

Building a Shared Personal Learning Environment with SAPO Campus

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Abstract. SAPO Campus (SC)¹ is an institutionally supported platform of integrated Web 2.0 services that allows its users to publish and share content in a safe environment.

However, more than a space where people publish their content to, this platform allows its users to build the roots of their own PLE within the SC community.

The implementation of these principles resulted in the idea of a Shared PLE (ShaPLE). Starting with SAPO Campus' base features some new sharing features were added to the platform, which we can broadly classify as platform and user driven.

These two driven sources will contribute to an integrated digital curation mechanism that will allow users to have a more relevant learning experience.

This paper describes and specifies the solutions developed in order to support the creation of a ShaPLE, and reflect upon the impact the development of this concept might have in the field of PLEs.

Keywords: PLE, Web 2.0, Curation, SAPO, Campus.

1 Introduction

The increasing speed at which technologies are adopted and implemented in the educational and professional contexts has contributed to the reasoning that students and workers need to learn continuously throughout their life [1]. In this context, the informal learning – i.e., the learning experiences that occur at personal and social contexts – has been progressively appreciated in order to promote lifelong learning [2].

The growth of the social Web, or Web 2.0 [3] has contributed to the development of collaborative learning styles and new ways of interaction [4]. Based on principles such as openness, collaboration, free sharing of information and User Generated Content (UGC), O'Reilly first coined the term Web 2.0. The Web 2.0 could be defined as “(...) the network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an "architecture of participation," and going beyond the

¹ <http://campus.sapo.pt/>

page metaphor of Web 1.0 to deliver rich user experiences” [5].

The Web 2.0 tools are based on features like collaboration, interaction and networking, effectively shifting focus from the end product to the process and how this process could be shared with others in order to significantly improve both: the product and the people involved with it.

According to Redecker, Ala-Mutka and Punie, the Web 2.0 comprises four main dimensions: content, creation, connection and collaboration [6]. This means that the Web is not only a reading Web but also a writing Web where users may interact, collaborate and “co-create” knowledge [7].

By empowering users to quickly and easily create and share content, the Web 2.0 tools and services have attained huge popularity. These new consumers who are also producers have been dubbed as prosumers, a term coined by Toffler in the early 1980s.

In this context, the concept of a PLE easily comes to mind. Although there is still no agreement on its definition, this idea seems to be accepted by the most experts: a PLE may be comprised of a multitude of different Web 2.0 applications and tools [1]. PLEs are typically flexible because, according to Attwell [1] “a PLE could allow a learner to configure and develop a learning environment to suit and enable his or her own style (and sources) of learning”. Attwell and Costa also reported “PLEs can be seen as the spaces in which people interact and communicate and whose ultimate result is learning and the development of collective know-how” [8].

The dichotomy between PLEs as a concept and PLEs as set of applications, according to Attwell, is false: “If it is accepted that the PLE involves the use of Information and Communication Technologies then it necessarily involves applications. On the other hand any learning technology (...) facilitates or hides different approaches to learning and knowledge construction. In other words all educational technology contains or supports an implicit pedagogic approach. The issue is not a concept or an application but rather the process of researching and designing technological and pedagogical approaches.”[9]

In this sense, PLEs are dynamic spaces for organizing tools and services, built and personalized by the users, allowing the development of their autonomy, reflection skills and self-directed learning [10].

In a context where it is recognized that learning occurs not only in formal spaces, and with the improvement of the Web and the development of learner-centered learning environments where the connectivity [12] and collaboration are predominant, institutions are facing a new challenge: to be able to apply the concepts of openness, collaboration and sharing in a true learner-centered environment. This challenge represents a new education goal, leading the way to a more open school. In order to respond to this challenge, the use of PLEs might be a valid option because they are dynamic spaces that enable the development of a “community of inquiry” [13].

In the next section we will describe and characterize SAPO Campus (SC), an institutionally supported platform of Web 2.0 services that aims to support the development of personal learning environments, promoting communication, sharing and collaboration skills in its users.

2 SAPO Campus: a Social Platform of Web 2.0 Services for Educational Context

The introduction and the development of Web 2.0 integrated platforms to support teaching and learning activities brings some challenges. These challenges are related, on one hand, with the choice of services or tools: what services or tools must be provided in order to attend to different agents that have different needs and preferences? Furthermore, other major questions arise, such as integration and management issues, architecture and scalability issues related with performance and maintenance costs and finally – and perhaps the more important ones – support, conceptual coherence and use assessment issues.

SAPO Campus is an integrated Web 2.0 services institutionally supported platform for use in educational contexts, resulting from a partnership between SAPO – a leading Portuguese IT Company – and the University of Aveiro. This platform is based in an independent and open set of social core services (photo and video sharing, blogs, status and comments), but also allows its users to build and develop it as an important part of their own personal learning environment.

In this context, there have been some challenges/concerns:

- How to provide sharing services and mechanisms respecting the privacy principles defined by the institutions?
- What is the best solution to optimize the process of selecting, analyzing and organizing information?
- How to provide some institutional management tools without affecting the principles underlying the PLE concept?
- What is the effective impact of the availability of this integrated platform and how its use may contribute to improve communication, sharing and collaboration between different community members?

In what platform services choice and availability is concerned, it was important to take into account that the set of available services should reflect everyday services used by the community and also its relevancy for broader and diverse institutional (in)formal learning activities. The set of institutionally supported services should ensure to the educational agents the possibility of building and customizing their own PLE based on commonly-used Web 2.0 services, while simultaneously not restricting the range of potential learning activities that can be carried out in a diverse environment as the educational context.

As Attwell (2005) cit. in Mota (2009) says the development of an institutionally supported PLE requires some flexibility from the institution without affecting secure publishing and content sharing [14]. In this sense, with the adoption of SAPO Campus, for instance, all registered users are equal and share the same privileges and responsibilities. This approach ensures that every user can access the same type of services as well as the same type of data. One important result from this assumption is that user tracking mechanisms cannot exist in this digital community, thus ensuring user privacy.

The SAPO Campus platform development is guided by a technological infrastructure, aiming to attend to users' interests and to allow them to build and develop their own PLEs based on the contributions of the community.

Fig. 1 presents the core services and privileges of SAPO Campus' institutionally

supported platform. We believe that by adopting the SAPO Campus platform an institution will be able to offer a set of high quality core services prepared for large-scale usage scenarios. The left side of the figure shows the authenticated members from the institution. Although with different profiles within the institution, all of them have the same privileges and responsibilities within the core services. This means that all authenticated users are able to freely create accounts and content in any service. This openness is not typical in educational information systems but it was an underlying and fundamental concept for the SAPO Campus platform. All the other Internet users are represented on the right side of the figure. These non-authenticated users within the institution could also have privileges that allow them to participate and consume some information published on core services but will not be able to create accounts. Due to the age of the main target audience of the SAPO Campus platform, it is the school administrator that will be able to set up the specific privacy rules of the institution.



Fig. 1. Core services and privileges of SAPO Campus platform [15]

In this context, openness is one of SAPO Campus' key-concepts: this platform is open to people outside of the school walls, like family and other school' members that are able to participate and get involved in discussions. This means that everyone, everywhere can consume and talk about content, tearing down the metaphorical walls that typically surround the institutional digital space [16].

The personal dimension in SAPO Campus is closely related with the PLE core technology and aims to promote users' control of their learning process. This control, from our point of view, implies that users must be able to decide when and what to consume, create, save and share and with who they want to share it.

In order to promote the SAPO Campus' personal dimension and the construction of a digital identity and presence of the users, each registered user has his/her profile page (Fig. 2).

More, two timelines are automatically generated: one of them based on school members activity (Fig. 3) and the other based on the activity of the community members followed by the user (Fig. 4). This fact - that any user from the same institution and public users from other institutions could be followed - allows the construction of a connective network [17], enhancing the interaction and the connective knowledge construction [18].

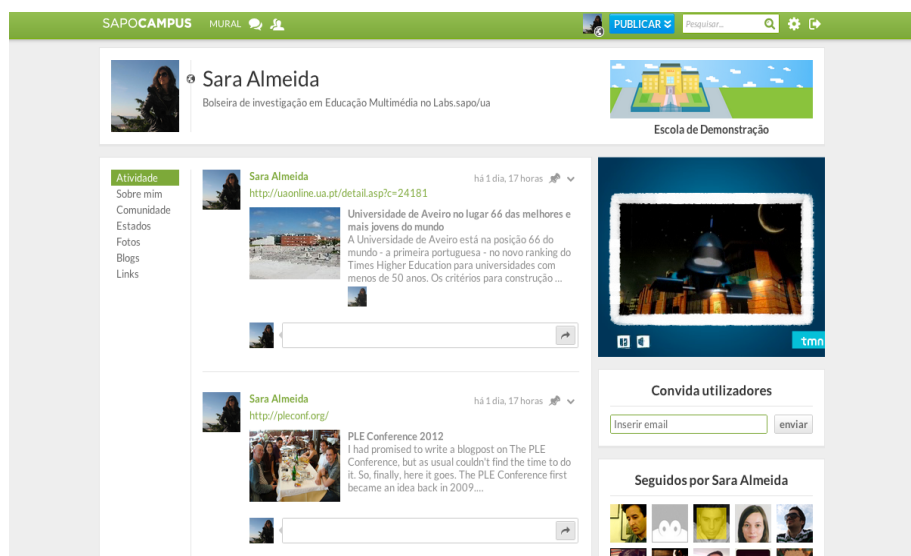


Fig. 2. User profile page



Fig. 3. The school timeline



Fig. 4. The community timeline

The promotion of lifelong learning is also an important goal of SAPO Campus. Even in the end of their studies, the users will still be able to access and customize their PLE. This possibility brings to the educational institutions a different perspective about the temporal and geographical relationship they have with the community: on one hand, former students can keep in touch with the school colleagues and all the knowledge that is being shared and, on the other hand, institutions could use this relationship as a new kind of communication tool.

Taking into account the current social and economic context that requires from users an active, connective and collaborative role, technologies could help individuals to draw more connections and to collaboratively share contents and knowledge. SAPO Campus, more than a space where the users can safely publish diverse types of content, aims to enhance users' active participation in creating their own personal learning environment, made up of the content and content sources with the highest interest to them, allowing them to share these resources with other members of the community.

Building a PLE requires from the users a certain degree of commitment. SAPO Campus tries to ease the initial stage by exploring a context that is relevant to its users. The relation to an educational institution, independently of personal interests and preferences, guarantees that each user starts in a context that is relevant and safe to him/her. In this setting, users are free to create their own contextual communities based on interests and preferences, and follow contexts that arise from their role in the institution (courses, classes, school years, etc.).

In this context, the concept of a ShaPLE (Shared Personal Learning Environment) appears. In the next section we will describe this emergent concept that comprises all the characteristics of the PLEs but aim to emphasize the SAPO Campus' social sharing and interactive dimension.

3 Building Shared Personal Learning Environments with SAPO Campus

The concept of a Shared Personal Learning Environment (ShaPLE) appears in order to promote SAPO Campus' essential concepts like communication, sharing and openness. With this concept, we intend to improve the involvement and motivation of the community members through the implementation of new sharing services allowing greater customization possibilities of their PLEs.

As stated earlier, SC guiding principles are collaboration, participation, openness and sharing. However, a critical review of the platform functionalities allowed us to identify a major limitation in the practical implementation of these principles: a lack of an effective SC social openness to its users.

This limitation portrays the main research question that led the ShaPLE concept to arise. To promote the use of PLEs and lifelong learning, it is essential to enhance the openness, sharing and social interaction in the SC platform. We think that in this way we could engage users and promote a greater involvement and participation, resulting from the need to develop a digital presence [19] and to create or sustain the interaction with other community members.

Being an open learning platform, the SAPO Campus platform should not only allow its users to actively aggregate content and sources but also, and utmost, should allow its users to open and share their data and learning space with other community members. In this point of view, this platform should shift its main focus from the user to the broader community through an integration model that naturally blends personal and institutional profiles, content and services.

This revised concept resulted in a new sharing and social layer that we are now able to add to the SAPO Campus platform. From our perspective, SAPO Campus should possess all the features of a PLE, but should also include mechanisms enhancing the sharing and communication between members of a community.

Starting from the SAPO Campus' basic principles, and assuming the use of a shared technological platform, we can add to the features associated with a PLE an integrated mechanism with some characteristics of content sharing which can be classified as:

- Platform-driven: all user actions are anonymously and automatically analyzed by a mechanism similar to a recommendation engine. This mechanism will allow identifying and recommending content and users that might be relevant to other users, based on their usage profile.
- User-driven: by adding a content classification mechanism (similar to a social bookmarking system), all users will be able to contribute with meta-information about their shared resources, which empowers the platform-driven functions mentioned above.

We believe that the development of these new functionalities will allow a major upgrade of SAPO Campus features, setting up new possibilities for users and establishing new ways of communication, interaction and sharing in an actual learning community. Its members will be able to not only be knowledgeable of the learning community dynamics but also to contribute to that dynamics becoming knowledgeable agents of a participatory learning community [20]. We also believe that these two driven sources will simultaneously contribute to what we intend to be a powerful inte-

grated digital curation mechanism that will allow users to have a more relevant learning experience while using SAPO Campus technology.

Thereafter, we will discuss the importance of these two systems for the educational context: on one hand, the social bookmarking as an user-driven mechanism to categorize the content and, on the other hand, the recommendation engine as a platform-driven mechanism that analyses users' activity in order to recommend new content.

3.1 The Development of an User-driven Engine for Content Classification and Sharing

Social software applications can be viewed as pedagogical tools. As stated by Anderson (p.42), "the greatest affordance of the Web 2.0 for educational use is the profound and multifaceted increase in communication and interaction capability" [21]. In this context, users are not only consumers but also "co-creators" of information and knowledge [7].

Social Bookmarking Systems (SBS) are Web 2.0 tools that allow users to store, classify, organize, describe and share interesting links or resources [22].

According to Vuorikari (p.10) "social bookmarking is a Web-based service to share Internet bookmarks on websites and pages. Instead of saving the bookmarks or favorites to a local computer, the Web-based service is accessible from everywhere" [23].

In this context, the allocation of keywords (tags) to the Web sites stored by the users allows the adoption of new ways to organize and classify the resources [24], and also the expression of different perspectives about that particular information and resource, because each tag works as a link to other contents which were classified in the same way by other users [25].

In educational contexts, some teachers have recognized the importance of social bookmarking in developing and improving some fundamental skills as research, analysis, evaluation, organization, communication, collaboration and sharing [26].

These systems also allow the construction of a collective memory, because by assigning tags, users can freely manage the information and discuss better ways of using it [27], and encourage the collaborative work [22]. Additionally, according to a socio-constructivist point of view, the assignment of tags enhances self-regulated learning, through the conscious involvement with PLE construction and subsequently, their own individuality as learner and as person [28].

In addition to the aforementioned potential of social bookmarking tools in educational contexts, we foresee the integration of a user-driven engine of content classification in the SAPO Campus platform as an opportunity to rethink user interaction on the web. Instead of building just one more tool for our users, we try to position it as a structured context for user action [29].

The main goal of the development and integration of this tool in the SAPO Campus platform is to enhance users' participation in content curation based on meta-information produced by the community. Besides, from our point of view, the integration of this content curation mechanism will encourage the users' involvement in the construction of a common and relevant knowledge with meaning for each user.

These mechanisms also have some weaknesses. One of the biggest problems lies on the subjectivity - each different user can add different tags (some of them could be very broad or restricted) related with the classification of the same content and/or information source.

In order to mitigate this limitation, we're developing a content classification en-

gine with three pre-defined (non-compulsory) tags indicating action goals and intentions (Think & Learn; Watch & Listen and Laugh & Fun). With this model – far way from the conventional one based on the contents’ thematic – the user will be invited to think about what for and why it is important to store or share certain information source, promoting the development of their metacognitive and content curation skills.

This type of interaction stays somehow in the middle between formal taxonomy strategies that are not suitable for informal spaces like social networks and folksonomy strategies that have been declined in recent years because of the difficulty to get relevant information from it.

Some users see social bookmarking as a mechanism that works like a forgotten archive of bookmarks. Adding new content implies from the users an explicit action, which, most of the times don’t bring them or the community any useful consequence. To avoid this eventual limitation, in the SAPO Campus platform the use of the social bookmarking mechanism could not be only explicit but also implicit, which means that the bookmarks are automatically extracted from the users’ sharing activity.

We don’t intent to interfere with the user’s dynamics of sharing and interaction. Thus, tags are assigned in a voluntary basis and the links can be shared through states and comments (Fig. 5).



Fig. 5. Sharing links on SAPO Campus

All shared bookmarks are also available in a particular area of the user’s profile page (Fig. 6). In this area, the social bookmarking system assumes a more traditional version, where the user can access a general page of the link and, if it does not go against the privacy rules, to the users who shared and commented the same link.

With the development of an integrated mechanism of content recommendation and classification we pretend to encourage the users’ true involvement with the platform, allowing the construction of meaningful personal learning environments for each user.



Fig. 6. The area of all shared bookmarks

3.2. The Development of a Platform-driven Engine to Navigational Support

The existence of a huge quantity of information, in combination with the dynamic and heterogeneous nature of the Web, makes information selection a hard task for the average user, who is usually overwhelmed by the quantity of information retrieved. In this context of information overload, personalized information access is becoming essential [30].

In 1997, Resnick and Varian argued that recommendation systems could be useful because recommendations are necessary if users have to make choices without sufficient knowledge about a certain thematic [31]. According to Adomavicius and Tuzhilin (2005) cit in Drachsler (2009), the general purpose of recommender systems (RS) is to pre-select information a user might be interested in [32].

There are two main kinds of recommender systems: the collaborative recommender systems and the content-based recommender systems [30]. The collaborative recommender systems aim at predicting appropriate items based on interaction data of many users within the community with similar interests [33]. If this method enhances the recommendation of items in any category (films, images, texts, etc.), the arrival of a new user or a new item represents a problem called “cold-start problem” [34].

The content-based recommender systems are based on a single user's preferences. This technique aims to recommend items similar to the ones the user preferred in the past [32]. Within this approach, the “cold-start problem” may not happen so often but the over-specialization problem could be hard to solve [30].

In order to reduce the “cold-start problem” in the SAPO Campus platform, each user starts in a relevant context – the school. In this setting the user will be able to, even in the beginning, easily receive relevant recommendations of people and content through the implemented collaborative techniques.

Recommender systems learn about the user's preferences and build a personal profile for each user [35]. In this context, recommendations appear to be useful for empowering learners to set up their own learning environments [36]. The main features

of recommender systems (collective responsibility, collective intelligence, user control, guidance and personalization) fit very well into socio-constructivist learning principles. However, recommender systems should not be directly transformed from commercial to educational contexts, since they need adaptations with regard to learners as producers of data [37].

According to Mödritscher [36], from a learner perspective a recommender strategy for educational context could comprise these five entities:

- Interactions
- Media collections
- Single documents for a specific situation
- Peer learning or learning tools relevant for an activity
- Points to communities: people sharing the same environment

The navigational support created by recommender systems may help users to reduce time and costs involved in selecting suitable information. This will help learners in selecting learning activities according to their individual needs [38].

In this context, these systems could offer guidance to the learner without limiting his freedom. This can be achieved through the mediation of the relationship between real and potential knowledge [39]. In a constantly changing learning, economic and social context, the need of lifelong learning is evident. With recommendations, users can find their own way, being self-regulated and responsible for their own learning process [40].

According to Mödritscher and his collaborators, recommendations are powerful tools in a PLE context as they provide the opportunity to: “retrieve relevant information; find peers and/or tools and get suggestions and motivational support from interaction with peers” [34].

Designing and establishing the interaction between a user and a recommender system is challenging. The system needs to successfully adapt the user’s profile and present him/her interesting items. For this to happen, the system criteria have to match the criteria that are relevant to the user [35].

In this context, is not hard to understand that developing a recommender system is not simple and there are many variables to take into account. The cultural context of the user is one of them: one user might be interested in a particular musician but not in his/her musical style and the inverse could happen with other user. Thus, the predictions made by these systems can lead to generalization or overspecialization issues [35].

The recommendation engines can adapt to the specific user’s needs, however such adaptivity could bring some challenges such as controllability, privacy and predictability [35]. According to Cramer and his colleagues, these systems take (semi)-autonomous decisions on behalf of users, which may undermine the users’ need to control. Besides, this platform-driven engines use some data about the users, which for privacy reasons, may cause some users’ adverse reactions.

In order to facilitate the system’s learning process and improve recommendations is important to gather users’ feedback [35]. For that reason, we are developing an integrated mechanism combining a recommendation engine (platform-driven) and a social bookmarking system (user-driven). With the user-driven system we will have the opportunity to involve the users in an integrated digital curation process that will allow them, on the one hand, to contribute and feed the recommendation engine, and, in

the other hand, to have a more relevant learning experience while using SAPO Campus technology. We believe that with this integrated mechanism we will be able to surpass the aforementioned issues and promote the users' control over the PLEs' customization process.

The open source recommendation engine that we are using – easyrec² – produces the information that feeds the two recommendation based functionalities that we actually have in SAPO Campus. One of them is the widget of relevant users (of the same institution or public users from other institutions), which is presented to all the users of the platform (right side of Fig. 7).

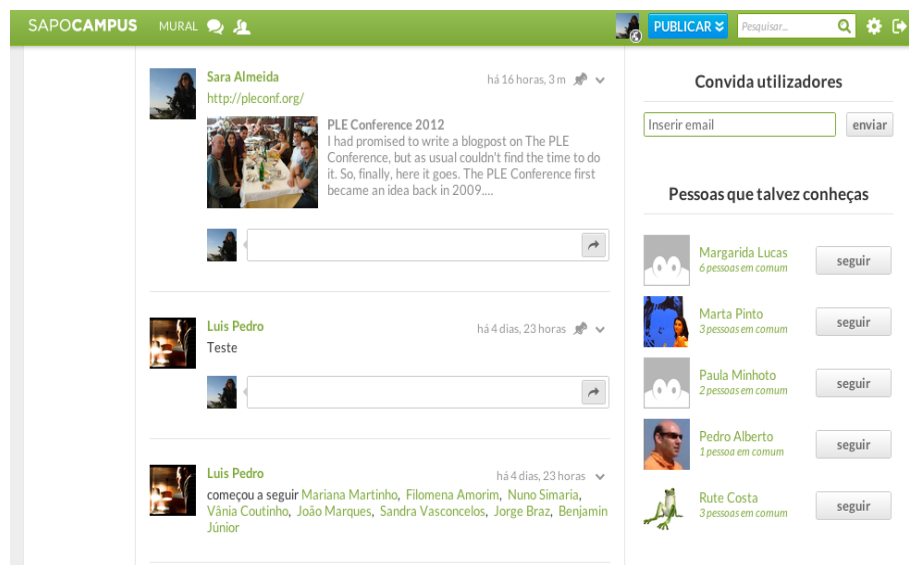


Fig. 7. Widget of relevant users

On the profile page, each user can access to a recommendation area that, initially, focuses on links and states (Fig. 8). For privacy issues, those contents can be presented without identifying the author of the recommended items.

In SAPO Campus, the recommender system does not represent the core of the interaction inside the platform. It works just like an additional element to support users' navigation and interaction. It is our intention that the core of the interaction between users of the platform to be essentially supported through sharing and community interaction. For that reason, we do not wanted to simply develop two disintegrated systems. Instead we tried to integrate the platform-driven engine with the user-driven system in order to provide a meaningful and personal learning environment to each user allowing them to enrich their learning experiences.

² <http://easyrec.org/>

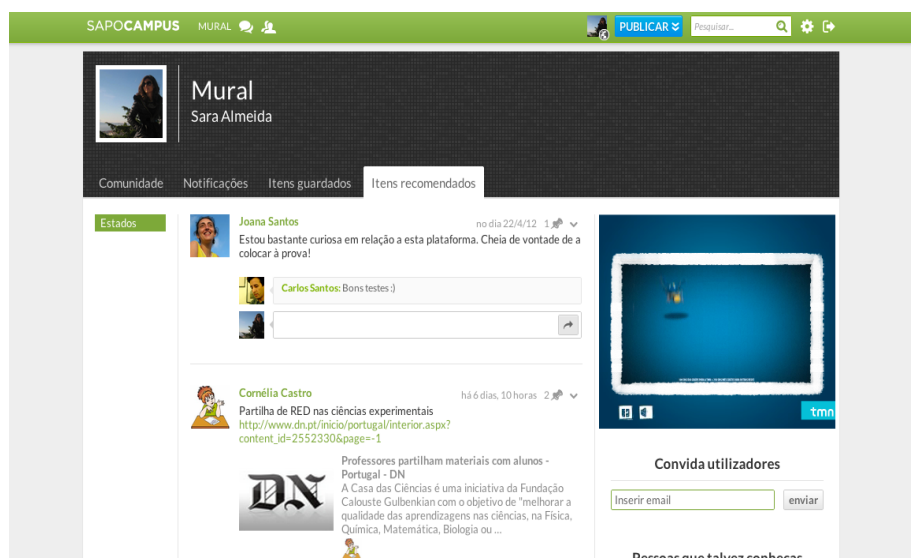


Fig. 8. The user's recommendation area

4 Final Considerations and Future Work

As we mentioned before, SAPO Campus is an institutionally supported Web 2.0 services platform for use in educational contexts. The development of this platform arose from an R&D project, taking place in a research laboratory that joins University of Aveiro and SAPO – a leading IT company in Portugal – researchers and developers.

Based on principles like openness, collaboration and communication, SAPO Campus tries to balance and compromise institutional concerns and responsibilities with an open, personal and social learning experience.

The concept of Shared Personal Learning Environment (ShaPLE) appears in this context to promote the aforementioned SAPO Campus' essential principles. With this concept, we intend to improve the engagement and motivation of the SAPO Campus' users by reinforcing their participation in the platform. We are implementing an integrated mechanism for content curation and sharing in order to launch an effective learner-based set of tools that supports contextual learning and also in order to promote an effective participation in this dynamic learning environment. This mechanism is two-folded including a recommender engine to support the users finding relevant people and content, and a content classification mechanism that will engage users as SAPO Campus' content curators.

We are aware of the potential and challenges that this integrated mechanism could bring to the SAPO Campus platform and users. In order to answer the users' goals and needs, these systems need to be constantly refined.

In this context, the adoption of an holistic approach seems appropriate, whereas the users might be involved in the developing and designing process. The first version of the aforementioned content curation mechanism will be tested soon by some users (teachers and students) in order to collect some relevant information and opinions about its strengths and weaknesses.

As a practical result of this project, we hope to improve the engagement of SC's users; understand the impact this new concept could have on the overall learning process and experience; and produce valuable contributions to the development of new features in the field of personal learning environments, which would readily be made available to all institutions that will adopt the SC platform.

Acknowledgements

The authors would like to acknowledge University of Aveiro, SAPO and TMN for the scientific, financial and technical support to the SAPO Campus project and the Labs SAPO/UA R&D activities. This work is part of the Shared Personal Learning Environments (ref: PTDC/CPE-CED/114130/2009) project funded by FEDER funds through the Operational Programme for Competitiveness Factors - COMPETE and National Funds through FCT - Foundation for Science and Technology (Portugal).

References

1. Attwell, G.: Personal Learning Environments – The future of eLearning? *ELearning Papers*, 2 (1). Retrieved from: <http://www.elearningeuropa.info/files/media/media11561.pdf> (2011)
2. Cross, J.: *Informal Learning: Rediscovering the Natural Pathways that Inspire Innovation and Performance*. San Francisco, CA: John Wiley & Sons, Inc (Eds), (2007)
3. O'Reilly, T.: Web 2.0: Compact definition? Retrieved from: <http://radar.oreilly.com/archives/2005/10/web-20-compact-definition.html> [blog post] (2005)
4. Beldarrain, Y.: Distance education trends: Integrating new technologies to foster student interaction and collaboration. *Distance Education*, 27 (2), 139-153. Retrieved from: <https://sites.google.com/site/edte281wiki/Home/pats-research> (2006)
5. O'Reilly, T.: What is Web 2.0?. In H. Donelan, K. Kear, M. Ramage (Eds.), *Online communication and collaboration: a reader*. Abingdon, Oxfordshire: Routledge. (2010)
6. Redecker, C., Ala-Mutka, K., Punie, Y.: *Learning 2.0 – The impact of social media on learning in Europe*. Institute for Prospective Technological Studies. Luxembourg: European Commission. Retrieved from: <http://ftp.jrc.es/EURdoc/JRC56958.pdf> (2010)
7. Lee, M. J. W., McLoughlin, C.: Harnessing the affordances of Web 2.0 and social software tools: Can we finally make "student-centered" learning a reality? In: *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications*, pp. 3825-3834. VA: AACE, Chesapeake. Retrieved from: <http://www.editlib.org/p/28915> (2008)
8. Attwell, G., Costa, C.: Integrating personal learning and working environment. *Beyond Current Horizons*. Retrieved from: <http://www.beyondcurrenthorizons.org.uk/integrating-personal-learning-and-working-environments/> [blog post] (2009)
9. Attwell, G.: Layering personal learning environments. *Pontydysgu Bridge to Learning*. Retrieved from: <http://www.pontydysgu.org/2012/05/layering-personal-learning-environments/> [blog post] (2012)
10. Henri, F., Charlier, B., Limpens, F.: Understanding PLE as an Essential Component of the Learning Process. In: *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications*, pp. 3766-3770. VA: AACE, Chesapeake. Retrieved from: http://www.unifr.ch/didactic/assets/files/didactic/henri-charlier-limpens_ed-media-08_article.pdf (2008)
11. O'Reilly, T.: The architecture of participation. *O'Reilly About*. Retrieved from: http://oreilly.com/pub/a/oreilly/tim/articles/architecture_of_participation.html [blog post] (2004)

12. Siemens, G.: Collective or Connective Intelligence. Connectivism: A Learning Theory for Today's Learner. Retrieved from: <http://connectivism.ca/blog/2008/02/> [blog post] (2008)
13. Garrison, D., Anderson, T., Archer, W.: Critical inquiry in a text-based environment computer conferencing higher education. *The Internet and Higher Education*, 2 (2-3), 87-105. Retrieved from: http://tccl.rit.albany.edu/knilt/images/9/90/Unit_1-a.pdf (2001)
14. Mota, J.: Personal learning environments: Contributos para uma discussão do conceito. *Revista Educação, Formação & Tecnologias*, 2 (2), 5-21. Retrieved from: <http://eft.educom.pt/index.php/eft/article/view/105/66> (2009)
15. Santos, C., Pedro, L.: Sapo Campus: a social media platform for higher education. In: *Proceedings V International Conference on Multimedia and Integrating ICT In Education* 2, 1104-1108. Formatex, Badajoz. Retrieved from: <http://www.formatex.org/micte2009/book/1104-1108.pdf> (2009)
16. Santos, C., Pedro, L.: Bridging the gap between open and social Learning and institutional supported technologies: the case of Sapo Campus. In: *Proceedings of Personal Learning Environment and Personal Learning Networks*. Athabasca University & National Research Council of Canada, Canada. (2010)
17. Boyd, D. M., Ellison, N. B.: Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication*, 13 (1). Retrieved from: <http://jcmc.indiana.edu/vol13/issue1/boyd.ellison.html> (2007)
18. Downes, S.: ELearning 2.0. *Elearn Magazine*, 2005 (10). Retrieved from: <http://elearnmag.acm.org/featured.cfm?aid=1104968> [blog post] (2005)
19. Aresta, M., Santos, C., Pedro, L., Moreira, A.: Building up Digital Identity in Higher Education. In: S. Warburton and S. Hatzipanagos (Eds.), *Digital Identity and Social Media*. IGI Global, London. (2012)
20. Wesch, M.: From Knowledgeable to knowledge-able: Learning in new media environments. In: R. Bass and B. Eynon (Eds.), *New Media Technologies and the Scholarship of Teaching and Learning*. CNDLS, Washington Dc. Retrieved from: <http://www.academiccommons.org/files/Wesch.pdf> (2009)
21. Anderson, T.: Toward a theory of online learning. In: T. Anderson and F. Elloumi (Eds.), *Theory and practice of online learning*, pp. 33-60. Athabasca University, Athabasca. Retrieved from: http://cde.athabascau.ca/online_book/pdf/TPOL_chp02.pdf (2004)
22. Estellés, E., Del Moral, E., González, F.: Social Bookmarking tools as facilitators of learning and research collaborative processes: The Diigo case. *Interdisciplinary Journal of E-Learning and Learning Objects*, 6, 175-191. Retrieved from: <http://www.ijello.org/Volume6/IJELLOv6p175-191Estelles683.pdf> (2010)
23. Vuorikari, R.: Folksonomies, social bookmarking and tagging: State-of-the-art. *Insight observatory for new technologies and education*. Retrieved from: http://insight.eun.org/shared/data/insight/documents/specialreports/Special_Report_Folksonomies.pdf (2007)
24. Anderson, P.: What is Web 2.0? Ideas, Technologies and implications for Education. JISC – Technology & Standards Watch. Retrieved from: <http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf> (2007)
25. Marlow, C., et al.: HT06, tagging paper, taxonomy, flickr, academic article, toread. In: *Proceedings of the Seventeenth Conference on Hypertext and Hypermedia*, 31-40. Oden-se. Retrieved from: <http://www.danah.org/papers/Hypertext2006.pdf> (2006)
26. Coutinho, C. P., Bottentuit Junior, J. B.: Using social bookmarking to enhance cooperation/collaboration in a teacher education program. In: *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications*, pp. 2551-2556. VA: AACE, Chesapeake. Retrieved from: <http://repositorium.sdum.uminho.pt/bitstream/1822/8466/1/Enhance.pdf> (2008)
27. Aquino, M.: Hipertexto 2.0, folksonomia e memória coletiva: um estudo das tags na organização da Web. *Revista da Associação Nacional dos Programas de Pós-Graduação em*

- Comunicação. Compós. Retrieved from:
http://www.compos.org.br/files/15ecompos09_MariaClaraAquino.pdf (2007)
28. Cernea, D., Del Moral, E., Gayo, J.: SOAF: Semantic indexing system based on collaborative tagging. *Interdisciplinary Journal of E-Learning Objects*, 4, 137-149. Retrieved from: <http://ijello.org/Volume4/IJELLOv4p137-149Cernea.pdf> (2008)
 29. Koch-Grunberg, T.: *Gameful Connectivism: Social Bookmarking no Sapo Campus* (Master's Thesis). Aveiro University, Portugal (2011)
 30. Gemmis, M. et al.: Preference Learning in Recommender Systems. In: *Proceedings of European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases*. Bled, Eslovénia. Retrieved from: <http://www.ecmlpkdd2009.net/wp-content/uploads/2008/09/preference-learning.pdf#page=45> (2009)
 31. Resnick, P., Varian, H. R.: Recommender systems. *Communications of the ACM*, 40 (3), 56-58. Retrieved from: http://www.ischool.utexas.edu/~i385d/readings/Resnick_Recommender_97.pdf (1997)
 32. Drachsler, H.: *Navigation Support for Learners in Informal Learning Networks*. PhD thesis. Center of Learning Sciences and Technologies – Open University of the Netherlands (2009)
 33. Deshpande, M., Karypis, G.: Item-based top-*N* recommendation algorithms. *ACM Transactions on Information Systems*, 22, 143-177. Retrieved from: <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA443228> (2004)
 34. Mödritscher, F. et al.: May I suggest? Three PLE recommender strategies in comparison. In: *The PLE Conference 2011*. University of Southampton, Southampton. Retrieved from: http://journal.webscience.org/561/1/May_I_suggest_Three_PLE_recommender_strategies_in_comparison.pdf (2011)
 35. Cramer, H. et al.: The effects of transparency in trust and acceptance of a content-based art recommender. *User Modeling and User-Adapted Interaction*, 18 (5), 455-496. Retrieved from: <http://dare.uva.nl/document/131544> (2008)
 36. Mödritscher, F.: Towards a recommender strategy for personal learning environments. *Procedia Computer Science*, 1 (2010), 2775-2782. Retrieved from: http://ac.els-cdn.com/S1877050910003157/1-s2.0-S1877050910003157-main.pdf?_tid=c9c13b9a4981c538249f84753cc63e75&acdnat=1337964574_a823441e436b095f2edacbc37ae6518 (2010)
 37. Buder, J., Schwind, C.: Learning with personalized recommender systems: a psychological view. *Computer in Human Behaviour*, 28 (1), 207-216. Retrieved from: <http://www.sciencedirect.com/science/article/pii/S0747563211001956> (2012)
 38. Santos, O. C., Boticario, J. G.: Modeling recommendations for the educational domain. *Procedia Computer Science*, 1 (2010), 2793-2800. Retrieved from: http://ac.els-cdn.com/S1877050910003170/1-s2.0-S1877050910003170-main.pdf?_tid=6899a710339de81138da94f634e71347&acdnat=1337964822_79ab974208c93634315d155973110b0b (2010)
 39. Lichtnow, D. et al.: O uso de técnicas de recomendação em um sistema para apoio à aprendizagem colaborativa. *Revista Brasileira de Informática na Educação*, 14 (3), 49-59. Retrieved from: <http://www.lume.ufrgs.br/bitstream/handle/10183/23202/000638307.pdf?sequence=1> (2006)
 40. Drachsler, H., Hummel, H., Koper, R.: Personal recommender systems for learners in lifelong learning networks: the requirements, techniques and model. *International Journal of Learning Technology*, 3 (4), 404-423. Retrieved from: <http://dspace.ou.nl/bitstream/1820/937/5/2008%20Drachsler%20IJLT.pdf> (2008)