ALDO: An Innovative Digital Framework for Active E-Learning

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ABSTRACT
In this paper, we propose ALDO (Active e-Learning by DOing), a novel, advanced digital framework supporting integrated facilities for effective, active e-Learning. The ALDO framework includes an active repository for collecting/sharing relevant materials, collaborative editing services for enriching so collected "raw" materials, and advanced data visualization tools (e.g., interactive maps, graphs, and timelines) to explore the spatial and temporal dimension of specific data contexts. Although the present research was carried out within the European Horizon 2020 Project DETECt (*Detecting Transcultural Identity in European Popular Crime Narratives*), focusing on the specific data context of European crime narrative, the generality of ALDO technological framework makes it suitable for any type of study/teaching activity. More in details, ALDO consists of a multi-functional digital infrastructure (back-end) for the integration of collaborative editing and e-Learning activities in formal and informal educational contexts. The platform supports effective services for collecting, sharing, retrieving, and analyzing data, together with advanced online collaboration tools, an e-Learning platform and advanced data visualization tools, all made available to teachers/students through a dedicated Web portal (front-end). The design and creation of above tools and services for teaching, together with their uses, are presented and discussed through a series of real examples taken from DETECt.

CCS Concepts
• Human-centered computing→Collaborative content creation • Applied computing→Interactive learning environments • Applied computing→Collaborative learning • Applied computing→E-Learning • Information systems→Database management system engines.

Keywords
E-Learning Platforms, Portals; Collaborative Learning; Advanced Data Visualization; Data Repository; Data Management.

1. INTRODUCTION
Thanks to the development and success of Information and Communication Technology (ICT), we are currently witnessing a rapid spread of Web-based services that allow collaborations and interactions between users of any kind of organization and from very distant locations. When considering the educational and academic contexts, remote interaction and collaboration are commonly implemented by schools and universities [1],[2],[3],[4],[5] through the adoption of collaborative editing systems and e-Learning platforms. More specifically, considering the education sector, several studies have confirmed the benefits of using collaborative writing [2],[3],[6],[7] and e-Learning platforms [1],[4],[5] in teaching. Furthermore, it has been proven that even greater benefits can be achieved by including multimedia digital materials within e-Learning courses [8] or by combining traditional teaching sessions with e-Learning sessions within school courses [9].

Any attempt to produce a "complete" e-Learning platform should therefore consider collaborative editing of learning materials and ICT-based facilities as a must part of the services to be offered.

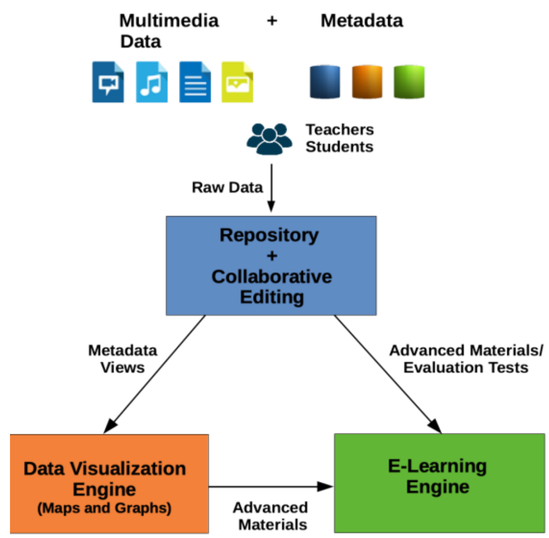

Figure 1. Active e-Learning exploiting ALDO framework.

In the DETECt project, one of the goals is to translate the European identity found in popular crime narratives to students of the academical partners. In this context, we present ALDO (Active e-Learning by DOing), a novel, advanced digital framework for active e-Learning as a means to vehiculate digital contents in an effective and active way for educational purposes. More in details, ALDO is able to offer, in a single, integrated platform, instruments for collecting, sharing, retrieving, and analyzing data, collaborative editing services for enriching materials, advanced data visualization tools to explore spatial/temporal dimensions of specific data contexts, together

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with e-Learning facilities to supporting the transnational collaboration of teachers and students.

Figure 1 shows how reaching effective, active e-Learning is feasible by exploiting ALDO digital framework. In our view, teachers and students can use the repository to collect multimedia materials and metadata. Using the collaboration tools provided by our collaborative editing/repository platform, teachers can work together to create advanced teaching materials based on the "raw" materials uploaded. Moreover, through appropriate selections ("views") of the collected metadata it is possible to create interactive visual displays of such data, through interactive maps, graphs, and timelines. Such advanced materials (teaching materials, maps and graphs) can therefore be used within the e-Learning platform to enrich the resources made available to students within the individual courses. Similarly, students can create their own materials in the repository (by building new materials or working on the basis of the resources already present in the e-Learning platform), working alone or collaborating in groups, and then uploading their evaluation tests to the courses attended in order to obtain an evaluation by the teacher. To the best of our knowledge, ALDO represents the first attempt to closely integrate all described services and tools into a single digital framework.

The rest of the paper is as follows: Section 2 presents the related work; Section 3 details ALDO digital framework through the use of real examples taken from DETECt. Finally, Section 4 concludes the paper by outlining interesting future directions.

2. RELATED WORK

Table 1. E-Learning features/services: A comparative analysis

	Moodle	Google Drive + Docs	ALDO digital framework
E-Learning	Yes	No	Yes
Data + Metadata Repository	Partially	Partially	Yes
Collaborative Editing	No	Yes	Yes
Interactive Data Visualization	No	No	Yes
Open Source Software	Yes	No	Yes

This section reports relevant state-of-the-art. In particular, due to the absence in literature of complete digital infrastructures able to support teachers and students in all above described e-Learning features and services, our study will concentrate on individual reference-based educational solutions, by paying particular attention to the possibility to develop customized implementations of the related technologies.

Concerning e-Learning platforms, Moodle was found to be one of the most used open source Learning System Management (LSM) and also one of the best evaluated [4],[10],[11]; it was quite natural to consider it for the design of our framework.

As regards cloud platforms able to offer documents storage tools and update data services through collaborative writing, it has emerged that Google Docs, in combination with Google Drive, is widely used in the field of education with documented benefits in terms of both student productivity and student involvement [2],[3],[6],[7]. However, since it is not possible to develop a customized implementation of Google Docs, for our purposes we had to refer to an open-source alternative to Google Drive and Google Docs, as will be detail in the following. In addition to this limitation, both Moodle and Google Drive do not effectively support the possibility to manage traditional metadata information.

Table 1 expresses a comparative analysis in terms of e-Learning features and services. As it is possible to observe, the peculiarity of ALDO consists in being able to effectively and efficiently provide all needed services and features that are normally provided individually by state-of-the-art platforms.

3. ALDO DIGITAL FRAMEWORK

This section describes ALDO software architecture (back-end) as well as all the services and tools integrated in the dedicated ALDO Web portal (front-end). In doing this, we illustrate their uses and how they can facilitate teaching and learning in any context of use.

3.1 Software Architecture

In setting the best software architecture for the Web portal, we have assumed the use of free or open source software as a fundamental requirement. The reasons behind this choice are many, but the most important is the possibility of being able to have direct access to source code of the software used with the possibility to customize provided applications: in combination with the open license, this greatly simplifies the development process.

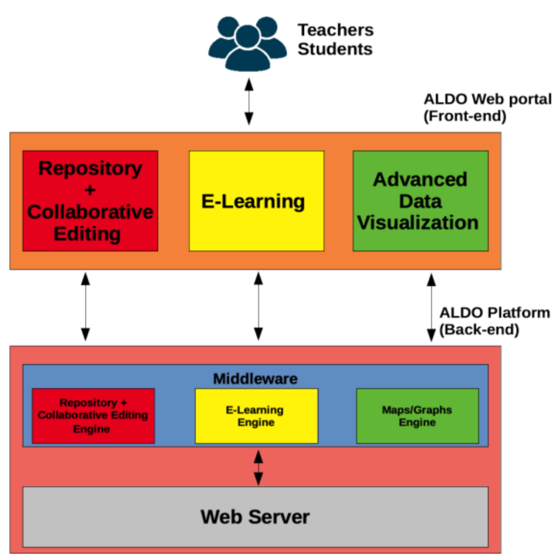

Figure 2. ALDO reference architecture.

The harmonious integration of the many, different customized software libraries included in ALDO is carried out within a dedicated, additional "middleware" layer of the reference software architecture (see Figure 2). More in details, the persistence of collected data and materials is managed by an active repository based on database technologies. All comments, tags, annotations, uploaded files, and conversations are stored in the repository that maintains different type of data like "raw" multimedia data, qualitative descriptions (i.e., metadata like the title of a series, the author, the description, etc.) and quantitative descriptions (e.g., annotations, comments provided by teachers/students).

Since ALDO Web portal acts as a showcase for all the services and tools made available to teachers, students, and public users, the choice of its reference structure has been virtually forced. ALDO Web portal is divided into public sections and private sections with restricted access. Restricted access sections include the e-Learning and collaborative editing platforms. The sections with public access are those related to maps and graphs used to offer advanced views of the metadata of specific context, as will be detailed in the following.

3.2 Repository and Collaborative Editing

Collaborative editing is a process of writing documents that involves multiple people and is aimed at producing a work through individual contributions. The use of collaborative writing tools can offer substantial benefits to projects ranging from increasing user engagement to simpler work processes. It often happens that when users can directly contribute to an effort and feel they have made a difference, they become more involved and tied to the project's result. Moreover, the final document will be even more accurate because the participation of more people offers different points of view and more skills, reducing the percentage of errors. Another advantage is that because this type of software gives the team the ability to speak in real time, projects can be completed faster. Finally, this type of software allows individual collaborators to participate at different times and from different places by facilitating users to contribute.

Designing and implementing a graphical user interface for an online collaborative editing enabled repository is not a trivial task. The first step towards this goal is to identify all the characteristics that a collaborative system must guarantee in terms of provided services. Among such features, a collaborative environment has to be able to arrange users in groups, limit users' privileges by assigning them different roles or reducing their permissions in accessing documents, offer the user the ability to collect or create documents, perform reviews, validate the work of contributors (through synchronous and asynchronous communication), and make specific annotations and/or comments to documents. Finally, a collaborative system must provide an automatic versioning system that keeps track of all document changes: this allows users to keep the history of the changes made and provides the possibility to retrieve them, starting from a previous activity.

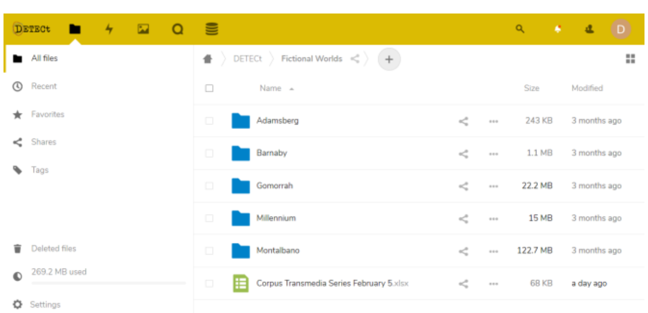

Figure 3. Repository interface.

To achieve our goal, we have exploited two open source software platforms: Nextcloud[1], for the development of the online file system functionalities, and LibreOffice Online[2] for the implementation of the collaborative editing services. These platforms have been opportunely customized in order to derive our repository implementation: the result we have obtained is a modern collaborative platform, simple and intuitive to use, and that meets all the requirements described above. A snapshot of the implemented repository interface is reported in the Figure 3.

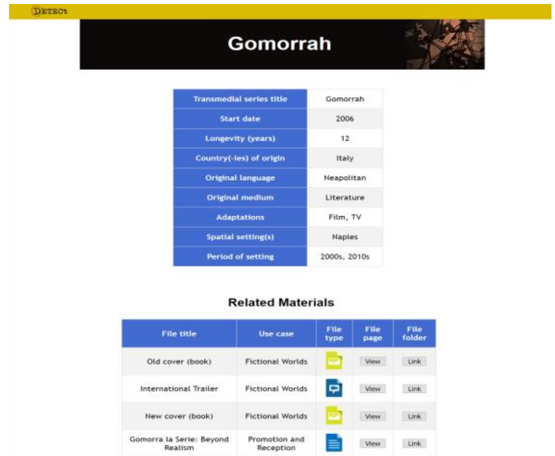

Figure 4. Result page for a semantic query (i.e., "Gomorrah"): relevant metadata information and multimedia materials.

The first, basic functionality offered by ALDO collaborative platform is represented by the possibility for the users to collect multimedia materials and perform the classical actions of deleting, copying/moving, and downloading uploaded files. In addition, users have the possibility to take advantage of a preview of the files, by directly inspecting the file content or the related details (i.e., the file size, the creation date, etc.). This function is particularly useful for examining the contents of a file without having to download it. Moreover, users can add to "favorites" the files they work on more often so they can view them all through with a single click on the dedicated menu item. Further, it is possible to access to the various activities done on each file, the comments inserted, the sharing activities and, above all, the different versions of the file. We remind that this last feature is an indispensable service for a collaborative editing tool. Finally, the interface provides a tagging field where the users can insert tags and/or view the tags associated to each file. The great advantage of providing the users with a tagging service is that, once the users have tagged documents, the tags can be profitably exploited for searching purposes: users can search for documents of interest by entering specific tags in the dedicated "search bar". This represents a fast and convenient direct access to the repository data. As additional functionality, if the structure of the folders is based on an ontological subdivision of semantic concepts relevant to a case of study, users can also add metadata concerning concepts or individual files simply by inserting an excel file in one of the intermediate folders (metadata concerning concepts) or in the folder where the multimedia files are present (metadata concerning the individual files). The import of metadata within the database is automatic; this operation enables the search for files and folders through the metadata search interface. Through this interface, it is possible to view all the information concerning a specific concept as well as all the multimedia files associated to it. For example, Figure 4 shows an example of metadata query for

[1] https://nextcloud.com/

[2] https://www.libreoffice.org/download/libreoffice-online/

one of the use cases of DETECt (i.e., "Gomorrah"). In details, metadata information and related multimedia files for the query "Gomorrah" are retrieved for the user. From this window the user can have a Web preview of each multimedia file or move directly to the repository folders that host the file of interest.

In addition, thanks to the customization of LibreOffice Online platform, the users can edit, directly from Web browsers, text files, spreadsheets and power point presentations contained in the repository. In Figure 5 we provide an example of online editing of a word document. The online file editing service enables the ability for the users to have the complete list of the various versions of the file that have been created over time, with the possibility of restoring previous versions and/or downloading each individual version.

To complete the description of the collaboration services offered by our repository interface, it is important to highlight that the interface further allows: to define users' groups with different rights and privileges of access to files, to manage the access/read/write/file sharing policies in a simple or advanced way and, depending on the needs, to use synchronous (e.g., chat) and/or asynchronous communication systems (e.g., file comments, system notifications on the changes made to the files) for best supporting the collaboration among students or teachers.

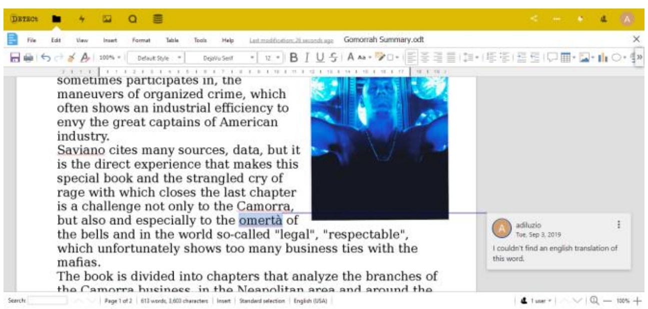

Figure 5. Collaborative editing interface.

3.3 E-Learning Platform

This section exposes the rationale for choosing Moodle as technology to build ALDO e-Learning platform, and how the tool has been implemented to respond to the needs of teachers involved in the project activities. As already mentioned, Moodle is an LMS designed to create virtual environments that allow knowledge sharing on the Web, in the logic of collaborative learning[3]. It is used internationally for educational and training projects that involve the active involvement of students and enable collaborative learning, teamwork and knowledge exchange.

In order to facilitate the creation of content by teachers (who are already used to working with the Moodle platforms made available by their schools/universities), we have decided to deliver a standard implementation of the Moodle platform, focusing more on offering an easy-to-use Web interface and, above all, a tight integration with the collaborative editing platform, in order to make easy and comfortable the sharing of teaching materials (created in ALDO collaborative editing platform) to students. In fact, in our e-Learning platform, teachers have the possibility to load resources into courses picking them directly from our repository (upon credentials verification).

In details, a teacher can implement the materials in three different ways: activities, resources and blocks. An activity is a tool through which students learn by interacting with each other or with the teacher, thus presupposing the active participation of the student. Some examples of activities, among the others, are glossary (that allows participants to create and manage lists of items, such as a dictionary or a collection of resources and information) and crosswords (a gamification tool that allows students to memorize the terms of the glossary by means of crosswords based on its definitions). A resource, instead, is an element that a teacher can add to the course to support learning, unlike activities they do not presuppose active participation between teacher and student: the student simply looks, reads and studies what is present in the resources. An example of resource are files inserted by the teachers within a course. Finally, a block is an element that the teacher usually adds to the sides of the course page and provides additional information or useful tools to facilitate learning. Some of the most common blocks are calendar (that shows course events, like deadlines for activities included in the course) and a text box that displays the description of the course. Figure 6 shows an example of a course page.

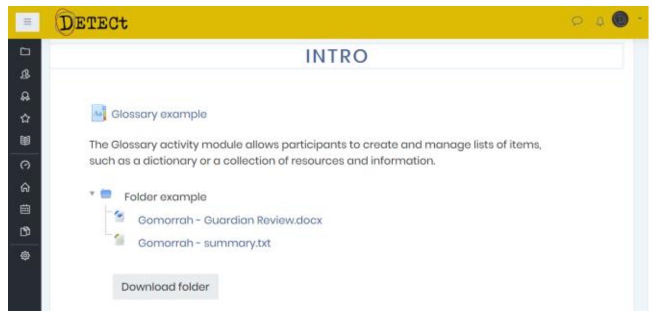

Figure 6. Example of a course.

3.4 Advanced Metadata Visualization

This section details ALDO Web portal visualizer. The basic reason to support the automatic generation of advanced data visualizations is to provide users with data inspecting tools, like interactive maps, graphs, and timelines, able to explore the spatial and temporal dimensions of specific data contexts. This is possible through specific metadata aggregations able to define views of interest for the users. Such views allow the emergence of peculiar data characteristics and the possibility to navigate them at different levels of granularity. The interactive resources will allow students to generate their own corpora to be examined from quantitative and qualitative perspectives. They will be invited, for example, to examine research questions based on these datasets: the questions might be prepared by the teacher, but they might also be developed by the students through the observation of the visualizations. Students will be asked to answer these questions by conducting independent research, using resources included in the portal but also, and primarily, by researching other sources.

We have equipped our metadata with geographic references so that to be able to derive two different types of visualization interfaces: maps (through Leaflet) and graphs (exploiting Highcharts).

Leaflet is an open source library for interactive geographic maps[4], that allows showing points of interest, lines, areas, and/or interactive zoom levels on the map. In our implementation we

[3] https://moodle.org/

[4] https://leafletjs.com/

focused on the most typical use of the technology: inserting a map into a Web page, mapping geo-referenced data (metadata plus related multimedia resources, all persistently residing in the active repository), and adding other elements such as markers and popups. Using Leaflet, metadata and multimedia resources associated to each data entry can be arranged on the map and displayed through markers.

Since Leaflet allows the display of more resources/metadata for the same location, it is also possible to have a preview of different data types like videos, audios, and images into the tooltip as shown in Figure 7. Since all the platforms that are part of our digital framework are deeply integrated, it is also possible to maintain the reserved access to the files displayed in the map by inserting, instead of the preview, a link that goes directly to the relative folder in the repository. This way, only users with credentials and display rights for such files can access them. As for the generation of graphs, we have chosen to use the Highcharts library for this specific task because it is the leading open source software for the generation of graphs/timelines[5].

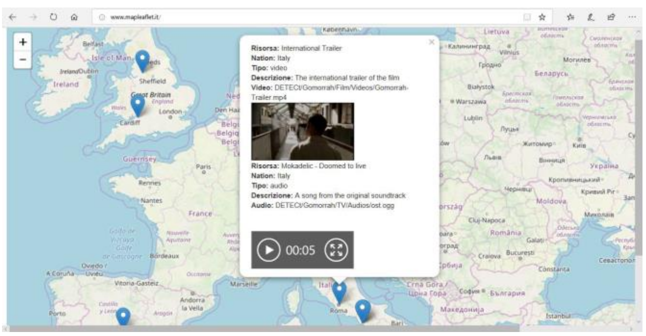

Figure 7. Previews of multimedia materials inside a tooltip.

4. CONCLUSIONS

In this paper, we proposed a novel, advanced digital framework called ALDO (Active e-Learning by DOing) supporting integrated facilities for effective, active e-Learning. ALDO consists of a multi-functional digital back-end for the integration of collaborative editing and e-Learning activities in educational contexts. The platform provides effective services for collecting, sharing, retrieving, and analyzing data, together with advanced online collaboration tools, an e-Learning platform and advanced data visualization tools, all made available to teachers/students through a dedicated Web-based front-end. The design and implementation of ALDO was carried out within the DETECt project. Since its launch, ALDO allowed teachers to collaborate on the selection, collection, creation, and analysis of their study materials and to offer their students samples of such materials, together with a variety of learning objects and activities, displaying the final result of this whole process through specific educational and interactive resources (e.g., e-Learning courses and resources as well as maps/graphs-based visualizations). The software architecture we have presented is fully operational; however, we expect to further improve both the digital multi-functional infrastructure and the dedicated Web portal by identifying their critical issues. This will be possible through the collection of the feedback provided by the users of the DETECt consortium, on the base of the daily use of the ALDO platform.

[5] https://www.highcharts.com/

5. ACKNOWLEDGMENT

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