Rich Open Educational Resources for Personal and Inquiry Learning

Agile Creation, Sharing and Reuse in Educational Social Media Platforms

María Jesús Rodríguez-Triana*, Sten Govaerts*, Wissam Halimi*, Adrian Holzer*, Christophe Salzmann*, Andrii Vozniuk*, Ton de Jong†, Sofoklis Sotirou‡, and Denis Gillet*, *Senior Member, IEEE*
*Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland
†University of Twente, Enschede, The Netherlands
‡Ellinogermaniki Agogi, Athens, Greece

***Abstract*—Open Educational Resources (OERs) are freely accessible, openly licensed multimedia documents or interactive tools that can be typically integrated in Learning Management Systems to support courses. With social media platforms becoming the central piece of the students' digital ecosystem, there is an emerging need to provide resources that can be integrated in various general-purpose open platforms. Courses are also deconstructed in smaller learning units for personal learning activities or in Massive Open Online Course sessions. As a consequence, rich self-contained educational resources embedding their pedagogical context and modality are required (these elements not being elicited anymore from the course itself). This paper presents Inquiry Learning Spaces (ILSs) –pedagogically structured learning environments that can contain labs, apps and resources– as rich OERs. Teachers can create ILSs for their students (as standalone resources or embedded in other platforms) and share them with other teachers who can adapt the ILS to their needs.**

Keywords*—Open Educational Resources (OERs), Social Media, Personal Learning, Inquiry Learning, Learning Environment, Learning Repository, Massive Open Online Courses (MOOCs).

I. Introduction

In this paper, we discuss the concept of Inquiry Learning Spaces (ILSs) as rich Open Educational Resources (OERs) that can be easily created in the Graasp[1] social media platform, shared in the Golabz[2] open repository, and exploited either as standalone resources or as embedded objects in open social media or educational platforms. Flagship platforms supporting the creation and the exploitation of Personal Learning Environments (PLEs) and Massive Open Online Courses (MOOCs) are especially considered.

A. Open Educational Resources

A wide range of learning materials can be considered as OERs, e.g., full courses, modules, student guidelines, textbooks, research articles, videos, assessment tools, interactive materials (such as simulations) or Web applications. In order to consider the aforementioned materials as open resources, two main requirements must be fulfilled: free and open access to knowledge, and the capacity to adapt and reuse materials [1].

The accessibility requirement is frequently ensured by open educational repositories, platforms developed mainly to facilitate storage and retrieval of learning objects. MERLOT[3] is a well-known, general-purpose repository that addresses all these features. Added value services are rarely supported by these platforms, even though they can increase repository adoption [2]. For instance, in the area of STEM (Science, Technology, Engineering, and Mathematics), PhET[4], Open Discovery Space[5], Open Science Resources[6], and weSPOT[7] offer the possibility of creating learning resources.

The adaptation and reusability requirements are often challenging due to the granularity and the monolithic nature of the resources (PDFs, videos or simulations). Nevertheless, platforms such as WISE[8] allow teachers to adapt existing resources for STEM education. The resources generated, however, cannot be used by students out of the platform.

In this paper, we show how rich educational resources, especially ILSs, may be offered as OERs. Two loosely-coupled platforms, namely Graasp (an ILS Factory) and Golabz (an ILS Repository), enable teachers to freely create, share, discover, embed and adapt learning resources according to their needs.

B. Personal and Inquiry Learning Environments

In recent years, efforts have been made to enable teachers and learners not only to enjoy learning environments, but also to craft, populate and personalize them. Especially, the concept of Personal Learning Environments (PLEs) has been consolidated by a very active learning community [3] and initiatives, including the ROLE European research project [4]. The current agreement is that a PLE is an integrated online set of multimedia content, information channels, end-user services and connected people gathered from the student's or teacher's personal digital ecosystem. A PLE is an environment dedicated to support a specific learning activity, created autonomously in an opportunistic way by exploiting either mainstream social media or dedicated platforms. The use of dedicated platforms promoted by part of the PLE community can be seen as a constraint for self-directed learners, but is enabling the archiving and sharing of PLEs with peers.

This concept of PLE has attracted interest in the STEM education community as a way to provide packaged resources to

[1]Graasp platform: http://graasp.epfl.ch (graasp.eu)
[2]Golabz Repository: http://www.golabz.eu
[3]MERLOT repository: http://www.merlot.org
[4]PhET interactive simulations: https://phet.colorado.edu
[5]Open Discovery Space: http://www.opendiscoveryspace.eu
[6]Open Science Resources: http://www.osrportal.eu
[7]weSPOT inquiry space: http://inquiry.wespot.net
[8]Web-based Inquiry Science Environment: https://wise.berkeley.edu

978-1-4799-5739-2/14/$31.00 © 2014 IEEE

structure and support inquiry learning activities [5]. Compared to the traditional PLE setting, in inquiry learning the resources are not aggregated by self-directed learners, but rather by teachers having the same strong need for contextualization and repurposing. The Go-Lab European project[9] is an ongoing initiative aiming at promoting inquiry learning with online laboratories (Labs) for STEM education at school [6]. These online labs are either virtual labs (simulations), remote labs (physical equipment accessible at distance), or data sets (shared by scientific organizations for exploration), accessible through Web applications (Apps).

Inquiry learning can be a successful pedagogical approach, provided that effective support is offered to the studentsn [7]. Support is implemented at various levels: first, activities are structured in successive phases; second, in each phase scaffolding tools supporting the activities are provided; and third, relevant cues are given to the students when necessary. In this framework, PLEs are exploited as ILSs [8] dedicated to support targeted inquiry learning activities on given STEM topics, using dedicated tools and resources complementing and reinforcing each other.

The rest of this paper is structured as follows: Section II details the concept of ILS, Section III shows how ILSs can be easily created individually or collaboratively, Section IV highlights the interplay between the platforms supporting the sharing and the repurposing of the ILSs as OERs, Section V provides exploitation examples of ILSs in various frameworks, Section VI details some technical features that enrich the ILS, and Section VII presents the conclusions and future work.

II. Inquiry Learning Space

The typical resource created and shared by teachers through Graasp and Golabz is an ILS. Such online resource is designed to support the study of STEM topics. ILSs are primarily dedicated to activities carried out with computers or tablets in the classroom under the supervision of a teacher. A teacher can use an ILS just once during a semester to complement regular lab activities or more often without changing the usual learning modalities.

The resource itself enforces inquiry learning phases to promote the study of science the way scientists carry it out, i.e., working on Orientation, Conceptualization, Investigation, Conclusion and Discussion [10] of the target topic. ILSs are available on the Web to ease access and integrate online labs, scaffolding applications or other learning materials such as texts, images or videos. Figure 1 depicts the student view of an ILS. The upper bar contains the title of the ILS (on the left) and the student's nickname (on the right). The tabs represent the inquiry phases and, in the specific case of the *Investigation* phase, this example contains an embedded lab for the study of satellite trajectories and the second Kepler law.

As such, ILSs are rich self-contained educational resources built according to a pedagogical structure (through a number

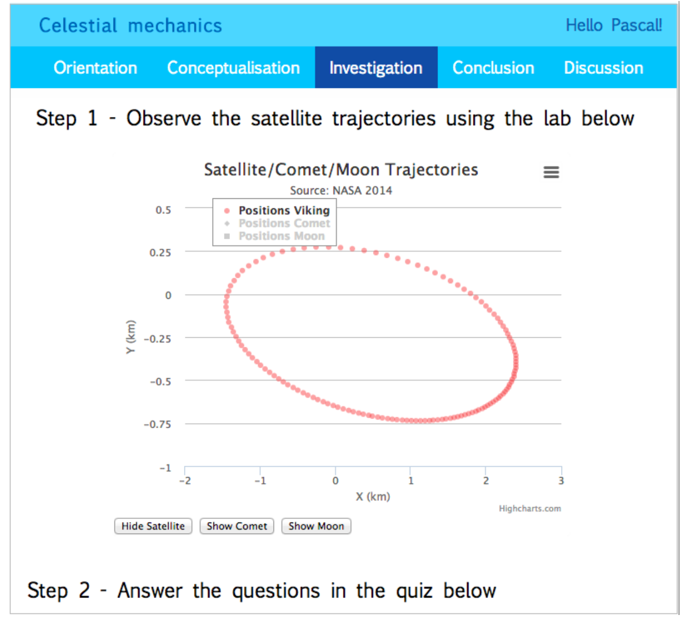

Fig. 1. Example of an ILS seen from the student's perspective.

of phases defined by the teacher, see Section III), embedding multimedia content (gathered from the cloud or from educational legacy repositories), as well as apps providing additional end-user services (scaffolding or lab interfacing apps).

To guarantee student privacy, ILSs are shared with the students by a unique secret URL, and only their nicknames are required to access the platform. Besides, to enable the assessment and personalization of the learning experience, the ILS tracks the students' activities and offers the teacher a learning analytics dashboard implemented using OpenSocial[11] apps. The data collected from the students as well as their learning outcomes are only available within the ILS, in order to protect such sensitive material. Further details about privacy, learning analytics and data management in ILSs are presented in Section VI.

III. ILS Creation

The creation of ILS is handled in Graasp. Graasp is a social media platform designed to support collaboration, learning and knowledge management [10]. More broadly, Graasp supports many types of collaboration and is especially well suited for agile and decentralized structures such as schools, universities and non-governmental organizations (NGOs) [11]. A *space* is the central concept in Graasp. It encapsulates the context of a collaboration. A space can be compared to a folder in a filesystem with members having permissions defined by their chosen role (as owner, contributor or viewer). Graasp provides a special type of space, called Inquiry Learning Space, which is already embedding sub-spaces corresponding to the inquiry learning phases mentioned above.

Figure 2 shows a screenshot of Graasp to illustrate a usage scenario. Pascal is a physics teacher who wants to create a lesson on celestial mechanics. He creates a new ILS space called 'Celestial mechanics'. This space contains the

[9]Go-Lab project: http://www.go-lab-project.eu

[10]Alternative sequences or naming of phases exist [9], but the main idea is always to encourage the students to develop their own questioning, figure out their own responses by making proper hypotheses and designing proper experiments, and reflect on the observations. Following this applied approach students may see how scientists works in a practical setting, gaining a better idea of the scientific method.

[11]OpenSocial: http://opensocial.org

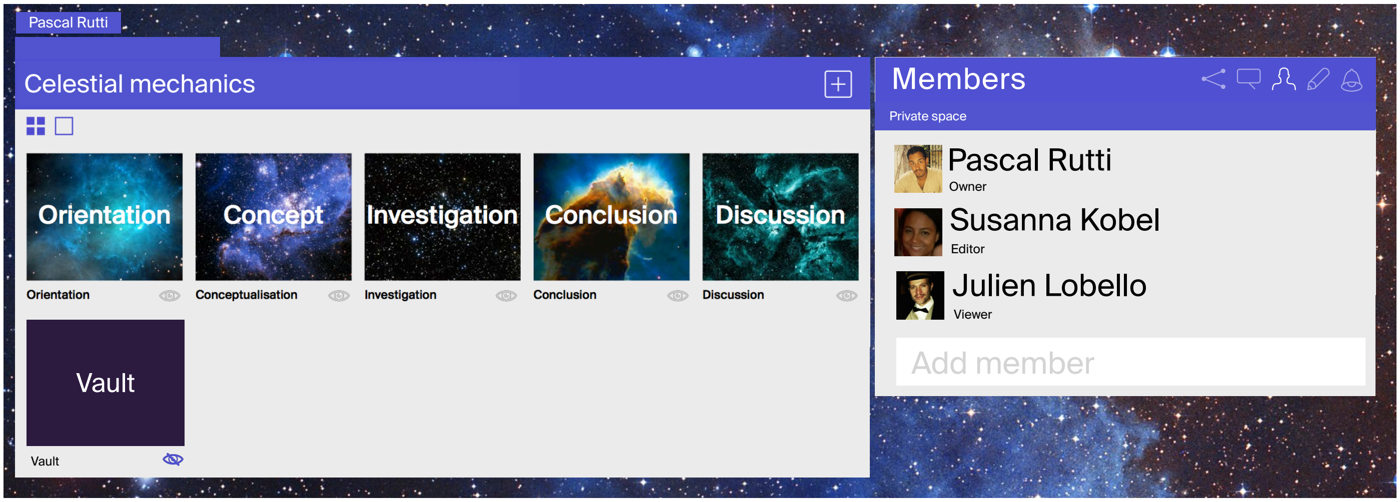

Fig. 2. Screenshot of an ILS in Graasp as it is shown to the teacher.

predefined ILS structure with five sub-spaces representing the five inquiry phases. The teacher may modify the existing sub-spaces or add new ones according to his needs. The ILS also includes a 'Vault' space for student files. Note that the 'Vault' space is set to invisible (the cross-eye icon on the bottom right is pressed) and will thus not be shown to students in their view of the ILS. It can however be used by apps integrated in the ILS for data storage and retrieval.

Pascal wants to collaborate with colleagues on this activity. Editors can add and edit content to the space, but cannot manage members, and viewers can only see the ILS content. Thus, he adds Susanna as an editor and Julien as a viewer. As Julien is very interested in the activity, Pascal can change his role to editor (or even to owner) at any time. With this permission scheme, it is easy to include collaborators for the creation and editing of the ILS. To create the content of his ILS, Pascal drags-and-drops materials (e.g., images) into each of these phases, aggregates resources (e.g., YouTube videos) from across the Internet using the GraaspIt bookmarklet, and loads apps and labs from the Golabz Repository. For instance, as illustrated in Figure 3, in the 'Investigation' space Pascal has added the 'Trajectory lab', the 'QuizMaster' app and a Youtube video.

Inside each space, items can be viewed as tiles and re-ordered by drag and drop (as shown in the top image of Figure 3) or viewed as students will see them, expanded one below each other with a description for each item (as shown in the bottom image of Figure 3). When Pascal has completed the creation of the ILS, he can share it with his class by using the 'Share' tab. Students will see a version of the space independent of Graasp, showing only the phases and their content structured by tabs (see Figure 1).

IV. ILS Sharing

Sharing and reusing ILSs is achieved through the Golabz Repository [12], from which teachers can access a collection of reusable resources. On the Golabz Repository teachers can create their own ILS, based on an existing one or an available lab. Figure 4 illustrates the lab page of the 'Satellite/Moon/Comet Trajectories' lab that Pascal used in his ILS. This page presents a detailed description of the lab using different metadata (e.g.,

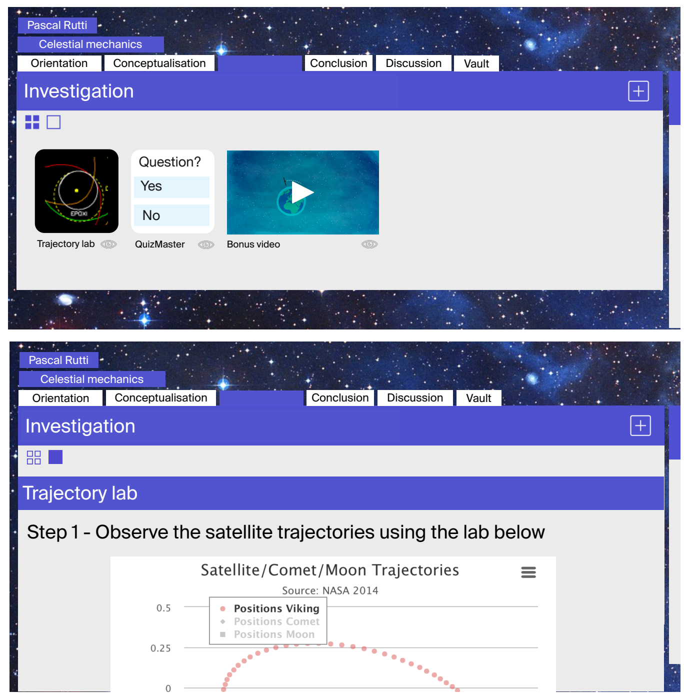

Fig. 3. Screenshot of the investigation phase of the 'Celestial mechanics' ILS. The top image shows the tile view (four square icon pressed) and the bottom image shows the expanded view (large square icon pressed).

the subject domains and grade level), as well as screenshots that can help him decide whether the lab is appropriate or not for his course. Pascal could have also instantiated an ILS directly from this page, by clicking on the 'Create Inquiry Space' button. Upon clicking this button, a new ILS owned by Pascal is created in Graasp with the Trajectories lab app already integrated in the Investigation phase. From this basic ILS, Pascal can start adding content, for example by adding apps from Golabz.

An even more convenient way for Pascal to kickstart his ILS, would be to select one of the ILSs shared by other teachers and experts on the Golabz Repository. Pascal can create his own version of a shared ILS on Graasp (in an identical fashion as for the lab in Figure 4). Once more, he can

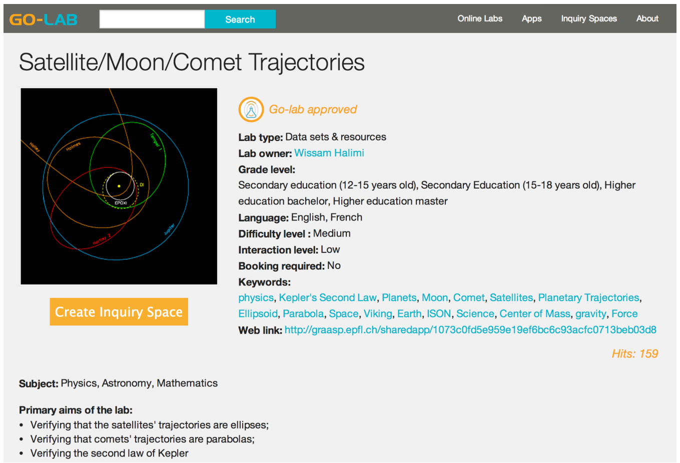

Fig. 4. The detail page of the 'Trajectories' lab on the Golabz Repository with ILS instantiation button.

just click on the 'Create Inquiry Space' button of an ILS detail page on the Golabz Repository. This will create a copy of the shared ILS with all content, apps and labs available (except for the documents uploaded by students in the 'Vault' space). Pascal can then further edit and extend this shared resource.

Once Pascal has completed his ILS, he can decide to share his personalized version with the teacher community on the Repository. Pascal can click on the 'Publish Inquiry Space' button in Graasp and will be asked to fill in a short metadata form to enable search. To lighten the metadata annotation burden, this form is mostly pre-filled based on information available (on Graasp, from the lab, or the original shared ILS). For instance, Pascal is asked how he wants to copyright his ILS. To encourage teachers to flexibly share ILS, Go-Lab has integrated Creative Commons (CC) licenses[12], which aim at making creative works available to legally build upon and share. To foster reuse, teachers can only share their ILS under non-commercial CC licenses. After completing the metadata, the new ILS is published on the Repository. Pascal can also later update the shared ILS on the Repository after he has made other changes in Graasp. However, the decision to share an ILS remains completely up to the teacher. Even if Pascal does not want to share his ILS on the Golabz Repository, he can collaborate and use the ILS in Graasp with several colleagues.

Such sharing and updating of ILS on Golabz can only be done for an ILS and not for labs and apps. However, teachers can extend the functionality of some apps and labs, through the Go-Lab App Composer [13]. The App Composer is an online tool to internationalize and configure apps and labs to specific course needs of teachers. Such translations and configurations can also be shared with other teachers.

To find the most interesting ILSs, the Lab Repository provides (aside from metadata) several social media mechanisms, such as rating and sharing on social networks, or commenting. Social badges [14] can be added in the future, to allow other teachers and Go-Lab experts to highlight the best labs, apps and ILS. Through these social validation mechanisms, the shared resources can be curated by the 'wisdom of the crowd'.

V. ILS Exploitation

ILSs may be suitable for different purposes. This section presents two contexts were ILSs have been used: schools and MOOCs. Additionally, we present a promising alternative for sharing and distributing ILSs: eBooks.

A. *STEM education at School*

As mentioned in the introduction, the Go-Lab Project focuses on supporting STEM education at school. Below, we describe two example school activities featuring ILSs, which have been carried out at Collège Sismondi in Geneva.

One pilot activity has been developed by three school teachers. They found that structuring the learning scenarios according to the ILS phases was challenging at the beginning, but more intuitive over time. As soon as teachers mastered the usage Graasp, they started to be creative when integrating resources, apps and labs. Indeed, they also proposed having specific scaffolding apps (e.g., a wiki tool where students can type their answers to questions, or a collaborative editor for discussions) and a special space to collect students' learning outcomes (the *Vault* space discussed in Section VI). According to the teachers' feedback, the authoring tool was powerful enough to create rich ILSs for one teaching session without the need of external tools.

The second activity involved two physics instructors and 39 students from 14 to 18 years old. The instructors created their own ILS and used it in 6 practice sessions. The students' feedback showed that they were pleased by having interactive content (videos, pictures, apps...), and that they appreciated the fact that their identity was not shared on the Web. Besides, the students were particularly satisfied by the lack of time constraints: those who were not able to finish their assignments during the session could complete them at home, not affecting their grades for in-class assignments. It is worth mentioning that the user interface, the integrated apps and multimedia resources played a major role in making the ILS attractive to students, who expressedan interest in repeating the experience.

B. *Inquiry Learning in MOOCs*

Massive Open Online Courses (MOOCs) disseminate learning material to a very large amount of users. The learning material is mainly made of short video sequences interleaved with multiple-choice questionnaires (i.e., students have to answer correctly the questions to continue watching the lecture). Additional reading material and exercises often are proposed in MOOCs. For example, it is possible to execute interactive simulations where students directly see the effect of a given parameter to the simulation. While such simulation can be added as an external component (e.g., an XBlock in edX), it does not provide features comparable to an ILS, especially regarding collaboration. Indeed, it is possible to integrate an ILS as a tool in the edX platform, as depicted in Figure 5.

The edX open source MOOCs platform proposes an API called XBlock[13] that enables the integration of external components in a MOOC. The XBlock architecture gives access to edX via a Phyton interface. Building an XBlock is not a trivial

[12]Creative Commons: http://creativecommons.org

[13]XBlock doc: https://xblock.readthedocs.org

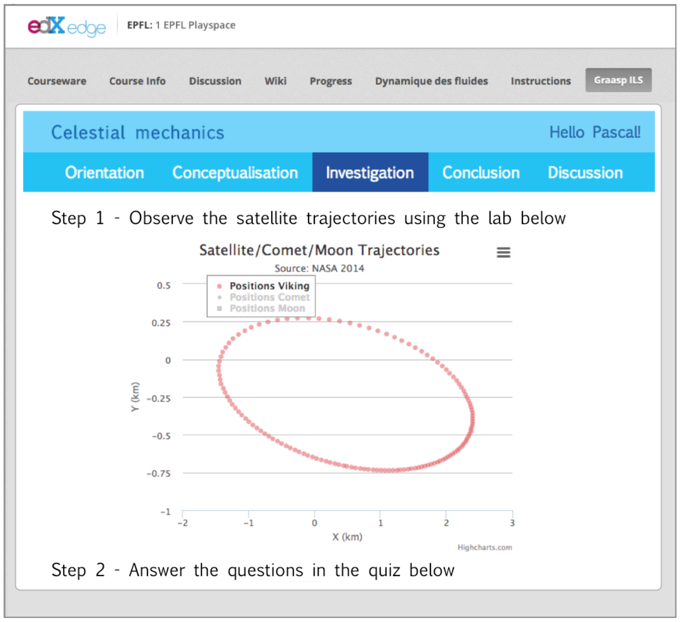

Fig. 5. ILS integration as a *tool* in edX.

task for a non-programmer. On the other hand, adding the ILS as a *tool* is straightforward and enables the seamless reuse of existing resources. However, as of this writing, adding an ILS as a tool does not permit direct communication between the ILS and edX.

After a first successful integration of an investigation tool in a MOOC on fluid mechanics at the EPFL, further full implementations of ILSs in MOOC platforms will be performed, with possible alignment of the ILS model to the XBlock format.

C. Inquiry Learning Space as eBook

With the growing number of tablets in the classroom, eBooks have become a popular way to bring OERs to students. An ILS could also be embedded in an eBook. Each inquiry phase can be seen as an eBook chapter. Basically, one can take the student view of the ILS (see Figure 1) and each tab (e.g., ‘Orientation’ and ’Conceptualisation’) can be a separate chapter. Since the ILS is built using responsive HTML, this content could be easily integrated in several eBook formats, such as EPUB[14]. Through the eBook format, ILSs could be shared on a wide range of repositories and marketplaces (e.g. the Apple iBooks store[15] or Amazon Kindle store[16]).

VI. Data Management

To enable the personalization of the learning experience and the sharing of ILSs with other practitioners, ILSs present specific characteristics regarding data management: students are traced to enable personalization but, at the same time, strict policies are applied to ensure the student privacy outside of the ILS. This section summarizes the main details of these additional features.

A. Learning Analytics Dashboard

Learning based on ILSs comes with challenges caused by its remote nature. In remote learning it is particularly hard for teachers and students to observe and adjust the learning process when needed. Learning analytics (LA) aims to address such issues by collecting and using traces that learners leave online [15]. By visualizing and analyzing such traces, a teacher could monitor live the students’ work and, based on this, intervene and adapt the course when required. On the other hand, LA can help students to better understand how they learn, and help improve their learning. For this reason, we provide teachers and students with a set of learning analytics apps along with the ILS [16]. The LA apps can be arranged into a dashboard that can be displayed in an additional Analytics tab of the ILS, to provide students with information about their learning progress, at a glance [17].

To enable learning analytics, the ILS tracks and records the student actions using ActivityStreams[17], a specification devoted to model user interactions. Currently, an ILS tracks the following activities related to the ILS (in accordance with the ActivityStreams Specification): *access*, *start*, *cancel*, *send*, *watch*, *add*, *remove*, *update*.

B. Privacy Enforcement

Apart from teachers, the main target users of the Go-Lab project are students from 10 to 18 years old. Due to the age of the students, their data privacy is of particular importance and is subject to stronger legal regulations. For instance, the European Union provides a data privacy framework, through the EU directives 95/46/EC (Data Protection Directive) and 2006/24/EC (Data Retention Directive). Therefore, to protect student privacy, two mechanisms have been used dealing with the identification and the data retention.

Among the different identification levels (going from anonymous to fully identified users), we have opted to follow a *nickname-based approach* [18]. On the one hand, teachers logged in the ILS editor can create an ILS and share it with their students via an unique secret URL, providing access only to those who know the URL. On the other hand, students do not need to create an account, they just need to provide a unique nickname (valid within the scope of the ILS) to identify themselves and access the ILS. Thereby, the real student name is not known by the system.

Asking students to use nicknames, however, does not guarantee that real names will not be used. Furthermore, student identity could also be revealed by the notes they are posting. To address this issue, a mechanism called *AngeLA* (the Guardian Angel for Learning Analytics) has been implemented to put the teacher in full control of students’ privacy at the ILS level [19]. AngeLA provides teachers with a way to completely enable or disable the data tracking, which guarantees that activity data are only collected if so desired. AngeLA is essentially a software agent that can be invited into an online space, along with its other members. When AngeLA is a member of an online space, it tracks and collects all activity traces of the space members, stores them in the local database, and shares them with authorized loosely-coupled third-party LA services.

[14] EPUB format: http://idpf.org/epub
[15] Apple iBooks: https://www.apple.com/ibooks/
[16] Amazon Kindle store: http://www.amazon.com/Kindle-eBooks
[17] ActivityStreams specification: http://activitystrea.ms/specs/json/1.0

C. Data Storage Handling

Two types of data are stored within an ILS: on the one hand, the content that will be exported and reused by potential users (i.e., the ILS structure, descriptions, resources and embedded apps, as well as the configuration parameters); and, on the other hand, sensitive material that should remain private such as learning outcomes uploaded by the students, the data stored by the apps, or the monitored user actions. To store these sensitive data, every ILS features a *Vault* space (shown at the bottom of Figure 2), accessible only to the ILS owner and editors.

VII. Conclusion

The concept of Inquiry learning Spaces created, shared, and reused as Open Education Resources has been developed in this paper. The proposed approaches and platforms enable the appropriation by the teachers of the full design and implementation cycle for personalized resources supporting high-level personal and inquiry learning activities.

Preliminary results about the ILS creation have been obtained from a participatory design process carried out in pilots with 10 teachers collaborating with the Go-Lab project, and 30 teachers participating in the 2014 Go-Lab summer school. These activities allowed us to design approaches and platforms that teachers would adopt to strengthen the inquiry learning activities they are offering to their students. As such, useful feedback has been collected and are integrated in the design of the new versions of the platforms described in this paper. In addition, ILSs created by inquiry learning experts have also been presented to promote the community-based paradigm of creating, sharing and reusing OERs.

Future work includes the validation of the completeness and the simplicity of ILSs in actual classrooms and MOOC settings, the validation of the sharing and repurposing scheme by teacher communities (including the willingness of teachers to share or not their resources under Creative Commons licenses), as well as the elicitation and validation of added value services to be integrated in ILSs to effectively empower students with scaffolding, investigation and reflection tools.

Acknowledgment

This research is partially funded by the European Union in the context of Go-Lab (grant no. 317601) project under the ICT theme of the 7th Framework Programme for R&D (FP7). Special thanks to Alexandros Trichos for his contributions to the implementation of Inquiry Learning Spaces. The 2nd to the 6th authors are listed by alphabetic order.

References

[1] UNESCO and COL, "Guidelines for Open Educational Resources (OER) in Higher Education," UNESCO/Commonweath of Learning, Tech. Rep., 2011. [Online]. Available: http://unesdoc.unesco.org/images/0021/002136/213605e.pdf

[2] P. Zervas, C. Alifragkis, and D. G. Sampson, "A quantitative analysis of learning object repositories as knowledge management systems," *Knowledge Management & e-Learning Journal*, vol. 6, no. 2, pp. 156–170, 2014.

[3] G. Attwell, "Personal Learning Environments - the future of eLearning?" *eLearning Papers*, vol. 2, no. 1, 2007. [Online]. Available: http://www.elearningeuropa.info/out/?doc_id=9758

[4] S. Kroop, A. Mikroyannidis, and M. Wolpers, Eds., *Responsive Open Learning Environments: Outcomes of Research from the ROLE Project*, ser. Lecture Notes in Learning & Instruction. Springer International Publishing, 2014.

[5] M. Sharples, P. Mcandrew, M. Weller, R. Ferguson, E. Fitzgerald, T. Hirst, Y. Mor, M. Gaved, and D. Whitelock, "Innovating pedagogy 2012: Open University innovation report 1," The Open University, Tech. Rep., 2012. [Online]. Available: http://www.open.ac.uk/blogs/innovating

[6] T. de Jong, S. Sotirou, and D. Gillet, "Innovations in STEM education: The go-lab federation of online labs," *Smart Learning Environments*, vol. 1, no. 3, 2014.

[7] T. de Jong, M. C. Linn, and Z. C. Zacharia, "Physical and virtual laboratories in science and engineering education." *Science*, vol. 340, no. 6130, pp. 305–308, 2013.

[8] D. Gillet, T. de Jong, S. Sotirou, and C. Salzmann, "Personalised learning spaces and federated online labs for stem education at school," in *Global Engineering Education Conference (EDUCON), 2013 IEEE*, March 2013, pp. 769–773.

[9] T. de Jong, "D1.1: Go-Lab learning spaces specification," Go-Lab European Project, Tech. Rep., 2013. [Online]. Available: http://www.go-lab-project.eu/deliverables

[10] D. Gillet and E. Bogdanov, "Contextual spaces as agile personal learning environments or informal knowledge management solutions," in *Information Technology Based Higher Education and Training (ITHET), International Conference*. IEEE, 2013, pp. 1–6.

[11] A. Holzer, A. Vozniuk, S. Govaerts, J. Mazuze, and D. Gillet, "Social, Flat, Agile, and Ad Hoc: Information Systems for NGOs," in *DEV'14. Under review.* ACM, 2014.

[12] S. Govaerts, Y. Cao, A. Vozniuk, A. Holzer, D. Zutin, E. Ruiz, L. Bollen, S. Manske, N. Faltin, C. Salzmann, E. Tsourlidaki, and D. Gillet, "Towards an online lab portal for inquiry-based STEM learning at school," in *Advances in Web-Based Learning ICWL 2013*, ser. Lecture Notes in Computer Science, J.-F. Wang and R. Lau, Eds. Springer Berlin Heidelberg, 2013, vol. 8167, pp. 244–253.

[13] L. Rodriguez-Gil, M. Latorre, P. Orduña, A. Robles-Gómez, E. S. Cristóbal, S. Govaerts, D. Gillet, I. Lequerica, A. C. Caminero, R. Hernández, S. Ros, M. Castro, D. López-de-Ipiña, and J. G. Zubía, "Opensocial application builder and customizer for school teachers," in *IEEE 14th International Conference on Advanced Learning Technologies, ICALT 2014, Athens, Greece, July 7-10, 2014*. IEEE, 2014, pp. 31–33. [Online]. Available: http://dx.doi.org/10.1109/ICALT.2014.20

[14] I. Glover, "Open badges: A visual method of recognising achievement and increasing learner motivation," *Student Engagement and Experience Journal*, vol. 2, no. 1, 2013.

[15] E. Duval, "Attention please! learning analytics for visualization and recommendation," in *Proceedings of LAK11: 1st International Conference on Learning Analytics and Knowledge*, 2011, pp. 9–17.

[16] T. Hecking and Y. Cao, "D4.4: Releases of the learning analytics, scaffolding services, and add-on services," Go-Lab European Project, Tech. Rep., 2014. [Online]. Available: http://www.go-lab-project.eu/deliverables

[17] A. Vozniuk, S. Govaerts, and D. Gillet, "Towards portable learning analytics dashboards," in *International Conference on Advanced Learning Technologies*, 2013.

[18] N. Li, A. Holzer, S. Govaerts, and D. Gillet, "Enforcing privacy for teenagers in online Inquiry Learning Spaces," in *Understanding Teen UX workshop at CHI Conference on Human Factors in Computing Systems*, Toronto, Canada, apr 2014. [Online]. Available: http://infoscience.epfl.ch/record/197892

[19] A. Vozniuk, S. Govaerts, L. Bollen, S. Manske, T. Hecking, and D. Gillet, "AngeLA: Putting the Teacher in Control of Student Privacy in the Online Classroom." in *ITHET 2014*, 2014.