Designing an Informal Learning Support Framework

Nikolas Galanis, Enric Mayol, Marc Alier
Universidad Politécnica de Catalunya – BarcelonaTech
UPC Campus Nord, Omega S206
Jordi Girona 1-3, 08034, Barcelona, Spain
(+34) 934137174
{ngalanis, mayol, ludo}@essi.upc.edu

Francisco José Garcia-Peñalvo
Universidad de Salamanca
Plaza de los Caídos s/n
37008, Salamanca, Spain
(+34) 923294500
fgarcia@usal.es

ABSTRACT
Informal learning, alongside competence-based learning and learning outcomes is getting a lot of attention lately. A large number of countries and organizations are busy defining guidelines for validating and evaluating informal learning experiences and formalizing its outcomes. In a globalized society where technology has brought together different cultures and educational systems, managing to keep track of a learner´s competences is a daunting task, and especially when trying to take into account the competences acquired through informal means. We are proposing a framework to gather, organize, evaluate and showcase a user's informal learning using a largely social approach.

Categories and Subject Descriptors
• **Applied computing~Interactive learning environments**
• **Applied computing~Collaborative learning** • *Applied computing~Digital libraries and archives*

Keywords
Informal learning, non-formal learning, e-learning, eLearning, lifelong learning, social learning, validation, evaluation.

1. INTRODUCTION
The concept of informal learning (IL) and its potential in the development of competences has been present for many decades. In 1999, the European Commission signed he Bologna treaty recognizing IL as a basic element of lifelong learning [1]. In a number of documents published since then, the European Commission emphasizes the importance of recognizing IL and identifies the need for a framework for the Accreditation of Prior and Experiential Learning (APEL) [2, 3].

This has given birth to a number of European initiatives for the validation of informal and non-formal learning. The leading European organization working towards these goals is the European Centre for the Development of Vocational Training - CEDEFOP (www.cedefop.europa.eu). Its mission is to gather IL experiences from European countries and define a European qualifications framework. As a result, the European Qualifications Framework (EQF) for lifelong learning was presented and adopted by the European Council and the European Parliament in 2008 [4]. The goal of the EQF is to facilitate the communication of qualifications among European countries.

In 2009, CEDEFOP published a set of guidelines for the validation of non-formal and informal learning; a framework of guidelines to be applied voluntarily [5]. The framework pushes for validation in four different, but equally important levels: European, national, organizational and personal.

Presently, as laid out by the roadmap of Europe 2020, the Commission is centering on the labour market and the creation of smart and sustainable market opportunities. To this end there is a big interest in the evaluation and validation of the non-formal and informal learning of the European workforce.

All the above provide evidence that IL is a recognized and important part of the education process. Even more so in technological disciplines where the rapid changes mean that what is new today will be old tomorrow [6]. Furthermore, megatrends rising form the internationalization and globalization of modern society require continuous learning in order to keep up with [7]. For this reason we consider that it is important to educate learners on the importance of continuous informal learning and provide them with the appropriate tools for it.

In this paper we present the design of a framework we are developing for offering support for a learner's IL. The framework is geared towards registering informal learning activities (ILAs) enriching them with metadata like tags and evidences and then present them in the form of an IL portfolio with social hooks where learners will be able to examine the IL profile of their peers, evaluate their activities and receive recommendations based on their own activity.

2. STATE OF THE ART
For convenience purposes, we begin this section of the paper by providing some definitions for non-formal and informal learning [8, 9, 10].

Non-formal learning is learning that takes place alongside formal learning but does not necessarily lead to a diploma or any kind of formal acknowledgement. It is structured in nature and is provided by trained individuals as a complement to formal education. Examples of non-formal learning are complementary classes for school, sports training, art classes, music, etc.

Informal learning refers to all learning resulting from activities individuals undertake in their own time. It essentially starts at birth and accompanies the individuals throughout their life as a natural by-product of their activity. IL can be intentional or not and is unstructured in terms of objectives, time investment and

support. Examples of informal learning are learning to ride a bike as a kid, learning to cook as a student or learning a programming language by searching for information online.

For the remainder of this document we will use the term informal learning (IL) to refer to both informal and non-formal learning since the framework we are designing will not make any distinction between the two.

A very important aspect of the IL process is social interaction. Learning by observing others, by working with others, tutoring and many more aspects of social learning play a very significant role in IL. Bandura [11, 12] was one of the first to study social learning and remark on how people tend to learn by observing others. Previously, Miller and Dollard [13] had proposed a theory that imitation is an instrumental learned behavior and that by imitating others, an individual eventually succeeds in their goal and learns from the process [14].

In more recent years, the advances of IT technologies and especially Web 2.0 and mobile technologies have given a boost to IL by providing the means to liberate the learning process from any location and time constraints [15, 16, 17, 18, 19, 20, 21]. The inherently unstructured nature of IL makes it that the benefits of connectivity, mobility and the social tools available today make it more approachable than ever. Social networks and tools like blogs, wikis, messenger software, YouTube, Facebook, Twitter, Instagram and Flikr exist and operate by merit of Web 2.0 technologies and all offer huge IL oportunities.

There are also a number of tools that provide direct assistance to IL and lifelong learning in general. TENCompetence is a European open source project that provides an infrastructure that fosters lifelong learning [22, 23]. Similarly, the TRAILER project provides tools to the learners to gather their IL activities, assign them to competences, build an IL portfolio and showcase their competences within an institution or an organization [24, 25, 26]. Other IL portfolio tools are detailed by Perennes and Duhaut [27], and McHenry and Stronen [28].

Additionally, we find in the literature many proposals for platforms that support collaborative and social learning. The L project proposed a platform with a centralized center for the learning material and clients for each learning institution that wants to connect to it [29]. MCPresenter is a mobile learning tool that supports collaborative learning activities in the classroom [30], Mobltz promotes the co-creation of learning contents through the use of mobile devices [31], L4All creates learning timelines for its users and allows them to see the timelines of other users for comparison and motivational purposes [32] and finally the Network Awareness Tool builds a learner´s network of contacts based on their learning activities [33].

In the subject of actual validation and evaluation of IL, the majority of the literature proposes the existence of an evaluator in the form of a physical person or a committee who reviews the evidence provided [34, 35, 36, 37].

More specifically in engineering contexts, a number of studies promote the co-existence of formal and informal education by providing techniques to seamlessly move from one type of learning to the other and correctly evaluate the learners without entering into jurisdictional problems. Kotys-Schwartz et al. [38], propose a six-strand approach for characterizing the informal part of a student's learning. These strands evaluate certain aspects (interest in science, scientific understanding, reflection, etc.) of a learner's evolution thanks to IL activities. Grant et al. [39], propose the use of Learner Agent Objects (LAO) for improving informal learning activities like collaboration and sharing of best practices. LAO is a framework for creating and transferring knowledge.

Having established in this section the importance and the existing interest in IL, we will proceed to describe our proposal for building a framework that will help learners gather their IL activities, build their IL portfolio and have access to a set of tools that will help them further explore and evolve their IL.

3. Platform Design

Expanding upon the work presented in [40], we are proposing an informal learning portfolio (Figure 1) that will receive as input informal learning activities (ILAs) either manually from learners or in more automated ways directly from webs, applications and online tools. The portfolio will have support for different roles of users like learners and supervisors. The supervisors could potentially be teachers, professors or company supervisors that may need to have access to some views of the portfolios of the learners affiliated to their company or institution. Finally, the portfolio offers support for exporting ILAs or ILOs in xAPI format using web services to any external interested parties.

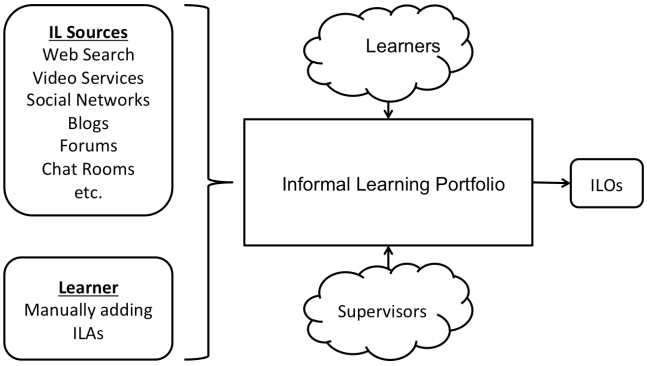

Figure 1: High-level concept of the Informal Learning Support Platform

The communication of activities to the platform will be done using the Experience API (xAPI, formerly Tin Can API). Once in the platform, the activity is stored in a Learning Records Store (LRS). Subsequently, the ILA can be enriched with metadata like evidences, tags, evaluation metrics and related competences. We will go into more detail for each of these characteristics shortly. For clarity purposes, we refer to these enriched ILAs as informal learning objects (ILOs). Figure 2 shows the structure of an ILO.

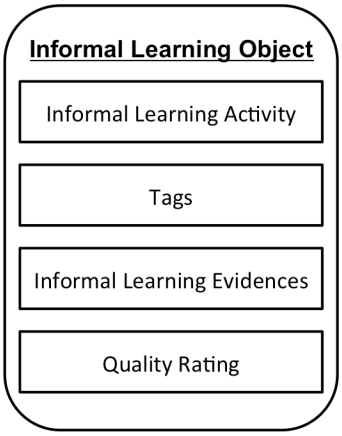

Figure 2: Structure of an Informal Learning Object

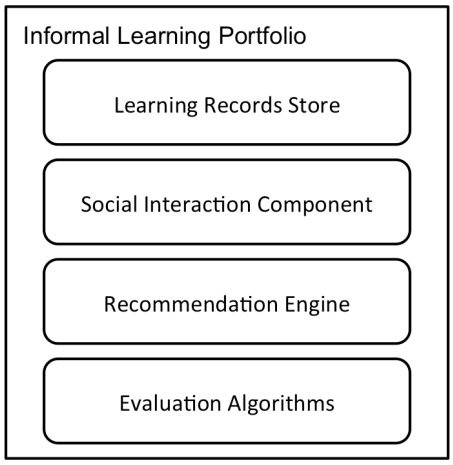

Figure 3: Overview of the framework components

Figure 3 shows an overview of the framework and the different components it is comprised of. In the following paragraphs, we go into more detail about each of these components.

3.1 Learning Records Store

The LRS is the database where the learning activities are stored. The term LRS was used to define the place to store learning records by the Tin Can API (tincanapi.com/learning-records-store). Tin Can API is now known as the Experience API (xAPI) and is the API we are using to communicate learning activities to our LRS. The xAPI is a specification that describes the interface and the storage and retrieval rules for statements of experience (http://www.adlnet.gov/capabilities/tla/experience-api.html). The format for communicating activities is "Actor, Verb, Object"; e.g., *I did this*.

Regarding the LRS, we are currently building our prototype on the Advanced Distributed Learning (ADL) LRS (adlnet.gov/tla/lrs.html). It is an open-source LRS available from github that uses Postgres for its database and supports OAuth /OAuth2 authentication for the xAPI communications.

3.2 Social Interaction Component

The last decade has been largely characterized by the expansion of the social networks. The amount of content and social interaction in these networks have catapulted them to one of the primary sources of IL [41]. This, in turn, has driven the entire process of IL to adopt a more social character [42, 43]. For example, the extend of Facebook's influence in education, coupled with the fact that it has been observed that students are more likely to express themselves on a social network than in an LMS [44], has led many education institutions to establish a presence there in order to be in touch with their students [45].

Collaborative or social constructivism has also gathered a lot of momentum with the introduction of technology-assisted education processes. Learners are no more just consumers of educational material, but they are also producers. This is especially evident in the case of IL where learners can create learning elements, expand on existing ones, discuss and interact among themselves [46].

3.3 Recommendation Engine

The recommendation engine will provide learners with personalized recommendations for further ILAs based on their profile and their recent activity.

The simplest iteration of a recommendation engine can be based on collaborative tagging. Tags can help learners discover new material that they would otherwise miss [47]. Macgregor and McCulloch [48] explain how a collaborative tagging mechanism can be more effective in learning material discovery than controlled vocabulary tagging.

Moving onto more complex recommender systems, metrics like accuracy, coverage and performance can be combined with measures taken from educational research like learner interest, learning history and behaviour to provide accurate recommendations for further IL [49, 50]. There is a lot of information in the literature about education-oriented recommendation systems [51, 52, 53].

The platform we are proposing will have access to a number of metrics that we are confident will provide us with a dataset capable of generating accurate recommendations. These metrics include:

- Interests (in terms of competences and tags)
- IL history (type of past ILAs, average evaluation, etc.)
- Average time investment
- Social interactions
- General tendencies of learners

3.4 Evaluation Algorithms

The evaluation of the activities within the platform will be carried out by a combination of self-assessment, peer assessment and activity popularity/adoption rate. All these activity streams will combine to provide a single evaluation metric for the different ILOs. In turn, these metrics will feed into the learner´s competence assessment where a competence supported by a number of highly-evaluated ILOs will be considered as more valid, or attained.

Due to us still being at the early stages of design and development of the platform we are currently unable to go into much more detail about the implementation of these algorithms since we expect it to change considerably as the specifics of the interactions among the different components of the platform become more defined.

3.5 Competence Catalogue

One of the biggest challenges of designing the platform is the competence catalogue. International efforts to define a comprehensive competence catalogue like ISCO-08 [54, [55] proposed by the International Labour Organization (ILO) may very well cover the entire spectrum of occupations, but for practical purposes cannot be used in an online portfolio because it is too long with extremely specific definitions that make it very complicated to find the exactly appropriate competence for an activity.

Our proposal for tackling this problem is to use a very generalized and simple initial competence list and let the learners define their own competences. These newly-defined competences will be added in the centralized list and help populate it. As the user types a competence, they will be presented with proposals for already existing ones in an effort to facilitate the process and reduce synonyms.

3.6 Component Interaction

Figure 4 shows how the different components interact among themselves. To sum it up, the ILAs enter the system using the Experience API (xAPI) and are stored into the LRS. From there, the ILAs can get evaluated, enriched with metadata and associated

to competences. This helps build the semantic model of the activities and transform ILAs to ILOs. All the additional information is inserted back to the LRS where ILAs and ILOs end up coexisting.

The recommendation engine takes its input from the ILOs, the evaluation module and the user interface and outputs the results directly back to the user interface for the learners.

Apart from the internal functionality, the framework provides support for exporting ILAs and ILOs to external services and applications that may require them. In the case of ILOs, they will be exported using the xAPI protocol where the *object* will be the enriched version of the object that entered the platform.

3.7 User Interface

From the user interface, the learners will be able to import their activities from different services/providers or manually define new ones.

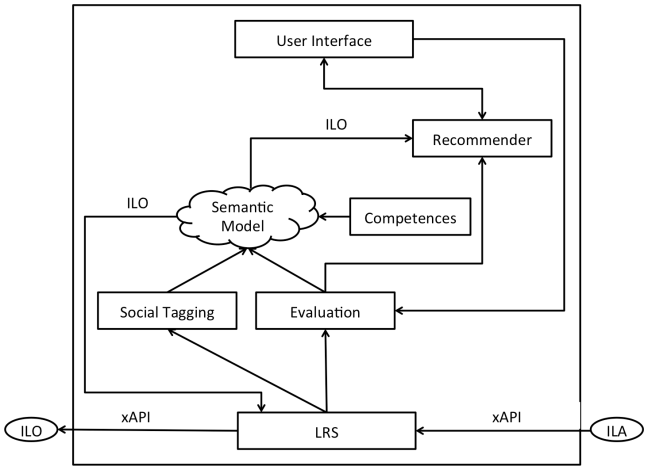

Figure 4: Internal diagram of the Informal Learning Portfolio

They will also have access to the list of the activities they have introduced to the system. These objects will be displayed differently depending on whether they have been marked by the learner as "complete" (ILOs) or not (ILAs).

By choosing one of these activities they will be able to edit or delete it.

- Editing the activity permits the learners to attach tags, competences, evidences, comments and an evaluation rating. The tags are entered manually by the learner with suggestions appearing as they type.
- Deleting the activity completely removes the activity from the user´s profile. If the activity has not been adopted by any other user, the activity is also removed from the LRS.

Once a learner considers that an entry is "content complete" they can choose to make it visible publicly or to a certain group they may be part of. This activity will then be visible in their portfolio and will also be available for the recommendation engine to use and recommend to anyone who has permissions to view it.

We plan to provide a lot of flexibility to learners for organizing and navigating their portfolio being able to visualize activities in a collection, collections relevant to an activity, activities related to a specific competence or competences justified by a collection of activities.

4. Methodology

For the design and development of our proposal we have chosen to adhere to the action research methodology [56, 57]. Action research consists in solving a particular problem by directly working on it and do a number of iterations of development and evaluation.

For the evaluation part, we are planning on organizing a couple of rounds of focus tests, where users from the academia and from the private sector will be invited to access the platform and use it for a short period of time (2-4 weeks). After that time, we will ask them to answer a questionnaire evaluating the platform. Moreover, the usage statistics that we will record for the duration of the tests will provide further data for our evaluation.

5. Conclusions and future work

In this paper we have established the importance of IL as an integral part of the educational process and we have presented our work-in-progress in designing and providing a framework that promotes, supports and evaluates informal learning. Our goal for the proposed framework is for it to be intuitive, with low overhead in terms of user implication and with a UI that will offer immediately useful information and feedback to the learner.

Our previous involvement in a related project funded by the European Commission means that we have already gathered valuable experience in designing such a framework.

We are at the point of concluding the initial design phase for the framework. Our next steps would be the implementation of a working prototype based on the ideas and directions detailed here. This prototype will initially connect to a limited number of popular ILA sources like YouTube. This will permit us to run a couple of pilot phases six months apart, in order to gather learner feedback and fine-tune the processes and the interface all the while expanding the list of connected IL sources.

6. ACKNOWLEDGMENTS

This work has been partially funded by the TRAILER project (519141-LLP-1-2011-1-ES-KA3-KA3MP) of the European Union Lifelong Learning Program.

7. REFERENCES

[1] European Commission. (1999). Towards the European higher education area. In Conference of Ministers responsible for Higher Education in 29 European countries

[2] European Commission. (2000) *A Memorandum on Lifelong Learning.* Accessed at http://tvu.acs.si/dokumenti/LLLmemorandum_Oct2000.pdf on 10 June 2015

[3] European Commission. (2001). *Making a European Area of Lifelong Learning a Reality.* Accessed at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2001:0678:FIN:EN:PDF on 10 June 2015.

[4] European Commission. (2008). *European Qualifications Framework*. Accessed at http://www.cedefop.europa.eu/en/events-and-projects/projects/european-qualifications-framework on 10 June 2015

[5] CEDEFOP (2009). European guidelines for validating non-formal and informal learning. *Office for Official Publications of the European Communities*

[6] Tripon, A. (2014). Innovative technology for sustainable development of human resource using non-formal and informal education. *Procedia Technology*, *12*, 598-603.

[7] Achtenhagen, F., & Winther, E. (2014). Workplace-based competence measurement: developing innovative assessment systems for tomorrow's VET programmes. *Journal of Vocational Education & Training*, 66(3), 281-295.

[8] Bjornavold, J. (2000). Making Learning Visible: Identification, Assessment and Recognition of Non-Formal Learning in Europe. Bernan Associates, 4611-F Assembly Drive, Lanham, MD 20706-4391.

[9] Colardyn, D., & Bjornavold, J. (2004). Validation of formal, non-formal and informal learning: Policy and practices in EU member states1. *European journal of education*, *39*(1), 69-89

[10] Eraut, M. (2004). Informal learning in the workplace. *Studies in continuing education*, *26*(2), 247-273.

[11] Bandura, A., & Walters, R. H. (1963). Social learning and personality development.

[12] Bandura, A. (1977). Social learning theory.

[13] Miller, N. E., & Dollard, J. (1941). Social learning and imitation.

[14] Schunk, D. H. (1996). Learning theories. *Printice Hall Inc., New Jersey*.

[15] Požgaj, Z., & Vlahović, N. (2010, May). The impact of Web 2.0 services on informal education. In *MIPRO, 2010 Proceedings of the 33rd International Convention* (pp. 944-948). IEEE.

[16] Pollini, A., Giusti, L., & Napoletano, L. (2011, September). Emerging informal learning 2.0 practices: a preliminary exploration. In *Proceedings of the 9th ACM SIGCHI Italian Chapter International Conference on Computer-Human Interaction: Facing Complexity* (pp. 71-75). ACM.

[17] Thomas, K. J., & Akdere, M. (2013). Social media as collaborative media in workplace learning. *Human Resource Development Review*, *12*(3), 329-344.

[18] Sánchez-Navarro, J., & Aranda, D. (2013). Messenger and social network sites as tools for sociability, leisure and informal learning for Spanish young people.*European Journal of Communication*, *28*(1), 67-75.

[19] Gu, J., Churchill, D., & Lu, J. (2014). Mobile Web 2.0 in the workplace: A case study of employees' informal learning. *British Journal of Educational Technology*, *45*(6), 1049-1059.

[20] Mills, L. A., Knezek, G., & Khaddage, F. (2014). Information Seeking, Information Sharing, and going mobile: Three bridges to informal learning.*Computers in Human Behavior*, *32*, 324-334.

[21] García-Peñalvo, F. J., Griffiths, D., Johnson, M., Sharples, P., & Sherlock, D. (2014, October). Problems and opportunities in the use of technology to manage informal learning. In *Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality* (pp. 573-580). ACM.

[22] Koper, R., & Specht, M. (2006). Ten-competence: Life-long competence development and learning.

[23] Berlanga, A., Sloep, P., Brouns, F., Bitter-Rijpkema, M., & Koper, R. (2008). Towards a TENCompetence ePortfolio. *International Journal Of Emerging Technologies In Learning (IJET), 3*, pp. 24-28. doi:http://dx.doi.org/10.3991/ijet.v3i0.552

[24] García-Peñalvo, F. J., Zangrando, V., Holgado, A. G., Gonzalez, M. A. C., Pardo, A. S., Griffiths, D., ... & Minovic, M. (2012, October). TRAILER project overview: Tagging, recognition and acknowledgment of informal learning experiences. In*Computers in Education (SIIE), 2012 International Symposium on* (pp. 1-6). IEEE.

[25] García-Peñalvo, F. J., González, M. Á. C., Zangrando, V., Holgado, A. G., Seoane, A. M., Forment, M. A., ... & Minovic, M. (2013). TRAILER Project (Tagging, Recognition, Acknowledgment of Informal Learning Experiences) A Methodology to Make Learners' Informal Learning Activities Visible to the Institutions. *J. UCS*, *19*(11), 1661-1683.

[26] García-Peñalvo, F. J., Johnson, M., Alves, G. R., Minović, M., & Conde-González, M. Á. (2014). Informal learning recognition through a cloud ecosystem. *Future Generation Computer Systems*, *32*, 282-294.

[27] Perennes, L., & Duhaut, D. (2009, April). E-portfolio for Lifelong Learning. In*Education Technology and Computer, 2009. ICETC'09. International Conference on* (pp. 101-105). IEEE.

[28] McHenry, J. E., & Strønen, F. H. (2008). The trickiness of IT enhanced competence management. *Journal of Workplace Learning*, *20*(2), 114-132.

[29] Wessner, M., Haake, J. M., & Tietze, D. A. (2002, January). An infrastructure for collaborative lifelong learning. In *System Sciences, 2002. HICSS. Proceedings of the 35th Annual Hawaii International Conference on* (pp. 9-pp). IEEE.

[30] Breuer, H., Konow, R., Baloian, N., & Zurita, G. (2007, July). Mobile computing to seamlessly integrate formal and informal learning. In *Advanced Learning Technologies, 2007. ICALT 2007. Seventh IEEE International Conference on*(pp. 589-591). IEEE.

[31] Lewis, S., Pea, R., & Rosen, J. (2009, June). Mobltz: a mobile multimedia tool for informal learning. In *Proceedings of the 9th international conference on Computer supported collaborative learning-Volume 2* (pp. 106-108). International Society of the Learning Sciences.

[32] De Freitas, S., Harrison, I., Magoulas, G., Mee, A., Mohamad, F., Oliver, M., ... & Poulovassilis, A. (2006). The development of a system for supporting the lifelong learner. *British Journal of Educational Technology*, *37*(6), 867-880.

[33] Schreurs, B., & De Laat, M. (2013). The Network Awareness Tool: A web 2.0 Tool to visualise informal learning in organisations. *Manuscript submitted for publication*.

[34] Mouros, N. J. (2003, November). Defining, teaching and assessing lifelong learning skills. In *Frontiers in Education, 2003. FIE 2003 33rd Annual* (Vol. 1, pp. T3B-14). IEEE.

[35] Mamaqi, X., Miguel, J., & Olave, P. (2011). Evaluation of the importance of professional competences: the case of Spanish trainers. *On the Horizon*, *19*(3), 174-187.

[36] Chianese, G. (2012). Assessment for learning: a way to improve continuously.*Procedia-Social and Behavioral Sciences*, *46*, 2927-2931.

[37] Rouvrais, S. (2012, April). Recognizing non formal learning experiences. In*Global Engineering Education Conference (EDUCON), 2012 IEEE* (pp. 1-5). IEEE.

[38] Kotys-Schwartz, D., Besterfield-Sacre, M., & Shuman, L. (2011, October). Informal learning in engineering education: Where we are—Where we need to go. In *Frontiers in Education Conference (FIE), 2011* (pp. T4J-1). IEEE.

[39] Grant, L., Abu-Aisheh, A., Hadad, A., Alnajjar, H., & Poole, B. (2012, April). Successful integration of informal learning in engineering education. In *Global Engineering Education Conference (EDUCON), 2012 IEEE* (pp. 1-1). IEEE.

[40] Galanis, N., Mayol, E., Alier, M., & Garcia-Peñalvo, F. J. (2014, October). A social framework for supporting, evaluating and validating informal learning. In*Proceedings of the Second International Conference on Technological Ecosystems for Enhancing Multiculturality* (pp. 589-594). ACM.

[41] Madge, C., Meek, J., Wellens, J., & Hooley, T. (2009). Facebook, social integration and informal learning at university:'It is more for socialising and talking to friends about work than for actually doing work'. *Learning, Media and Technology*, *34*(2), 141-155.

[42] Shepherd, C. (2011). Does social media have a place in workplace learning?.*Strategic Direction*, *27*(2), 3-4.

[43] Merchant, G. (2012). Unravelling the social network: theory and research. *Learning, Media and Technology*, *37*(1), 4-19.

[44] Schroeder, J., & Greenbowe, T. J. (2009). The chemistry of Facebook: Using social networking to create an online community for the organic chemistry laboratory. *Innovate: Journal of Online Education*, *5*(4), 1-7.

[45] Berg, J., Berquam, L., & Christoph, K. (2007). Social Networking Technologies: A" Poke" for Campus Services. Educause Review, 42(2).

[46] Whitty, C., & Anane, R. (2014, January). Social network enhancement for non-formal learning. In *System Sciences (HICSS), 2014 47th Hawaii International Conference on* (pp. 1645-1654). IEEE.

[47] Mathes, A. (2004). Folksonomies-cooperative classification and communication through shared metadata.

[48] Macgregor, G., & McCulloch, E. (2006). Collaborative tagging as a knowledge organisation and resource discovery tool. *Library review*, *55*(5), 291-300.

[49] Drachsler, H., Hummel, H., & Koper, R. (2008, October). Navigation support for learners in informal learning environments. In *Proceedings of the 2008 ACM conference on Recommender systems* (pp. 303-306). ACM.

[50] Manouselis, N., Drachsler, H., Vuorikari, R., Hummel, H., & Koper, R. (2011). Recommender systems in technology enhanced learning. In *Recommender systems handbook* (pp. 387-415). Springer US.

[51] Anderson, M., Ball, M., Boley, H., Greene, S., Howse, N., McGrath, S., & Lemire, D. (2003). Racofi: A rule-applying collaborative filtering system. *Proceedings of COLA'03*

[52] Tang, T., & McCalla, G. (2004). Beyond learners' interest: personalized paper recommendation based on their pedagogical features for an e-learning system. In *PRICAI 2004: Trends in Artificial Intelligence* (pp. 301-310). Springer Berlin Heidelberg.

[53] Manouselis, N., Vuorikari, R., & Van Assche, F. (2007, September). Simulated analysis of MAUT collaborative filtering for learning object recommendation. In*Proceedings of the 1st Workshop on Social Information Retrieval for Technology Enhanced Learning* (pp. 27-35).

[54] ILO: International Labour Organization - International Standard Classification of Occupations, ISCO-08. [Online; accessed 10 June 2015].

[55] D. Hunter, ISCO-08 draft definitions, ILO *Bureau of Statistics, Geneva*, 2009.

[56] Lewin, K. (1946). Action research and minority problems. *Journal of social issues*, *2*(4), 34-46.

[57] Whyte, W. F. E. (1991). *Participatory action research*. Sage Publications, Inc.