelong time at work before retirement than the relatively brief period in university.

In real life, lifelong learning can take many forms. The whole design of the external parties layer of the hamburger model is for students to come into active contact with them and learn from them their lifelong learning attitudes, behaviors and skills in a productive, effective and agile manner by integrating peer-based social learning in the two contexts synergistically – campus and business world. In this way, students will be stimulated to consider and prepare for other forms of lifelong learning already existed as well as the emerging ones in the future. They will live with the new mode of learning proposed by the hamburger model in later life, improve it over time and get incremental advantages at different stages of life. In fact, the model will facilitate them to stay in the same virtual learning world which will expand after graduation but assume a different role – that of lifelong learning professionals.

4. Research methodology for design evaluation

In conducting the evaluation of the conceptual PLE&N model designed, two different methodological approaches were adopted, each addressing the needs of an area of the assessment and they were: semi-structured interview and questionnaires.

4.1 Semi-structured interview to identify learning needs of students

Semi-structured interview was chosen for identifying the students' learning needs in their studies. In this approach, the interviewer is at a short distance from the students and both parties are free to use facial expressions and other body gestures to communicate an idea, a thought, a view, a response, a fact or even a counter-question in addition to spoken words. Also their minds stay closer to each other too. These two advantages enable the subject matter to be examined and investigated more effectively and thoroughly (Morehouse, 1994). Therefore, this approach was regarded as appropriate for the purpose intended. An interview guide was prepared to assist the interview process, consisting of open-ended questions aiming at exploring the background, learning motives and learning experiences of students. In actual interviews, follow-up questions were raised where appropriate to obtain more in-depth understanding of students' thinking, which is another feature of this form of interview (Shaw and Huang, 2005). A total of 15 students were interviewed who were either undergraduate or postgraduate students. All interviews were face-to-face, each lasting around 40 minutes. At the beginning of the interview, a PLE&N overview was given, drawing on analogies from their existing knowledge and experiences in using the common productivity and communication software on PCs or smartphones which they were quite familiar with. The interview was not only for obtaining information, but also for making interviewees think more deeply or take into account other factors not considered before.

4.2 Survey to evaluate learning results of students

A questionnaire was designed to get the feedback of students on their experiences with the new mode of learning in order to access the PLE&N effectiveness. The questions made use of eLearning assessment criteria in past studies done by Chang (2001) and Shee and Wang (2008). The questionnaires were distributed to students at the end of a course.

The questions cover these areas: (a) usefulness in learning a subject, (b) encouragement in learning with peers, (c) updatedness of information exchanged, (d) scope of information exchanged

compared to subject syllabus, (e) recommendation to other courses or students, and (f) worthiness of staying in the same PLE&N after course completion. The four items for analyzing comparison data between undergraduate and postgraduate students are: usage, user-friendliness, relevancy and usefulness. The questionnaires also collect students' comments or opinions for analysis. See Appendix B for the details of questions.

Table 1
Four items in PLE&N study

Items	Definition
Usage	Usage of PLE&N during the course
User-friendliness	User-friendliness of PLE&N when in use
Relevancy	Relevancy of contents posted for the topic under discussion
Usefulness	Usefulness of contents posted in improving understanding of the subject

4.3 Data collection

PLE&N was adopted in 12 subjects taught by teachers in a university in Hong Kong and the study period lasted for 20 months. A total of 632 questionnaires were collected. Questionnaires with one or more unanswered question(s) were considered invalid and removed, resulting in 571 usable questionnaires (90.348%) for further cleaning up. If a student took part in the survey for more than one time because he/she studied more than one subject, only the first reply to the survey was counted, to be consistent with other students who were surveyed only once as first-time users. This filtering reduced the number of usable questionnaire to 372 (23 outlier cases were also removed as explained in section 5.2.1), with 171 questionnaires (45.966%) from undergraduate students and 201 (54.032%) ones from postgraduate students.

4.4 Data analysis

The data analysis consisted of two levels: descriptive analysis and independent t-test analysis. The former was to evaluate the learning results of students using PLE&N in their subjects and the latter was performed to determine if there was a statistically significant difference between the means of the two groups of students (undergraduate and postgraduate) for the four items in Table 1.

Before the Independent-samples t-test, three assumption tests were performed for the four items. 23 cases were classified as outliers as demonstrated by the box plots and were removed from the data set. The test of normality, as assessed by the inspection of Normal Q-Q Plots, showed that the four items were approximately normally distributed for each group of students. There was homogeneity of variances for the four items, as assessed by Levene's test for equality of variances. The significance values (p-values) for each item as shown in Table 4 were greater than 0.01 ($p > 0.01$), indicating that the variance in undergraduate and postgraduate groups were equal. Therefore, the assumptions of the Independent-samples t-test were met.

Table 2
Results from Levene's test

Item	p
Usage	0.393
User-friendliness	0.241
Relevancy	0.011
Usefulness	0.802

Independent-samples t-test was used to test, for each of the mean scores of the four items: usage, user-friendliness, relevancy and usefulness, whether the differences between the undergraduate and postgraduate students, if any, were a result of sampling variation or the differences really existed in the population. In other words, it was used to test whether the population means of the two groups of students were different, not only the sample means. The confidence interval (CI) for the t-test was set as 99%. The effect size, Cohen's d, which measures the practical significance of the result, was calculated.

In general, the mean score of postgraduate students in the four items was higher than that of undergraduate students at a confidence interval of 99% as shown in Table 3. All the p-values of the four items were greater than 0.01, indicating that there was statistically significant difference in the mean score between the two levels of students in these four items indicated by an asterisk (*) as shown in Table 4. The effect sizes for SU and CR were medium and those for SUF and CU were between small and medium according to the importance value of Cohen'd reported by (Cohen, 1988).

Table 3
Mean scores in four items

Item	Undergraduate student		Postgraduate student	
	Mean	S.D.	Mean	S.D.
Usage	2.526	0.897	2.988	0.988
User-friendliness	3.421	0.744	3.664	0.690
Relevancy	3.594	0.653	3.841	0.559
Usefulness	3.392	0.818	3.704	0.827

Table 4
Results from independent-samples t-test

Item	Difference	99% Confidence interval of the difference		t	d	Strength
		Lower	Upper			
Usage	0.461	0.206	0.716	-4.682*	0.487	Medium
User -friendliness	0.243	0.050	0.436	-3.268*	0.340	Small to medium
Relevancy	0.247	0.085	0.410	-3.936*	0.409	Medium
Usefulness	0.312	0.091	0.534	-3.648*	0.379	Small to medium

*$p < 0.01$.

5. Findings and discussion

In this section, the major findings of the study are presented and discussed, including learning needs of students, evaluation of the PLE&N design, and differences between undergraduate and postgraduate students in using PLE&N and lifelong learning.

5.1 Learning needs assessment of students

The learning needs of the participants were divided into two groups: undergraduate and postgraduate students. The results obtained in the semi-structured interviews with the students showed differences between them.

(a) Undergraduate students
Undergraduates generally had no or a little working experiences or only some internship experiences. Their learning needs were centered on course grades, skill sets acquisition and personal interest discovery, academic or career. Those who were more concerned with future career showed more interest in improving learning skills, learning from others, especially the experienced and good internship training.

(b) Postgraduate students
The postgraduate students could be further divided into two sub-groups: full-time students and part-time students. Full-time students normally only had some working experiences before starting their postgraduate studies. They put more emphasis on having an advanced collaborative platform for inter-personal communication, knowledge/ideas sharing and discussion, retrieving and organizing research information and efficient file sharing on the cloud. Their part-time counter-parts, on the other hand, had day time jobs and thus their learning needs were more on efficient communication, productive collaboration and beneficial sharing of learning/working experience with others.

In general, the learning needs of the two groups were different.

5.2 Evaluation of PLE&N design

The descriptive data analysis results of the questions in the survey are as follows.

(a) Usage:
Google+ and Feedly reader were the two most used tools by students in their PLE&N activities during the course. The weekly total usage time of Google+ among students were: 30-60 minutes (37.6%) and over 60 minutes (29.9%); and those of Feedly were: 30-60 minutes (31.5%) and over 60 minutes (20.2%). Therefore, students spent more time in posting in social media Google+ than in reading articles in Feedly. This was expected as social media offers interactive communication with other students which may be more interesting than reading articles in Feedly. Given that using PLE&N in learning was new to them and was not a great part of a busy course, the usage time could be considered high in general.

(b) User-friendliness:
Quite good responses from students were obtained for the questions about the user-friendliness of the PLE&N. On a scale of 1(least user-friendly) to 5 (very user-friendly), the results were: '1' (0.3%) and '4' or above (67.5%) for Google+; and '1' (4%) and '4' or above (43%) for Feedly. Maybe Google+ is more popular than Feedly and presents a very familiar social media user interface, making it score higher than Feedly which is less known and has less users. Putting this comparison aside, the user-friendliness scores of both software applications are high, implying that the two kinds of software is easy to use. The results showed high quality work of the team in selecting the collaborative tools to be used, getting user requirements for customization and training offered to use the tools.

(c) Content relevancy and usefulness:
The percentages of students found that the contents in PLE&N were relevant to the course were around 74.7% and 54.3% for Google+ and Feedly respectively. With regard to whether the contents helped them understand the course better, their responses were: 'somewhat' (32.5%) and 'mildly slightly to very much' (58.1%) for Google+; and 'somewhat' (36.6%) and 'slightly to very much' (48.2%) for Feedly. The question asking them whether both applications provided up-to-date information about the course yielded the replies of 'sometimes' (36.3%) and 'often/always' (59.1%). Thus on the whole, both software applications provided relevant, helpful and updated contents for the courses, though Google+ scored somewhat higher than Feedly in the favorable responses category.

(d) Overall opinions/remarks about the system:
The students learning activities were in general not restricted by topics in the syllabus. They responded that some of the contents were beyond the syllabus but also useful. Their responses to whether contents discussed were outside the syllabus were: somewhat (32.3%), slightly (40.1%) and very much (19.4%). Equally impressive was that they also discussed the contents with other students when they met, with response results as: 'sometimes' (46.5%) and 'often to very often' (15.8%). These two sets of responses explained why in answering the question asking them whether the PLE&N raised their course assessment grade, 44.6% considered it 'somewhat' and 40% considered it 'considerable to very much'. The results also explained why when students were asked whether they would like to implement PLE&N in other subjects, their responses were:

'maybe' (31.5%) and 'some or all other subjects' (55.9%). The possible underlying reason for the consistencies across these questions was that PLE&N style of learning – sharing, discussing and commenting – provided them good opportunities to reflect on what they learnt in lecture rooms and over the Internet, thus improving their understanding of the course materials. Besides, PLE&N made them think and sometimes actively engage in going beyond the syllabus to explore the subject taught further, not alone but with other students and instructors together.

Lastly, the survey indicated as well that the PLE&N became friendly and personal towards the end of the courses. This was supported by the students' replies to two questions. They responded with 'remove me immediately' (0.0%), 'removed me later' (4.8%), 'wait and see' (38.7%) and 'keep me registered' (56.5%) to the question asking them whether they would like to be removed from the PLE&N after the course is finished. When being asked whether they would recommend PLE&N to others for learning, on a scale of 1(least recommend) to 5 (most recommend), they were highly in favor of the PLE&N as shown in the response results: '1' (0.3%) and '4' or above (53.9%). Therefore, most students had positive experiences with the PLE&N. Such high recommendation rate also reflected one important phenomenon – high loyalty to the PLE&N and to the learner community – an important attribute developed naturally towards the end of the course, which was not thought of before when the study started. Furthermore, these figures were high and encouraging because both students and instructors, as creators or assessors of those contents (ideas, comments, views and news or articles from other sources), had put more than average time and efforts to ensure high quality of contents being shared. They showed their good team work results which were important in PLE&N learning. This also implied that the PLE&N provided a platform or medium to motivate them to share and collaborate.

Considering the response results of all the questions mentioned so far together, it follows that the quality of contents of the course and its delivery to learners belonging to the same PLE&N community was high. This high quality was a direct result of all contributions of every learner.

5.3 Differences in adoption of PLE&N between students

The first major finding from the independent t-test is that the postgraduate students regarded the system to be user-friendly but the younger undergraduate students rated this aspect less favorably though the majority of both groups still regarded the system to be easy to use. Content relevancy to the subject taught was considered important, especially in the postgraduate group. Both gave high scores to relevancy and usefulness, implying possibly that the participants were active and provided high-quality information in views, comments and articles recommended to others. In general, both groups found that the system was effective in helping them to adopt the new mode of learning which complemented the traditional learning. As a whole, most students had no issues in recommending both the PLE&N system and social, peer-based lifelong learning to others.

Comparing the differences in adopting PLE&N and social, peer-based learning between the undergraduate and postgraduate groups has positive effects on understanding and interpreting the survey data better. The independent t-test indicated that there were significant statistical differences between the groups in their responses to questions in the four items: system usage, system user-friendliness, content relevancy and usefulness. Related to this finding, it is worthwhile to note the mean scores of the postgraduate students were higher than those of undergraduate

students in all the four items. Possible explanations for the differences are as follows.

First, the postgraduate students who study more advanced subjects are in general more mature, better time planners and more aggressive in learning than the undergraduate students, making them spend more time in PLE&N learning to complete assignments and gain more relevant knowledge. Second, when using a PLE&N, a postgraduate student put much focus on the contents being posted, received, exchanged or shared with other learners. The higher quality the contents, the better. Thus, the postgraduate students did not pay too much focus on the user-friendliness because they knew how to get around bad interface design or other not user-friendly features of the system. The younger undergraduate students, on the other hand, liked eye-catching and user-friendly interface for almost any application in study or private life. Therefore, the postgraduate students tended to give higher scores to user-friendliness and the undergraduate students, being more demanding in this respect, tended to rate user-friendliness lower.

Finally, comparing with the undergraduate students who put less emphasis on contents because of less mature learning attitude, the postgraduate students considered the contents of the PLE&N to be high quality, relevant and useful even though they had a higher expectation of contents in order to meet their learning needs. In both content relevancy and content usefulness questions, the postgraduate students gave them higher scores than another group. This may be a result of the combined efforts of all participants – student, instructors and others who valued the system and were enthusiastic to contribute best contents.

7. Conclusions, limitations and future research work

7.1 Conclusions

The PLE&N mode of learning is still relatively a new concept to most university students. Compared to traditional learning, they need more assistance, advice, encouragement and motivation to use this learning mode more beneficially. First, both the instructors and students had the same opinion that instructor assistance and participation as a facilitator in the learning process were not only helpful and timely but also critical in students acquiring the skills for and shaping the right attitudes towards this newer form of learning. In fact, the regular appearance of postings from the instructor on the topic under discussion was more than postings in their own right. The instructor actually became the role model to learn from for the best practices in PLE&N learning activities – using the most appropriate writing style and accepted or welcomed network behavior, for example. It follows that students become more organized, focused and objective-oriented in learning new topics related to the course through PLE&N. Second, by making the performance of students' participation in PLE&N learning be counted towards the award of the final assessment grade of the course, the students were strongly motivated to participate and engage with other students. This effective motivation method may be recommended especially in the early stage of rolling out PLE&N t to gain wider acceptance in shorter time.

The study found empirically that there were differences in expectations and focus in learning between the two groups of students – undergraduate and postgraduate students, as shown in (a) learning needs identification interviews, (b) activities and behaviors in using PLE&N, and (c) end-of-course surveys. Both groups had largely positive experiences with the new learning, however.

These differences imply that if PLE&N is to be deployed to a wider learning community, identifying important learning attributes of students of different backgrounds must be done so as to let them maximize the benefits obtained after using PLE&N.

The training received and practices of peer-based social learning on a PLE&N platform by students are lifelong assets which they can re-use advantageously not only in university but also in work place or other situations after graduation, either formally or otherwise. The personal learning platform they have constructed during the course can be extended with ease in the virtual world as frequently as and as rich in contents as the students wish. The learning behaviors which PLE&N promotes, like initiative, independence, agility, inquisitive mind, self-regulated study and learning anywhere any moment, are all typically expected in lifelong learning. As a result, students have acquired a skill set for learning with peers of different ages or profiles, which is even applicable in life after retirement. Indeed, PLE&N and peer-based social lifelong learning are a promising candidate to complement traditional classroom learning in terms of scope in space (global), time (24 hours), technology (versatile, expanding), people (no class size, no enrollment) and impact (lifelong).

7.2 Limitations

In a study such as this one dealing with exposing many students to a new mode of learning in a number of courses, limitations encountered due to time, resources or experiences constraints are expected. First, the internal study team is small, implying that support and training efforts can be an issue in some courses. Second, during the 20-month study period, only first-time users of the PLE&N are studied in detail when in fact there are a group of repeated students who attend more than one course with built-in PLE&N capability. The learning experiences of this smaller group of students are very worthwhile to explore from the research perspective to improve the whole design further. However, scarcity of resources prevents this from happening. Last, the survey should preferably have asked some questions related more to the core of this type of learning, for example, the synergy of studying the same topic in classroom and in the PLE&N after class. As a matter of fact, the available resources are too thin to support these more in-depth aspects of learning.

7.3 Future research work

The study of non-first time students using the PLE&N and synergy between the new mode of learning and traditional learning, as discussed in Limitations section, can be dealt with first. Second, as new collaborative tools come to the market regularly and are becoming more versatile and user-friendly, it is beneficial to consider them as replacements of or additions to the existing array of software applications if the required support issue can be tackled. Third, statistically, noticeable differences are found between undergraduate and postgraduate students in PLE&N learning. Investigation and comparison of this type can be extended to gender, subject or degree major, for example. Such findings are useful for future PLE&N enhancement efforts. Furthermore, resistance to change, low interest or other barriers in using a new learning mode needs to be dealt with more effectively to increase the popularity of PLE&N. Other kinds of motivation besides course assessment grade and encouragement must be identified to make students more frequently, productively or even innovatively use PLE&N for more areas of learning anywhere anytime. Similar efforts are also required to improve the ‘stickiness’ of PLE&N so that students are engaged

and inspired in the learning circle. Finally, the researchers should not fail to notice the importance of increasing awareness and competence of lifelong learning in students by conducting further studies.

Considering what have been and will be done in the three paradigms – PLE&N, peer-based social learning and lifelong learning, the future work looks bright and rewarding in the global connected learning world.

Appendix A. Additional theoretical background

Pedagogical approach to PLE&N learning

Several past empirical studies found that the PLE&N mode of learning could benefit students. A study lasting 10 months in Spain of 33 university students who registered for a business management course reported that they considered that learning together with other students, sharing information and working collaboratively were useful features of PLE&N (Kompen, Edirisingha, & Monguet, 2009). In an educational institution, a basic e-learning program for a computer course was later transformed to run on a PLE&N platform. Improved self-organization of knowledge was found (Ivanova, 2009). Even a PLE&N implementation in a K-12 school in the United States to replace traditional textbooks met with quite positive feedback from students on breadth and quality of PLE&N (Drexler, 2010). Tu, Sujo-Montes, Yen, Chan, and Blocher (2012) reported a study lasting for 3 semesters in which a PLE&N-like product was developed after merging two internal learning platforms. The students commented that the new system was connective, personal and social. In yet another research, Rahimi, van den Berg, and Veen (2015) put forward a model which assisted a group of 29 students in a Netherland secondary school to set up and expand a personal learning environment by gradually increasing the use of more Web 2.0 software and web resources and the number of co-learners. Evaluation of the model showed that the teacher-student communication played an important role in the process as well the increased sense of engagement, self-control and ownership of his/her learning environment among the students.

In higher education, PLE&N is a new concept in learning (Johnson & Liber, 2008). The technologies required for implementation, though important, only play a secondary role. It is not so much about technologies themselves as it is about an approach to using advanced technologies to solve basic issues in learning and teaching (Valtonen *et al.*, 2012). Attwell (2007) also shared similar views. Some scholars regarded that students needed training on using technologies like Web 2.0 set of tools for personal learning even though they may be well conversant in using the Internet and some common social media and other software in activities not so related to learning (Kvavik, 2005; Valtonen *et al.*, 2012) and Valtonen *et al.* (2012) was of the opinion that students did not have formal education in using such tools for learning. In his study of a group of 33 vocational or polytechnic students in eastern Finland having used PLE for a year, the feedback from the students was that teacher and pedagogical support were necessary in all stages of PLE activities. The absence of the necessary formal training might be explained by the fact that there is still no formal sound theory developed on how to integrate these tools into the students' learning environment in school or at home (Rahimi *et al.*, 2015). Furthermore, sustainable success of any PLE&N implementation requires the support of institution-based services. All the above implies

that PLE&N and peer-based social learning cannot be implemented informally. A pedagogical approach accompanied by well-thought and systematic implementation plan is a prerequisite for any PLE&N study.

Lifelong learning facilitated by PLE&N

It is still quite uncommon to find that scholars address PLE&N and lifelong learning together and there is little related literature, particularly in the higher education context. However, the use of PLE&N in campus actually prepares students well for lifelong learning after graduation because all the tools, skills and knowledge gained in PLE&N can be applied again in private or work life. First, as PLE&N allows and encourages learners to organize their learning environments individually as time goes by and needs change (Attwell, 2007), it facilitates continuous lifelong learning which takes place over a long period of many years. Second, PLE&N, once set up, provides the means to access and select knowledge to learn and to engage other learners by exchanging online messages and information sharing. The access helps self-learning which is common in life after school to be done more easily and rewardingly and the engagement enables peer group learning at work or in private social life when formal education is much less frequent as a person gets older. Moreover, the nature of PLE&N being flexible and independent of time, location and situations in life particularly suits the likely living patterns – events difficult to schedule well in advance – occurring in lifelong learning. More specifically on the learning behavioral side, the active use of PLE&N can change positively the attitude and mindset towards learning modes other than traditional classroom learning. This positive change and the enhancement in learning capability by PLE&N practices should prove valuable in years after university.

Appendix B. Questionnaire

Question		Measurement on Likert scale
Item		
Usage	How much time do you spend each week?	1=less than 15 mins 2=15 to 30 mins 3=30 to 1 hour 4=1 to 2 hours 5=More than 2 hours
User-friendliness	On a scale of 1-5, how user-friendly do you find?	1=Not user-friendly 5=Very user-friendly
Relevancy	How relevant do you find the content to the subject?	1=Not relevant at all 2=Not relevant 3=Neutral 4=Relevant 5=Very relevant
Usefulness	Has the content improved your understanding of the subject knowledge?	1=Very little 2=Little 3=Somewhat

Question	Measurement on Likert scale
	4=Slightly 5=Very much
Overall impression of PLE&N	
Does PLE&N provide up to date information about the subject?	1=Never 2=Rarely 3=Sometimes 4=Often 5=Always
Does PLE&N provide you with knowledge beyond the syllabus?	1=Very little 2=Little 3=Somewhat 4=Slightly 5=Very much
How often do you discuss face-to-face with your classmates the content on PLE&N during your subject study?	1=Never 2=Rarely 3=Sometimes 4=Often 5=Very often
Has the content posted on PLE&N assisted you in the subject assessment (i.e. homework, test, etc)?	1=Very little 2=Little 3=Somewhat 4=Considerable 5=Very much
On a scale of 1-5, to what degree will you recommend PLE&N to others?	1=I will definitely NOT recommend to others. 5=I will definitely recommend to others
How much do you want other subjects to operate on PLE&N?	1=No comment 2=No, I do not want 3=Maybe 4=Yes, some subjects 5=Yes, all other subjects should
Do you want to be removed from PLE&N after the semester?	1=Certainly do not 2=Do not 3=Wait and see 4=Remove me later 5=Remove me immediately

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