ITEC

D8.4 – ITEC FINAL TECHNICAL REPORT.

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**Executive Summary**

This deliverable brings together the results of technical work packages 7-9, in the context of the pilot evaluation (WP5), and is focused on the lessons learned from the technical development and deployment.

The iTEC project researched integration of learning tools and content to support teacher access and sharing across technically different education environments, using the iTEC Shell to deliver new and existing resources and services, using open specifications. Apache Wookie was chosen as a starting point for the development of a 'connector', to enable an application to select and display W3C widgets in an iTEC Shell.

The challenges in this development started with a requirement for teachers to describe and discover resources, and the needs of teachers who wanted to create their own resources. This resulted in the creation of the iTEC Widget Store, by Bolton University, which was incorporated into a (Moodle) Shell in a number of ways, for testing. Additional Shells, connecting with the Widget Store, were developed by iTEC partners FUNDP and Knowledge Markets, to widen the research (Open Sankoré, an open source IWB presentation tool and DotLrn, an open source LMS, respectively).

Initially, the open standards, and technologies chosen in iTEC supported easy modification of Shells and integration of resources, with the Widget Store being the central place to access widgets, and being exposed as a widget itself, allowing seamless integration into all Shells developed. DotLrn was also developed to integrate packages of widgets to make it possible for a user to select and instantiate a whole Learning Activity. The DotLrn Shell was also developed to make use of the Learning Tools Interoperability (LTI) specification, providing users with a wider choice of available learning resources, including seamless connection to externally hosted applications and content including commercially provided content.

The two leading ICT providers SMART Technologies and Promethean also carried out developments to integrate the widget store within their popular IWB platforms (SMART Notebook, and ActivInspire respectively), and also contributed to the creation of a number of educational widgets. Both companies also used their experience within iTEC to inform the development of new tools to support advanced pedagogical approaches such as collaborative learning, and embracing trends such as “bring your own device”. These new tools, released in 2014, are the SMART amp, a cloud based tool designed specifically for educators, and ClassFlow, developed by Promethean to enable real time interaction and collaboration within a web environment linking teacher and student devices.

To widen the types of resources available, the iTEC People & Events (P&E) Directory acts as a social networking website for education which promotes collaboration and community-mindedness and aims to provide teachers with a rich source of people and events that can offer valuable support in the design and implementation of Learning Activities.
The various technical components of the iTEC architecture are integrated through a single User Management and Access Control service (UMAC). Research with users resulted in a system where users could re-use an existing account they may already have, with their school or any third party provider (like Facebook, Google or Yahoo). The oAuth2 and OpenID open protocols were adopted to achieve this. Although the proposed approach did not design any new protocol, its innovation lies in the way it brings together various protocols and uses them to bridge the technology gap between different components.

The technical challenges and barriers encountered in the development work included:

**Widget Store** – The fundamental goal has been met through the Delivery of services and resources to multiple software and hardware platforms in different countries. This involved:

- A connector framework around Apache Wookie, and the iTEC Widget Store resulting in an open framework for Shells.
- Changes made to Apache Wookie, through the adoption of an App Store paradigm.
- Integration with the UMAC authentication system requiring features such as the addition of roles to the Apache Wookie OpenID implementation.
- Cross browser support for JavaScript and CSS, as both the feature set and browsers evolve.
- Widget Store development as a W3C widget.
- Making the Widgets from any Wookie server discoverable, making paradata available to users to guide their selections and adding a number of UI, tagging and categorization advances.
- Creation and storage of user generated widgets.

The easy creation of widgets resulted in issues relating to quality control and widget management. An administrative section of the Widget Store, and an associated workflow was created to tackle this, along with other UI features to allow better user management of their own widgets.

**DotLrn Shell** - one of the main technical challenges resided in the integration of composite widgets that represent Learning Activity descriptions created via the Composer as follows:

- Rendering a learning activity description as HTML so the information is represented as a web document in any standard web browser, or processed otherwise by third-party applications.
- Packaging a Learning Activity description as a W3C Widget so that it can be instantiated in an LMS and viewed offline on a phone, or published in a Widget Store.
“Transforming” an instantiated Learning Activity Widget into a mashup (based on Open Mashup Description Language) using a client side cross-context communication channel to transmit a description of the additional resources required, enabling the Shell to instantiate all the Widgets required for the Learning Activity.

UMAC - Development required agreement on the overall iTEC Cloud architecture and to make the different protocols work together - to glue all components into a consistent and scalable approach, without reducing the quality of user experience. This was more difficult, done in parallel with the development of the other ITEC components.

The P&E Directory – the search options adopted led to a faceted search which uses filters that are usually not available on other established social networks. Other technical challenges included: federated access to learning resources; designing an effective search engine; automatic harvesting of events; data collection and database storage; log and system files; security and privacy concerns; backward compatibility with client software; related social network features and educational sites; integration with iTEC activities and other learning tools; and compliance with standards.

Challenges in deployment and adoption included:

General usability issues were encountered during deployment, as shown by the evaluation work of MMU. The greatest challenges facing teachers were “insufficient access to ICT”, “unreliable access to the internet” and “outdated school ICT policies”, preventing access via student-owned technologies. Additional challenges included: “inadequate teacher ICT skills” and “insufficient local support”. These barriers applied to all technologies, but iTEC tools were inevitably less technically mature when compared to existing commercial products. Also the introduction of this technology led to teachers (and national co-ordinators) feeling “overloaded” with the challenge of having to learn about a number of new technologies concurrently. The constraints on internet access had a particular impact on the Widget Store, because, for example, the use of interactive widgets, such as TeamUp, generates high network traffic.

Other deployment challenges specific to iTEC technologies included:

Widget Store - convincing teachers of the added-value of the Widget Store due to their “preferences for existing (commercial) tools”; “proliferation of widgets and apps” leading some teachers to feel ‘overwhelmed’; and creating widgets demanded a “higher level of technical expertise”.

The National Coordinator was of great significance, as the person who could present the Store in terms that made sense to teachers. In some countries, notably Portugal, the Widget Store matched the objectives of the National Coordinators, who were able to align local needs with the potential of the Store.

The Composer - User feedback from pilots identified obstacles and adoption barriers, during the development of the tool, which led to a number of features and changes to
increase usability including: simplifying the user interface; adding a private area within the collaborative, wiki-style tool, allowing users to create their own Learning Activities based on a public template; optimizing the tool to support mobile devices; and enhancing the metadata model of the Learning Activity descriptions to allow for an improved search mechanism.

The concept of the Composer was viewed positively. However, users with less positive views of the Composer commented that it was repetitive, “time-consuming and confusing”, noting also that it was useful for less experienced teachers.

**P&E Directory** – Users were positive about the potential benefits of the People and Events Directory should it be developed into a mature product and sufficiently populated with both people and events. However, some teachers felt that the directory “duplicated existing tools”. The limitation on numbers of People and Events was the main barrier, with “improving the interface” and adding a “wider range of resources” also being suggested.

*Achievements and lessons learned include:*

As regards the Widgets Store, the iTEC project proposal made reference to two factors which together made a strong case for the development of the Widget Store, concerning the future requirements of VLEs in education and the potential role of the W3C widget standard. These hypotheses have been tested, with the conclusion that the changing technical context has moved to a position where the increasingly dominant, closed mobile and tablet platforms make it now either difficult or (more often) impossible in many countries for open standards to provide a solution in this domain.

However, In the case of the DotLrn Shell, the use of the more commercially oriented open standard LTI, and the development of the market place solution, Eduthek, has shown greater potential for longer term success, as demonstrated by significant adoption in its pilot year. Overall 3,225 users have accessed Eduthek in the last school year in Austria (451 teachers, 2,774 students). The LTI interface “survived” a first stress test by delivering 23,336 learning resources. 20,595 of which were consumed by students. Beyond these figures, the nomination of Eduthek as an IMS Learning Impact Award finalist was another highlight related to this interoperability work in iTEC. In the light of the successful use of LTI, the Widget Store has been adapted

in the final year of the project to enable it to handle and deliver LTI resources. This enables the Store to be used without the Apache Wookie, and, in effect, also enables the Store to function as an IMS App Store. This capability opens up new potential areas for application.

The idea of the Composer was well received in general, but in practice has not achieved a critical mass in terms of user adoption on its own. Knowledge Markets plan to transfer the ideas of the Composer to the more successful Eduthek, where a new learning
resource type called “teaching idea” has been implemented, as a Learning Activity
description, designed to inspire other teachers to use technologies in the classroom.

It is important to note that the consolidation of powerful “free” Web applications, such as
Facebook and Google Apps, has changed the landscape of eLearning. These
applications are familiar to most teachers and learners and the resources poured into
the creation of these services, and their resulting power and sophistication make it hard
for smaller developments to compete. In this context, innovative services such as the
P&E Directory could still have a series of potential benefits for teachers and students,
particularly in supporting greater collaboration through a dedicated portal for teachers
and educators. Although the P&E Directory has not been widely used to date and
feedback is preliminary, responses suggest that interest in using the Directory to find
‘events’ (in the traditional sense) is limited. However, teachers do see a value in using it
to identify other teachers they can work with and to find resources that can be
incorporated into their teaching and which can support their professional development.

The iTEC Widget Store has achieved impact through its influence on the systems
developed by iTEC partner Promethean. The ClassFlow web application developed by
Promethean for teachers to use in planning their classes was informed by the
company’s participation in iTEC pilots with the Widget Store. ClassFlow makes use of
the widget paradigm which was developed in the Widget Store, and can integrate
widgets from the Widget Store.

For Promethean, the ITEC project delivered the right idea at the right time. There were
no major technology barriers as Promethean and iTEC were both looking at the same
emerging standards and opportunities – HTML5, tablets, cloud services and productivity
tools, and use of social media in professional development and education communities.
The ITEC project provided early validation that the technical directions on pedagogical
innovations were correct for Promethean. A number of ITEC scenarios pointed to new
forms of collaboration around devices that Promethean were able to develop and test in
a research context and bring to market before the end of the project.

The market response to ClassFlow has mirrored ITEC teacher feedback. The initial
feature set has addressed an immediate opportunity to ensure teachers can better
coordinate the use of student devices and harness the power of the cloud to make
teaching and learning more productive.

Promethean believes it has created a type of unified Search and Composer tool that the
ITEC project envisaged. It supports “mashing up” of a huge variety of web based
content, including images, video, files, web pages and widgets, into coherent, easily
shared lessons.
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1. Summary of Technical Innovation in iTEC

The technical work within iTEC has provided valuable insight into the barriers and enablers that influence the adoption and exploitation of innovative technologies in the complex educational environment. The experiences and evidence from testing, evaluation, deployment and training can all combine to provide an informative picture of what can be achieved and pitfalls to avoid. This output is intended to provide useful lessons learned through this uniquely large and technically complex integration and validation exercise.

This deliverable replaces two originally proposed deliverables:

D8.4) Standardisation and Impact: The standardisation report will document iTEC’s contribution to existing standards including IMS LTI and W3C widgets, drawing on core demonstrators of those contributions from the project. It will document the formal process of engaging with IMS, W3C and Apache in defining standards modifications. Demonstrators will include iTEC LTI functionality of Wookie, and extensions to the W3C widget specification.

And...

D9.4) Report on lessons learned from directory maintenance: The final deliverable for this WP is a report that presents the lessons learned from the maintenance of the iTEC directory. Particular attention will be paid to suggested actions for continued sustainability of the iTEC directory on a technical level after completion of the project.

The rationale for this combined deliverable is to provide a single, more valuable document, that brings together the work of work packages 8 (Widget Store) and 9 (People and Events Directory), and includes additional input from work packages 7 (Shells) and 5 (evaluation of pilots). Please note that in the original description of work there was no plan to produce a WP7 deliverable in the final year. However, it was felt that a contribution from this work package, following pilots, would be of added value, particularly in supporting the Exploitation planning.

The report on work package 10, concerning the delivery of the Scenario Development Environment technology, has been kept in a separate document as originally proposed (D10.4). Consideration was given to including WP10 within D8.4. However, it was agreed that the scope of the D10.4, with a focus on the technical developments to produce resource recommendations, would be better presented in a separate and more comprehensive document. The focus of D8.4 is very much on the lessons learned from the testing and piloting of the widget store and shells, together with the People and Events Directory, with the technical developments reported in previous years.
Please also note that a version of the originally proposed D9.4 is included as an appendix to this document.

1.1. Shell developments and content integration

One of the technical goals of the iTEC project was to enable teachers to integrate the learning tools and content they need in order to set up a tailored learning environment, while supporting sharing across different education institutions and administrations that have widely differing requirements and technological infrastructure. An iTEC Shell is an application that has the capability to select and deliver iTEC resources and services, and to combine them with already existing, "native" applications.

It was a requirement that iTEC should be based on the use of open specifications, and at an early stage in the project the W3C Widget specification was selected as the enabling technology which would support the integration of resources and services into iTEC shells. One advantage of this approach was that there was an existing and well-established open source project which provided some of the necessary functionality: Apache Wookie. As described in the deliverables of WP8, iTEC has extended the functionality of Apache Wookie in order to meet the requirements of the project. The creation of an iTEC Shell involved, therefore, developing a 'connector', i.e. code which enabled an application to select and display W3C widgets.

Work on Wookie resolved the technical delivery of resources and services to different systems and users. However, two other challenges remained. Firstly, it was necessary to enable teachers to describe and discover the resources that they wanted to include in their tailored environments. Secondly, support was needed for teachers and pedagogic coordinators who wanted to create their own resources. Both these needs were addressed by the development and deployment of the iTEC Widget Store. The Widget Store adopts the paradigm of an App Store, which is familiar to all users of mobile platforms such as iOS and Android. Since the development of the Widget Store, the user interface of Apache Wookie has been eliminated, and the Widget Store (or an equivalent application) is the only way that users select and deploy widgets.

The iTEC Widget Store has been implemented with an application programming interface (API) which enables applications to create their own interfaces with which to carry out operations on the Store, and to interrogate the store about its contents. The iTEC Widget Store has also been implemented as a widget, which offers another approach to integration. The Widget Store Widget can itself be integrated into a range of Web based platforms. This creates opportunities for a number of approaches to integration, best illustrated by describing work carried out with the iTEC shells.

The iTEC Widget Store can also be deployed as a stand-alone application. In this mode the user can create, describe and discover widgets, and can copy embed codes which they can embed in other Web applications (for example WordPress). This requires a minimal understanding of HTML, which is not needed for other integration approaches.
In order to test and demonstrate the capabilities of the Widget Store in creating shells, partner Bolton incorporated the Store into Moodle in three different ways, with differing degrees of integration, and which demonstrate differing approaches to integration with a shell.

1. Widget store as a widget. In this approach the iTEC Widget Store is embedded into a Moodle page. Using this approach, widgets held on the Store can be created, reviewed, tagged, described and discovered, but there is no support for installing them. This level of integration is very easy to achieve in any Web based platform.

2. Widget store Moodle block. Within Moodle a block is an component of a page which allows users to select a Moodle resource (for example a forum, or a piece of content). Integration involved development of a new block, which does not give access to a piece of internal Moodle functionality, but rather communicates with the API of the iTEC Widget Store. The indexed search facilities in the store are used to populate the interface, enabling a widget to be installed directly into a block in any page format. Because of the properties of blocks in Moodle, the user is constrained to including a single widget in each block.

3. Widget store Moodle page format. In this approach the iTEC Widget Store is integrated into a custom Moodle page format, building on work carried out within the Omelette project. When the user adds a new widget into the page the store is displayed in a overlay (popup window) with all it’s features and an additional install option next to each widget. This approach has the additional advantages of enabling multiple widgets to be embedded in the same page, and to export and import collections of widgets using Open Mashup Description Language (OMDL).

The changes implemented in the iTEC Widget Store in the final year of the project are detailed in the Release notes to the iTEC Widget Store 1.5, included as an appendix to this deliverable.

1.2. Open Sankoré

Open Sankoré is a free open source digital teaching software which is compatible with most of interactive whiteboard hardware. Although the software did not support W3C widgets by default, the University of Namur has extended it to enable such support and allow it to integrate iTEC components. The integration approach has been discussed with the Open Sankoré team. It has been challenging because of the different technologies used to build Open Sankoré. The overall result is a connected Interactive Whiteboard application that embeds the iTEC Widget Store, and allows the users to select individual widgets or a complete Learning Story. Behind the scenes, the integration links to the other iTEC developments through the common User Management and Access Control component (see section 1.7 below). This work has been experimental and some integration issues still remain. The goal was to demonstrate the technical feasibility and the interest of using standards to quickly integrate different technologies.
Thanks to an architecture based on open-standards and technologies, integration of iTEC components has been greatly facilitated. Through the approach of making content and tools available as widgets, it has been relatively easy to modify shells, as containers, to host any of the other iTEC components. The Widget Store being the central place to access widgets, and being exposed as a widget itself, it has been integrated in the Open Sankoré software, giving access to the full collection of iTEC resources.

![Fig. 1: The iTEC Widget Store in the Open Sankoré IWB software](image)

1.3. DotLrn

DotLrn is an open source enterprise-class learning management system (LMS). DotLrn is the technological foundation of Austria’s leading LMS solution, lms.at. Lms.at serves about 1,200 schools in Austria. The first wave of adoption of lms.at was facilitated by the support of tailor-made use cases of technology-enhanced learning. Beyond the provision of content, lms.at supported an increased transparency of the grading process as well as the exchange of good practices of organising school life via calendar and file sharing. Within iTEC, the providers of DotLrn, Knowledge Markets, sought to innovate on existing LMS functionality by enhanced availability of standardized content and tools as described
in the following sections. As well as integrating the Widget Store, DotLrn was also developed to make use of the existing Learning Tools Interoperability specification (LTI).

Initially DotLrn did not support the W3C widget standard, but thanks to iTEC the widget technology became integrated also into this LMS. The iTEC year 3 version of the DotLrn widget integration supported not only the instantiation of single widget. Whole packages of widgets representing a learning activity can now be selected and instantiated within a DotLrn course, thereby reducing the effort for setting up DotLrn for a widget-supported learning experience. The following figure shows a DotLrn course that is based on the learning activity “Air Pollution”.

![Fig.2: A DotLrn Course based on the Learning Activity “Air Pollution”](image)

Overall, DotLrn benefits from the integration of third party components based on two standards: W3C widgets and IMS LTI standard. As a result, DotLRN users benefit from a wider choice of available learning resources, but also from a new user experience when it comes to managing DotLrn Portlets. The basic use case behind LTI is to allow the seamless connection of web-based, externally hosted applications and content – summarized under the concept (remote) “Tool” – to platforms that present these Tools to users. For example, it allows the secure integration of external assessment applications
or hosted premium content with learning management systems without having to develop and maintain custom integrations for each application or content provider.

Based on this "Tool" concept, LTI distinguishes between the "Tool Consumer", in many cases the Learning Management System "consuming" the Tool, and the "Tool Provider", as it "provides" the Tool for use in the Tool Consumer (IMS 2012). At the Tool Consumer, a Tool is launched within a certain "Context" relevant to the Tool Provider. Examples for a relevant Context are a course, or a school organisation representing groups of users sometimes with different privileges (e.g. instructors, students).

When it comes to the integration of external tools, the iTEC project supported the following requirements, with access management implications:

- **R1. Acquire access to a plethora of high-quality learning resources**: To maximize the benefits for learners and teachers, an LMS provider needs to offer a broad variety of learning resources from all kinds of relevant publishers and other institutional content providers.

- **R2. Maximize coverage for school book publishers**: On the other hand, in order to reach out to its customers, it is in the highest interest of a publishing house to make its learning resources available within as many (technology-enhanced) learning environments as possible.

- **R3. Keep publishers in control of the provided content**: One important requirement that has been identified is to ensure that a publisher of premium content stays in full control of learning resources provided at any time within its lifecycle (i.e. creation, sharing, delivery, termination).

- **R4. Allow publishers to manage access to resources**: Another requirement stemming from our publisher’s business model is the need for staying in control of content access policies. Given the fact, that a subset of the learning resources offered might be considered premium content – and therefore the publisher has no interest in making it freely available – a third party must not be in charge of managing access control.

- **R5. Support sharing of different learning resource types**: In the school sector, relevant content varies significantly and, as a consequence, the integration approach needs to be able to support the hosting of all different kinds of materials. While some educators prefer content that is optimized for a paper-based learning environment (e.g. PDF documents) others feel the need to share standard formats (e.g. PowerPoint) for electronic delivery. Others might even require the exchange of e-learning content in SCORM or other formats.

- **R6. Allow easy integration in learning management systems**: From the perspective of the provider of a learning management system, the integration of learning resources should be as seamless and easy as possible. Providers would like to avoid developing and maintaining custom integrations for each content-providing institution.
Based on the above-mentioned requirements, our integration approach has been carried out and tested in the context of the following case studies:

Austria’s leading publishing house in terms of market share, Veritas, agreed to provide all its school-book accompanying online materials to the marketplace using LTI. Veritas is now able to seamlessly integrate an archive of LTI links to its online material within Austria’s leading LMS. This archive is un-packaged, the metadata extracted together with the LTI links. The set of LTI links is then made available to the end user. From the Tool Consumer’s point-of-view, i.e. the LMS, the LTI integration allows an automated login and authorization at the Veritas web site where the premium content is hosted.

1.4. SMART Technologies: Widgets and SMART amp

From the beginning of the project SMART Technologies developed three iTEC widgets based in the pedagogical part of each cycle scenarios to support the development and adoption of Learning Activities.

- Random Words for lateral thinking
- Six thinking hats for changing perspectives and reflection
- Idea cards to trigger observation methods (to support design and inquiry methods)

The three widgets were developed in two formats, W3C for being implemented in the Widget Store and also in any other IWB, VLE, PLE; and also in SMART Notebook format for being displayed in SMART Notebook learning platform. The widgets were translated into English, German, Spanish, Polish, Hungarian, and were used by teachers in cycles 3-5 of pilots.

Those widgets are available for teachers in both the Widget Store and in SMART Exchange http://exchange.smarttech.com/
This special SMART Notebook Widget was developed specifically to run iTEC widgets (W3C) within SMART Notebook software.

Using this specific widget, teachers and students are able to embed any iTEC widget from the Widget Store in their lessons using SMART Notebook software. SMART Notebook software is a learning platform that has been used as a shell for developing the iTEC LA and LS.

The ability to include iTEC Widgets into SMART Notebook collaborative learning software has allowed teachers to develop their iTEC Learning Activities using one learning platform.

The iTEC Widget Store concept, along with the design of Learning Scenarios and Learning Activities, has supported the development of the SMART amp collaborative learning software. SMART amp is a cloud based tool designed specifically for educators. Its power is unlocking the potential of student’s devices in the classroom. Most of the iTEC concepts like collaboration, reflection, peer evaluation, design,.. are behind SMART amp concept. SMART amp enhances collaboration, content creation, communication, sharing and assessment from anywhere, on whatever device is being used. Lessons can begin with a huge, blank workspace, ready for student contributions, or can be prepared with specific learning paths in place so SMART amp has become the perfect tool for developing iTEC learning scenarios in different levels and subjects where collaboration is the key anywhere, at any time and in any device.

SMART amp supports not only trends in education that have been developed during the project like BYOD, but also is breaking the classroom barriers, allowing teachers and students to work together, collaborate and share inside and outside the classroom. As it lives in the cloud, it connects any web-enabled device and gives students freedom to learn.
1.5. Promethean: ClassFlow

Involvement in the iTEC project has significantly influenced the development of ClassFlow. [www.classflow.com](http://www.classflow.com) by the ICT Supplier Promethean.

This novel software was developed and tested by teachers during the project and taken to large scale public BETA in January 2014 at the BETT show in the UK.

Key technological and pedagogical themes explored and researched in ITEC are now embedded into its design, including collaboration and student centred creativity, web widgets, cloud services and use of emerging social media connections as a method of sharing lesson ideas and projects.

ClassFlow is innovative in the level of ‘frictionless’ real time interaction and collaboration it achieves both within the web environment and between student devices. HTML5 and associated widgets have been a focus of ITEC and are maximised in ClassFlow to enable a diversity of student devices to connect to each other and to the lesson. Camera and drawing functions enable students to co-create content in real time and a simple URL & 5 letter code enables a very simple way of enabling an interactive classroom.

The product was released as version 1.0 in summer 2014 and has since won a number of education software awards including ISTE “Best in Show” at the largest Education Technology Show in the USA.

Widgets, as proposed by ITEC, are supported in ClassFlow and prototype lesson ideas were demonstrated early in the project using Promethean’s Inspire software. A demonstration lesson early in the project used widgets to show how real time maps of traffic and pollution data could be combined or ‘mashed up’ into a single lesson. These ideas are now embedded into ClassFlow.

A number of widgets available in the ITEC widget store work directly with ClassFlow and widgets from popular tools like Google Maps, GeoGebra, etc. also work.
In addition to viewing widgets embedded into ClassFlow cards, ClassFlow uniquely allows a teacher or student to annotate over the widget. Teachers or students can also “share cards” and if the widgets are interactive, each student can work with them independently. The rich sharing is a feature of ClassFlow.

Fig. 6: Students using embedded map widgets shared by their teacher in ClassFlow in an ITEC pilot school

1.6. Resources beyond content

The iTEC People & Events (P&E) Directory - a social networking website for Education - promotes collaboration and community-mindedness and aims to provide teachers with a rich source of people and events that can offer valuable support in the design and implementation of learning activities. iTEC teachers from all cycles, as well as ‘experts’ linked to the project, were encouraged to register with the P&E Directory in spring/early summer 2014.

The aim of the ‘People’ section of the iTEC P&E Directory is to make it possible to find an individual with a specific profile who may not easily be found via other existing social media platforms and online communities. The feature that distinguishes the P&E Directory from other directories (like Facebook, Twitter or LinkedIn) is the possibility it offers of finding someone (for example, an expert in Biology) who speaks a specific language and who can be reached by a chosen tool or platform (such as Skype).

The ‘Events’ section of the Directory harvests event listings likely to be relevant to teachers from various organisations suggested by partners. In addition, iTEC partners, and teachers were also invited to create webinars lasting around 5-10 minutes which would provide information to help other teachers innovate in their teaching practice.
P&E Directory is one of the components of the iTEC Cloud, which is an integrated network of technical components developed to provide complete support to the pedagogical scenarios and life-cycle process of the iTEC project. The pilot experience with the P&E Directory has already enabled a community of practice where users can connect, share and interact with one another.

The P&E Directory has a federated architecture. As such, the directory obtains its data from different sources. The P&E Directory reads RSS channels from existing educational repositories such as those from Ministries of Education, European portals and educational institutions. In addition, the P&E Directory harvests from other repositories such as the iTEC Scenario and Development Environment (SDE) repository¹, which scrapes existing web sites, transforms it into web 2.0 data structures and exposes it in either RDF triples or JSON data structures. As an example, events are scraped from CEN/ISSS, the open education portal. Finally, registered users can also submit new entries to the directory.

¹ [http://www.itec-sde.net](http://www.itec-sde.net)
1.7. User Management and Access Control

iTEC integrates a wide variety of components: shells, web applications, self-contained widgets, widget-based applications... This integration raises some questions in terms of user management and access control:

- user authentication may take place at the shell level, but also, some integrated services may require some form of authentication or at least be aware of the visiting user’s identity. This implies the need for an authentication mechanism that can span the range of components and provide consistent information about the user.

- access control policies may be defined centrally, at the iTEC Cloud level, but these policies have to co-exist and be consistent with those defined at the shell level, or at the integrated services level, if any. Again, this requires an authorisation mechanism that integrates at the various levels of the architecture.

In addition to those considerations, a survey run among teachers in Europe showed that a significant number of them were not willing to create yet-another-user-account to access a service but would rather re-use an existing account they may already have, with their school or any third party provider (like Facebook, Google or Yahoo). A review of existing approaches and standards hinted at the use of oAuth2 and OpenID open protocols. Not only are those widely adopted but also are they designed with web interactions at their core, which particularly fit the overall iTEC Cloud architecture.

To integrate those protocols into the iTEC environment, we designed the UMAC (User Management and Access Control) framework, which is comprised of the following components:
• the UMAC server is responsible for user authentication, issuance of authorization tokens, and management of user data and privileges; it plays the role of the OpenID’s Identity Provider, the oAuth’s authorisation server, and implements a back-end service to access, store and manage user data and privilege information. It links with external services like Facebook or Google for user authentication, where applicable.

• the UMAC filter is an authorisation guard that sits in front of back-end services; the back-end service represents the oAuth’s Resource Server, and the UMAC filter is in charge of validating access tokens.

• the UMAC widgets are a collection of widgets that make it possible to access and manage authentication and authorisation information in the iTEC Cloud. These widgets make it possible to register a new user, to update a user’s details, to create sets of users, and to assign iTEC roles.

• the UMAC library is a JavaScript library of tools to help the widget developer to easily integrate with the UMAC framework without knowledge of the various protocol implementations.

Based on this framework, other iTEC components could be easily integrated; user authentication was delegated to the UMAC server through the OpenID protocol while web services were protected using the UMAC filter, in an almost completely transparent way for the service developer.

Although the proposed approach did not design any new protocol, it is believed that it’s innovation lies in the way it brings together various protocols and uses them to bridge the technology gap between different components.

  • The Widget Store is designed to inherit the authentication of users from the container platform. Consequently it works smoothly as an embedded application without the need for further authentication. However, a stand-alone version of the Widget Store has also been implemented which has its own authentication mechanism.

  • In the case of DotLrn, the project also successfully experimented with the IMS Learning Tools Interoperability (LTI) specification (IMS 2012). The basic use case behind LTI is to allow the seamless connection of web-based, externally hosted applications and content – summarized under the concept (remote) "Tool" – to platforms that present these Tools to users. For example, it allows the secure integration of external assessment applications or hosted premium content with learning management systems without having to develop and maintain custom integrations for each application or content provider.

Based on this “Tool” concept, LTI distinguishes between the "Tool Consumer", in many cases the Learning Management System "consuming" the Tool, and the
“Tool Provider”, as it "provides" the Tool for use in the Tool Consumer (IMS 2012). At the Tool Consumer, a Tool is launched within a certain "Context" relevant to the Tool Provider. Examples for a relevant Context are a course, or a school organisation representing groups of users sometimes with different privileges (e.g. instructors, students).

- Promethean’s ClassFlow has an extensive API and is also deeply integrated with a number of other services via APIs to provide a seamless, single experience. As a result, Web search and cloud folders are fully integrated into ClassFlow which means teachers do not need to juggle applications or windows to create or manage a lesson. All content is held in the cloud and a user can access it from any devices using a login. ClassFlow currently supports login/authentication with Office 365 for Education, Google Apps for Education and Facebook as well as its own accounts. Sign on with popular cloud productivity solutions provides a route to millions of other education users and helps further in taking iTEC ideas “to scale”

![Sign In Options for ClassFlow](image)

**Fig. 9: Sign on options for ClassFlow**
2. Challenges and Barriers to Innovation

2.1. Technical challenges and barriers

2.1.1. Content Integration: Widget Store

The design and development of the iTEC Widget Store has been a major undertaking, and a substantial achievement for the project. In creating the Store a number of technical challenges have been met.

*Delivery of services and resources to multiple software and hardware platforms in different countries.*

In meeting the fundamental goal of delivering services to multiple platforms in different countries, the project built a connector framework around Apache Wookie, and the iTEC Widget Store. The results constituted an open framework for shells, which was demonstrated by the development team in Moodle. An architecture was designed which enabled the newly established Widget Store to interoperate with Apache Wookie. In carrying out this work changes were made to Apache Wookie, as shown by the following two examples. Firstly, the adoption of an App Store paradigm created duplication and confusion with the Wookie user interface. The project argued for and implemented the deprecation of the user interface to Wookie, with this functionality now being handled exclusively by clients (such as the iTEC Widget Store). Secondly the UMAC authentication system required features such as the addition of roles, which were added to the Apache Wookie OpenID implementation.

An ongoing challenge for the Widget Store (like any Web based application) has been the maintenance of cross browser support for JavaScript and CSS, as both the feature set and browsers evolve.

The initial version of the Store was an html/javascript site which called the REST API. To make integration of the Store more agile, it was re-developed as a W3C widget which included all the functionality and more, that was in the original site. This could then be embedded in the shell in the same way that any other widget could.

From the point of view of the Store, the full Wookie API has been implemented so that widgets from any Wookie server can be made discoverable and managed. The store collects and makes available paradata about the use of widgets, which can be displayed to users to guide their selections.

Users requested support in discovering widgets, and this has been designed and implemented with features such as:

- Facetted search based upon Tags and Categories
• Implementation of icons for widgets, also available in the widget creation tools.

• Implementation of users’ favourites, which are the default view on login, and are also available to other users to be copied into their own collections.

• Classification of widgets, using classifications provided in the iTEC taxonomy, assignment of degrees of affordances, and including, optional, categories, such as 21st century skills list and age range.

• Testing and revision of the interface, leading to the introduction of tabs.

In order to maximise the opportunities for exploitation, tight coupling between the components of iTEC was avoided. On the other hand, information about the widgets available on the Store needed to be made available. To achieve this, an API is provided by the Widget Store. This can be queried to provide information on the metadata which describes widgets, and paradata regarding their use.

The creation of widgets was always a challenge to be handled by the project, and this increased as it became clear that large numbers of useful W3C widgets would not become available from mobile Web platforms. Functionality was conceived which enabled teachers to:

• make simple widgets by 'wrapping' web resources and services.

• create a widget from an existing Flash or Java Applet.

• upload a hierarchy of web pages and turn them into a widget.

This functionality required the implementation of fields asking the user for the extra metadata required for making a widget package. Sending this form triggers a widget package creation section in the store which, uses templates to create the widget configuration file and packages the result as a widget package, which is then posted to Wookie, indexed, and made searchable.

The easy creation of widgets meant that large numbers of widgets were created. This created a number of problems for administrators: How could the creation of inappropriate content be avoided? How can tests be distinguished from widgets intended for publication? Who should be able to delete widgets that are no longer valuable? How could users’ attention be directed to potentially useful widgets? To address these needs, the development team created an administrative section of the Widget Store, and an associated workflow. This enables the administrator to prevent publication of widgets until they have been approved as appropriate. It also enables widgets to be deleted, and set as ‘featured’ on the store.

Large numbers of widgets also created challenges for users, who were unsure if their new widgets were publicly available, and found it difficult to manage all their widgets. In
response to this, a new “My Widgets” area was created, which made it possible for users to edit the widgets which they had created. It also enabled users to set Publish levels for their widgets. Only the creator can see new widgets and edit them, and set them as published when happy with them. This generates a request to the administrator to review the widget and accept or reject it.

2.1.2. Content Integration: DotLrn Shell

As far as the widget integration in DotLrn is concerned one of the main technical challenges resided in the integration of composite widgets that represent learning activity descriptions created via the Composer, since these descriptions were also designed to include the actual resources required for carrying out the learning activity.

After investigating different options for implementation the project opted for a layered approach that follows the “web best practices” of progressive enhancement and the rule of least power. Consequently, when entering a higher level, interoperability decreases, while functionality increases. At the lowest layer we render a learning activity description as HTML. Hence, the fundamental (narrative) information of such a guide is represented as a web document and thus can be viewed in any standard web browser, or processed otherwise by third-party applications.

Packaging a learning activity description as a W3C Widget represents the second layer, which allows teachers to (more easily) use the learning activity description in various manners, e.g. instantiate it in their LMS and view it offline on a phone, or publish it in a Widget Store. At these two levels the Learning Activity description already provides added value to the teacher, both when preparing the Learning Activity and when it takes place.

However, many useful learning activity descriptions will go beyond mere textual descriptions and will require actually useful resources (e.g. Applications, Content). Hence, the technology shall support the teacher in augmenting DotLrn with these resources. We therefore progress further in the functional enhancement by “transforming” the instantiated Widget representing the learning activity description into a mashup. Technically, to this end our approach utilizes a client side cross-context communication channel to transmit a description of the additional Learning Resources required. As we consider all resources to be delivered via Widgets, we represent the resources required by the learning activity description in the form of a mashup description based on the Open Mashup Description Language (OMDL). Finally, DotLrn instantiates all the Widgets required for conducting the learning activity that is described by the Widget representing the learning activity description.

2.1.3. User Management and Access Control

The main difficulty in designing and developing UMAC was to first get to a common agreement on what the overall iTEC Cloud architecture would be. Without such specifications, it was not possible to build a model of interactions and then design a proper solution. On the other hand, some protocols already existed that fulfilled some of
the requirements. The challenge has been to make the different protocols work together to glue all components into a consistent approach, without reducing the quality of user experience, for instance in terms of performance. Particular care has been given to developing an efficient and scalable approach. Another difficulty has been that the work on UMAC was done in parallel with the development of the other ITEC components, while there existed some evident dependencies between them, sometimes requiring the retrofitting of an updated approach into just released products.

2.1.4. The P&E Directory

The pilot phase of the project, including development and refinement of existing features, has confirmed the scalability of the P&E Directory. The pilot phase also indicates that the initial development could be easily upgraded into a production system thanks mainly to the use of proven scalable technologies. The search options adopted and investigated in the framework of the People and Events directory has led to a faceted search which uses filters that are usually not available on other established social networks. These search filters allow users to find people in a European multilingual network based on a specific country, by the language(s) they master, subjects of expertise, and a series of contact channels to reach them. Similarly, events from across Europe can be found using the following filters: country, language, subject, category, and place. The events may also come from different sources and be of different types.

Fig. 10: Search engine and faceted search of the P&E directory
In order to have sufficient People and Events available, the harvesting of events from trusted and suitable sources is essential. As such, the establishment of a network of contributing partners is key.

The technical challenges and maintenance requirements of the People & Events directory have been classified in the following items: federated access to learning resources, search engine, automatic harvesting of events, data collection and database storage, log and system files, security and privacy concerns, backward compatibility with client software, related social network features and educational sites, integration with iTEC activities and other learning tools, and compliance with standards and valuable information for standard bodies. Each one of these items has been studied and further explained (appendix 3).

In addition, the experience with a variety of RSS sources for events, has shown how different patterns and XML labeling schemes which are used for the feeds, making them very heterogeneous and, thus, difficult to harvest and match with existing vocabularies or ontology-based dictionaries. This indicates that semantic interoperability of harvested resources can be very much improved by an application profile for the RSS feeds as well as Atom feeds. In order to achieve such semantic interoperability it is necessary that the same network of partners would agree on the application profiles and their implementation.

2.2. Challenges in deployment and adoption

2.2.1. General User Issues

The iTEC evaluation reports produced by MMU identify that the greatest challenge facing teachers in using iTEC (and other) technologies in schools was “insufficient access to ICT”. This was one of the top three barriers identified by teachers (C2: 28%, teacher survey, n=261; C3-5: 43 of 68 case studies; C4: 6 of 10 teacher focus groups). In addition, teachers also identified “unreliable access to the internet” as another of the top three barriers (C2-3 teacher survey: 19%, n=595; C5: 4 of 8 case studies). In some cases, BYOD was considered a solution to the problem of a lack of resources. However, “outdated school ICT policies” were identified as a barrier (C3: 7 of 47 case studies), preventing access via student-owned technologies.

Turning to skills-related issues, “inadequate teacher ICT skills” were mentioned in 13 (of 47) case studies in Cycle 3 and noted to be one of the most important barriers by teachers in the UK in Cycle 2. Despite the support available to teachers through iTEC, “insufficient local support” within the school was identified as a problem for some teachers. In cycle 3, basic technical problems which could have been resolved with adequate technical support were noted in 31 of the 47 case studies. Lack of technical support was also a problem in cycle 4 when teachers were dealing with immature technologies or faced compatibility issues (2 of 10 teacher focus groups, 4 of 13 case studies).
Considering the iTEC tools specifically, one of the main barriers faced by end users was that, as prototypes, iTEC tools were inevitably less technically mature when compared to existing commercial products, making it difficult for teachers to use them in a normal classroom setting. A challenge affecting a number of iTEC technologies was the perception of a “degree of overlap” between the various tools which made it difficult for teachers to decide when they should use each tool. This problem was exacerbated by the fact that more mature tools were only made available to teachers at wide scale during the final two cycles. This led to teachers (and national co-ordinators) feeling “overloaded” with the challenge of having to learn about a number of new technologies concurrently, whilst also finding ways to incorporate these into their teaching. In the case of those tools providing content (Widget Store, SDE, Composer), “the amount, and in some cases the quality, of material available” in these prototypes was another problem noted.

The iTEC evaluation report concludes that the main challenges facing teachers in using iTEC were related to the infrastructure available to them. Some simply had insufficient access to ICT. When they had access, however, this was sometimes subject to constraints, because connections to the internet were unreliable, or restricted by outdated school ICT policies. The constraints on internet access had a particular impact on the Widget Store, for two reasons. Firstly, as regards unreliable connections, the use of interactive widgets, such as TeamUp, generates more network traffic than static resources. The experience of the development team was that, when demonstrating the system in real world environments, the performance wireless access points would sometimes be severely impacted by all members of a class accessing interactive resources at the same time, sometimes leading to dropped connections. Secondly, as regards policies, the use of embedded widgets was sometimes prohibited by administrators for security reasons. In some cases the Widget Store could be added to a whitelist to enable access, but in practice this often proved difficult to achieve. In other cases the ports used by the Widget Store were blocked.

2.2.2. Content Integration: Widget Store

In some cases, during the Widget Store pilots, it was difficult to convince some teachers of the added-value of the Widget Store due to their “preferences for existing (commercial) tools” which were commonly used in schools, and the “proliferation of widgets and apps” becoming available, leading some teachers to feel ‘overwhelmed’. Creating widgets also demanded a “higher level of technical expertise” than most teachers currently possess and, given that many iTEC teachers rated themselves as having high levels of ICT competence, its likely that this issue may have provided more of a barrier to a wider group of teachers. A number of challenges were raised by teachers’ survey responses. Teachers found it difficult to use, particularly the “search facility” to identify suitable widgets, thus requiring additional support (C4-C5: 35%, n=161). The “range and quality” of widgets was perceived to be limited (C4-C5: 20%, n=161, C4: 3 case studies; C5: 7 of 9 teacher focus groups). General technical issues were also noted (C4-C5: 16%, n=161).

The iTEC Widget Store has a wide range of potential applications, and as such it is not immediately obvious to a teacher why they should adopt the system. Consequently the
role of the National Coordinator was of great significance, as the person who could present the Store in terms that made sense to teachers. In some countries the National Coordinator felt that the Widget Store did not respond to the needs of the teachers under their remit, or national coordinators did not have time or appropriate opportunity to understand the potential contribution of the Widget Store. In these cases use of the Widget Store was very low. On the other hand, in some countries, notably Portugal, the Widget Store matched the objectives of the National Coordinators, who were able to align local needs with the potential of the Store.

The Portuguese experience showed how content and services made available on the Store need to be profiled by a coordinator, or a community which can take this role. This needs to be carefully aligned with local conditions, and is not something which can be achieved from the centre. In the absence of this, potential adopters may find the range of options available on the Store to be confusing.

In the period since the start of the iTEC project there have been many changes in technology which have impacted on the Widget Store. We discuss these, and the implications for use and adoption of the store in sections 3.1 and 3.2 below.

2.2.3. P&E Directory

Respondents were very positive about the potential benefits of the People and Events Directory should it be developed into a mature product, sufficiently populated with both people and events. However, some teachers felt that the directory “duplicated existing tools” which provide information about people and events (2 of 9 teacher focus groups). Suggested improvements included increasing the “number of events and people” listed (24 teachers, 3 other stakeholders, 3 of 9 teacher focus groups, 1 implementation case study), “improving the interface” (7 teachers, 6 stakeholders, 2 of 9 teacher focus groups), including a “wider range of resources” or linking to other services/platforms (7 teachers, 3 stakeholders), more active promotion of collaboration (6 teachers) and improvements to the search facility (5 teachers).

The experience of pilots demonstrated that the main factor that should be in place for a successful deployment of the P&E Directory on a larger scale is to find and attract good sources for persons and event descriptions. During the pilot phase of this project, the Ministries of Education, stakeholders and teachers involved in the project were asked in a number of trials to sign up in the directory and contribute by pointing out continuous professional development opportunities and other sources of educational events relevant in their respective contexts, as well as directly sharing their own experiences. As a result of this effort, almost 300 registered users from at least 21 countries used the iTEC P&E Directory to perform more than 9,400 searches on People and Events, and over 37,000 total actions.

2.2.4. The Composer
The implementation of the Composer was accompanied by 19 small-scale user evaluation activities which were carried out in order to identify challenges and barriers especially with respect to user adoption. These evaluation activities mainly consisted of open expert interviews from which a better understanding of the user requirements were derived. The evaluation events mostly involved pedagogical experts. Based on the evaluations action logs resulting in concrete implementation changes to the Composer were developed. As result of the identified obstacles and adoption barriers, the user interface of the Composer was significantly simplified. We also introduced a private area within the collaborative, wiki-style tool, where users were able to create their own learning activities based on public templates. Last but not least we optimized the support of mobile devices like tablets.

Later in the project the Composer formed part of the Edukata process in two of the case study countries (ES, SK). When using the Composer as part of the Edukata process, teachers looked at existing learning activities for inspiration and used the Composer to ‘present’ the learning activities/story they had devised during the workshop. In the context of this evaluation activity the main improvement requests were related to enhancing the metadata model of the Learning Activity descriptions. Extending the metadata model, for example by elements such as typical age range or level of difficulty, would subsequently allow for an improved search mechanism.

Similar instability problems were experienced with the Composer, but there was little time to rectify problems experienced by users after Cycle 4 in preparation for the Learning Activity design workshops in Cycle 5. The concept of the Composer, particularly a library of Learning Stories, was viewed positively. However, reported responses from participants were mixed. Those with less positive views of the Composer commented that it was repetitive, “time-consuming and confusing” for teachers. Teachers expressing their views in focus groups had similar mixed views, noting it was useful for less experienced teachers. The extent to which it supported the Learning Activity design process, rather than simply the presentation of the final product, was another issue. However, teachers raised concerns about “usability” including layout and login, complexity and translations. Suggestions for improvement included ‘drag and drop’ features, improving search and browse functionality and offering it in all “languages.”

2.2.5. Other Technical Prototypes

In Cycle 2, the “instability” of the early prototype of TeamUp (http://teamup.aalto.fi/) was identified as a problem in half of all participating countries. By Cycle 5, when most of these initial problems had been dealt with, teachers were largely positive about TeamUp. Suggestions for improvement included: integration with other classroom management tools, increasing opportunities to personalise student profiles, enabling use without a webcam and integrating it with mobile devices (particularly iPads).

ReFlex (http://reflex.aalto.fi/) was introduced in cycle 4. Its uptake in piloting was limited. A relatively small number of teachers in cycles 4-5 (n=55) tried ReFlex and were positive about its use and potential. However, in wider discussions (teacher focus groups) it was
noted that little use had been made of this tool possibly because it was felt to offer “highly similar functionality” to TeamUp, which teachers were, by this point, more familiar with.

No specific feedback was provided by users relating to the UMAC subsystem, which is not surprising since users are exposed to UMAC in a very limited way, the core processes taking place behind the scenes, in a way that does not impact the users. From a user’s perspective, functionalities provided by UMAC are very simple and have been implemented in a way that is user-friendly (this was ensured by having the development driven by the result of a survey) and similar to what users already experience on the Web.
3. Achievements and lessons learned

3.1. Lessons learned

3.1.1. Content Integration: Widget Store

The technical development of the iTEC widget store has been successful, but the strategic assumptions which informed it have not been fulfilled. The Widget Store was conceived as an intervention in an environment dominated by VLEs, which would make a shared and open infrastructure for schools more flexible, integrated and agile. More specifically, the iTEC project proposal made reference to two factors which together made a strong case for the development of the Widget Store.

a) that there was a need for an open and standards-based infrastructure which would enable resources and services to be distributed across national and institutional boundaries.

b) that W3C widgets could not only meet this need from a technical perspective, but would also be widely adopted on desktop and mobile platforms, which would provide a wide range of resources and services which the project could consume.

The technical work carried out by iTEC has, among other achievements, tested these hypotheses. We can conclude that while they were credible when the project was planned, the evidence generated by iTEC indicates that they cannot be sustained at the close of the project. The technical environment of eLearning has changed, and the Virtual Learning Environment (VLE) is no longer seen as a leading context for innovative technical development or teaching practice. Indeed, in many cases the need for a VLE has been questioned. This was not unforeseen by iTEC, and the development of the Widget Store was in part intended to unite mobile and VLE platforms. However, VLEs are mostly open systems, which can be adapted to work with the Widget Store and can be administrated and configured locally, or at regional level. In contrast the increasingly dominant mobile and tablet platforms are closed, and incorporation of the Widget Store in these platforms is either difficult or (more often) impossible, while administration and configuration of the system is largely restricted to commercial providers.

The closed nature of these new platforms is due to the strategy of each provider to capture and maintain a sector of the market. These providers have no reason to welcome an interoperability specification, which undermines the competitive advantage which they hope to gain from their own catalogue of apps. Consequently, the specifications for Web Apps adopted by each provider vary slightly to ensure that interoperability cannot become a reality, even though at the technical level the tasks that they perform are quite similar.

In earlier phases of eLearning researchers who developed new applications found enthusiasm for their offerings, in part because they offered expertise and free products which were not available to schools from other sources. However, the consolidation of
powerful Web applications, such as Facebook and Google Apps has changed the landscape of eLearning. These applications are familiar to most teachers and learners.

The huge financial resources poured into the creation of these services, and the resulting power and sophistication of their products, make it hard for smaller developments to compete. The fact that these powerful applications are also free and universally available means that in many cases educational users are prepared to sacrifice data privacy and other concerns in order to make use of the functionality they offer, and it is hard to change their mind by appealing to openness or interoperability.

3.1.2. Content Integration: DotLrn.

In the case of the LTI-based market place solution, Eduthek, (developed by Knowledge Markets) there was significant interest from an Austrian school book publisher who started to adopt LTI in the meantime. As far as the DotLrn adoption in Austria was concerned it became apparent that the future of VLEs and LMSs resides in an integrated approach, where LMSs become part of an interoperable learning information system landscape. In such a scenario, the link between the LMS and external content and tools (based on LTI) is of a similar level of importance as is providing interfaces to student administration systems and other back office solutions of the school sector.

The idea of the Composer was well received in general, but in practice has not received a critical mass in terms of user adoption on its own. Knowledge Markets plan to transfer the ideas of the Composer to Eduthek, where a new learning resource type called “teaching idea” has been implemented. Teaching ideas are Learning Activity descriptions designed to inspire other teachers to use technologies in the classroom. An Austrian ministry-led project called “App-o-thek” was launched as a sub-project of the Eduthek development, where this new learning resource type is already used in order to provide teachers with hands-on guidelines when it comes to using Apps in the context of their classroom teaching.

3.1.3. P&E Directory

An initial analysis carried out with stakeholders revealed that the P&E directory could have a series of potential benefits for teachers and students attending a teacher training institution and for people in the education area in general. In the final year, a quantitative and qualitative evaluation was designed in order to better understand and describe the deployment and adoption of the P&E Directory in real educational settings. This evaluation has been approached from different perspectives, including usability evaluation, as well as using usage and social metrics.

The pilot study was conducted from the 28th of January to the 28th of May 2014. During this period, almost 200 registered users from at least 20 countries used the iTEC P&E Directory to perform more than 7100 searches on People and Events, and over 32 thousand total actions.
Fig. 11: Usage analytics of the iTEC People and Events Directory during the pilot study

After analysis of this activity, additional development work was necessary to improve the way events were introduced and presented to users in the system. Later, the pilot phase of the project, including development and refinement of existing features, confirmed the scalability of the system.

In the last stage of the pilot, the user interface of the P&E directory included an evaluation tab with links to an online survey available in nine languages. The final usability report, prepared by Manchester Metropolitan University, remarks on the enthusiasm among iTEC teachers for greater collaboration locally, nationally and internationally to enable them to improve their knowledge of new pedagogies and technologies and to help create a community of innovative teachers who can support each other. Although the P&E Directory was felt to duplicate existing social media networks to some extent, there was notable enthusiasm for a dedicated portal for teachers and educators.

3.1.4. User Management and Access Control

UMAC had a very specific status, acting as a glue layer between all components within the iTEC technical architecture, handling authentication and authorization. The main lessons learned in developing this subsystem concern, on one hand the complexity to elaborate detailed specifications while a global overall architecture is being developed in collaboration between a number of parties, and on the other hand, the necessity of adapting and further refining standards to adapt to specific situations.
The first challenge is hard to overcome, in particular in a large scale project as iTEC; the global architecture is constantly evolving, in particular in the first years of the project, where an agile approach is used to iteratively develop and refine services based on user feedback.

The second challenge is inherent to the nature of standards that provide a general framework but still need further work to be fully operational; however, this profiling is time-consuming. Moreover, some technical limitations (like same-origin policy of browsers) sometimes go against a proper implementation of standards, and require solutions that are not as user-friendly as one would expect for systems that are meant for broad adoption.

3.1.5. ClassFlow

For Promethean, the ITEC project delivered the right idea at the right time. There were no major technology barriers as Promethean and iTEC were both looking at the same emerging standards and opportunities – HTML5, tablets, cloud services and productivity tools & use of social media in professional development and education communities.

Promethean already has a highly engaged user base of nearly 2,000,000 teachers sharing lessons who already sign into Promethean’s online service. Moving this group from locally installed software to the cloud is not seen as a major challenge. The rapid adoption (1,000 new users a day at the moment) and education community awards suggest the teacher community feels the same need and opportunity.

The ITEC project provided early validation that the technical directions on pedagogical innovations were correct for Promethean. A number of ITEC scenarios pointed to new forms of collaboration around devices that we were able to develop and test in a research context and bring to market before the end of the project.

While the project introduced many technological ideas it was refreshing that the focus on formative assessment and feedback enhanced with richer forms of capture using drawing and camera tools, motivated teachers to explore the software.

3.2. Achievements and future developments

3.2.1. Content Integration: Widget Store

A substantial achievement of the iTEC project has been to conceive, implement and pilot a unique Web service: the iTEC Widget Store. The quality of this work has been demonstrated within the project through the pilots. In particular the popular TeamUp tool has been distributed and run through the Widget Store, showing that the technical analysis which led to the Store's development was not misplaced, and that the technical work carried out was effective. The Store has been well received by participants in pilots. The most recent evaluation carried out found, among other results, that 31 out of 34 teachers responding said they would use the Widget Store again and the same number...
said they would recommend it to other teachers. Twenty-nine agreed that, providing it contains more useful widgets and is easily accessible, the Widget Store has the potential to lead to technical innovation.

The tools for creation of widgets have proved to be easy to use, and indeed the proliferation of widgets became a design problem to be addressed in the interface and search capabilities of the Store. The Widget Store has been used to create a number of demonstrators which illustrate the different ways in which this infrastructure can be of value in particular the use of LTI, OMDL and inter-widget communication (Bolton’s demonstrator) and the integration of the store in existing environments such as Moodle (Portugal and China). The code required to run the Store has all been published as open source. The store is comprised of a number of technologies which form a technology stack. The various aspects of this stack can be obtained from the IEC Widget Store web site http://109.74.200.115/. This site has links to the binaries required to run the stack as well as the source repositories. It also has a link to the IEC’s hosted store demonstrator.

The iTEC Widget Store has achieved impact through its influence on the systems developed by iTEC partner Promethean. The ClassFlow web application developed by Promethean for teachers to use in planning their classes was informed by the company’s participation in iTEC pilots with the Widget Store. ClassFlow makes use of the widget paradigm which was developed in the Widget Store, and can integrate widgets from the Widget Store.

The flexibility of the Widget Store has been shown by configuring it to be deployed as a compliant IMS App Store. It is the first open source application which can make a claim to being an implementation of the IMS App Store specification.

### 3.2.2 Content Integration: DotLrn

For Knowledge Markets, the main achievement of their iTEC involvement relates to the LTI-based marketplace solution Eduthek. As indicated by the data provided in Appendix 2, Eduthek has achieved significant adoption in its pilot year. Overall 3,225 users have accessed Eduthek in last school year in Austria (451 teachers, 2,774 students). The LTI interface “survived” a first stress test by delivering 23,336 times learning resources. 20,595 times these learning resources were consumed by students. Beyond these figures, the nomination to the IMS Learning Impact Award finalists was another highlight related to the interoperability work in iTEC.

Nevertheless there are still open issues that need to be tackled in order to develop Eduthek from a research prototype to a professional product. In order to tackle Eduthek’s main technical challenge, i.e. weak search mechanisms, a new Knowledge Markets internal project called “Content-Finds-Teacher” has been established. “Content-Finds-Teacher” aims at improving the search mechanisms of Eduthek through various new features ranging from push mechanisms based on teachers’ user profiles to an improved organisation of learning content based on enhanced metadata as well as paradata.
The large-scale European pilots in iTEC have increased the current scope of openness and emphasizes the importance of providing open access to resources beyond content. One of the available outputs of this project is the iTEC People & Events (P&E) Directory, which brings together information about the various components (e.g. actors (persons), tools, services, and contents) that are required to compose and carry out different teaching and learning activities. The P&E directory has an added value in the structuring of information and knowledge at the European level as it supports the extraction of information from existing repositories and uses semantic-enhanced information to combine data from multiple heterogeneous sources and enhance search results through filtering.

The successful integration of open resources into learning activities depends largely on establishing an educational network. The P&E Directory has already enabled a community of practice where users perform over a hundred daily searches to find persons and browse events that can contribute to their learning activities. The initial evaluation confirms the improvements over existing networks, demonstrates the interest of teachers, and provides an overview of the benefits of integrating the P&E Directory into everyday educational practice.

Feedback on the P&E Directory demonstrates the enthusiasm among iTEC teachers for greater collaboration locally, nationally and internationally to enable them to improve their knowledge of new pedagogies and technologies and to help create a community of innovative teachers who can support each other. Although the P&E Directory was felt to duplicate existing social media networks to some extent, there was notable enthusiasm for a dedicated portal for teachers and educators. There may be potential for other educational 'experts' to play a role in such a community, but the limited number of experts currently available in the P&E Directory meant it was not possible to explore this possibility. Teachers were also keen to find new resources to use in their teaching and felt that such a community offered them a possible means to do that.

Although the P&E Directory has not been widely used to date and feedback is preliminary, responses suggest that interest in using the Directory to find ‘events’ (in the traditional sense) is limited. However, teachers do see a value in using it to identify other teachers they can work with and to find resources that can be incorporated into their teaching and which can support their professional development. Of course, this is dependent on sufficient collaborators and resources being available through the Directory.

The issues addressed during the project provide the foundation to identify areas for future work. The use of a federated architecture along with proven scalable technologies facilitates future expansion of the P&E Directory and integration with other educational systems and repositories. However, the experience of using a variety of sources for events shows the difficulty of harvesting and matching existing information with ontology-based dictionaries, and highlights the importance of using metadata and application profiles to improve semantic interoperability. User Management and Access Control
The development of the UMAC subsystem did not result in any new type of protocol or approach. However, it was still innovative in the way it put to work different existing protocols to bring common authentication and authorization services to independent applications that follow their own model and use their own technologies. The key achievement is in bridging technologies that have been designed and developed separately, to provide security services to a highly distributed and heterogeneous environment.

3.2.4. ClassFlow

The market response to ClassFlow has mirrored ITEC teacher feedback. The initial feature set has addressed an immediate opportunity to ensure teachers can better coordinate the use of student devices and harness the power of the cloud to make teaching and learning more productive.

Emerging open standards, such as HTML5, have matured and been utilised over the timescale of the ITEC project and provided a foundation for a common experience with an increasingly diverse range of devices. Widespread support of the same standards in the wider market, suggest good long term potential and longevity for any content developed using the new ClassFlow tools.

Promethean believes it has created a type of unified Search and Composer tool that the ITEC project envisaged. It supports “mashing up” of a huge variety of web based content, including images, video, files, web pages and widgets, into coherent, easily shared lessons. Search and resource library functions are fully integrated reducing the authoring complexity for teachers.

Far more than composing simple content presentations and aggregations, ClassFlow goes further and provides a collaborative framework for a classroom to connect a multiplicity of screens and allow content to be shared among users in a seamless way. This has been extremely well received by the ITEC research teacher community. Student creativity and input is valued and, within ClassFlow, content can be created or annotated by students and shared with the teacher other students to provide real time feedback to help guide lessons and to engage students more deeply with the content and ideas.

In keeping with the ITEC aims to look at how teacher communities help ideas “go to scale” – ClassFlow features extensive social media platform integration. There is a shared library of lessons that teachers can use or contribute to using a simple “share” function and this is extended with Twitter and Facebook integration to allow lesson links to be shared with the wider education community and PLNs (Personal Learning Networks). High quality lessons feature a range of formative and summative assessments and opportunities to harness student feedback. ClassFlow also incorporates a polling and assessment platform.
Appendix 1 - iTEC Technologies

Shells and Composer (Work Package 7)

Knowledge Markets – one of iTEC’s technical partners – has worked on three technical artefacts in the context of its involvement in WP7 and WP8:

- Eduthek: An LTI-based market place solution for learning management systems
- DotLrn: iTEC’s shell based on learning management systems
- Composer: iTEC’s authoring environment for learning designs

The technologies produced by University of Namur in iTEC are the following:

- UMAC server for a central management of the authentication and authorization processes for all iTEC components
- UMAC filter to protect individual web services in a transparent way
- UMAC widget library to help develop secured widgets that work with the UMAC subsystem
- an experimental porting of the Open Sankoré shell to work with the widget store and hence with all other iTEC technologies

They are critical for a secure deployment of an education cloud.

The iTEC Widget Store (Work Package 8)

The iTEC Widget Store supports the W3C Widget specification and OpenSocial Gadgets, and has been extended in 2014 to support IMS Learning Tools Interoperability (LTI). It provides functionality for hosting, creating, describing, discovering and deploying widgets. To provide this extensive functionality, the Store has built on a number of established open source software systems, and has initiated new code projects where necessary. The software components which have been included in the Widget Store, and extended and adapted by iTEC are:

- Edukapp 10: provides the Store service itself is based upon Edukapp 10. This software has been extended to include a dedicated pure REST API and also to include some model requirements particularly to describe functionalities.
- Apache Wookie 7: houses, parses, manages and delivers W3C widgets.
Solr 8 – used for search indexing and query language.

Shindig 9 – houses, parses and manages OpenSocial gadgets.

The user interface for the store is implemented as a client in a separate software package. The architecture of the Store was designed by iTEC in order to make this separation of concerns possible. The architecture is centred on the REST API (Documented on the IEC WidgetStore Web Site) implemented by the project in Edukapp, which manages communication between the store and the clients. Implementation of the architecture also led to extensive enhancements to the code of Apache Wookie and Edukapp.

In this case a pure html/javascript client has been written and packaged as a W3C Widget.

This approach provides great flexibility in the way that the store can be embedded in client platforms. This has been demonstrated through the development of a Moodle block that communicates with the store through the API, through a Web site based Widget Store, and a full implementation of the Store as an embeddable widget.

The People and Events Directory (Work Package 9)

iTEC explores to what extent creating an educational community of practice and enabling interactions other than the traditional classroom interactions can positively affect educational attainment and enhance engagement. More in particular, the iTEC Directory makes information about People and Events available that can contribute to such interactions. As a result of this project the following technologies have been developed and incorporated into iTEC:

- A search engine for People and Events, implementing the combination of a full text search with a faceted search.
- An RSS harvester for the ingestion of events from external sources.
- A harvester for ingesting collections of iTEC formatted events from other iTEC components, such as the SDE repository.
- A harvesting target such that other authorized systems can harvest information from the P&E Directory.
- A vocabulary handler that ingest and handles multi-lingual vocabularies from the Vocabulary Bank for Education (VBE)2.
- Facilities to manually submit new and enrich harvested entries about Persons and Events.

2 http://aspect.vocman.com/vbe/home
• A usage data logger implementing an application profile of the Experience API (xAPI)\(^3\)

• Analytics tools to provide a suitable visual representations of quantitative information about the usage and social interaction with the People and Events Directory.

Additional Technical developments

The provision of The Scenario Development Environment, by Vigo University, within work package 10, is covered more extensively in deliverable 10.4. In addition to this, a number of other technical prototypes have been developed specifically for use in the project including a collection of educational widgets provided by SMART Technologies and Promethean, and European Schoolnet, and the TeamUp and Reflex tools produced by Aalto University.

\(^3\) [http://www.adlnet.gov/tla/experience-api/](http://www.adlnet.gov/tla/experience-api/)
Appendix 2 - iTEC Widget Store 1.5 Release Notes

August 2014

1. Introductory comments
This is the final release of the iTEC Widget Store at version 1.5. Subsequent releases will be transferred to the Widget Store, its successor.

These release notes are an amalgamation of the release notes for 2014 to date and subsume the notes for the January release. The release notes are based upon a series of screen shots with descriptions. These notes assume that the user is aware of previous versions of the store documented in the release notes for version 1.

The screenshots in this document have been made using local (development) instance of the store so the widgets and data are different from the iTEC instance. The screenshots included here are all taken from the point of view of a signed-in user, as without sign-in the ‘Favourites’, ‘My Widgets’ and Creator tabs would not be visible. Most people who log into the store will not be able to see the admin tab.

2. New features in the 2014 Version

2.1 Front Page

The usability research undertaken at the end of year 3 of the project indicated some difficulties with users finding widgets and seeing relevant information about them. Changes were implemented, increasing the size of icons and adding category and rating information to the placards. The principal changes are as follows:

- The way widgets are displayed on the front of the store has been modified and now includes categories and ratings on the Favourites and Featured widgets sections.
- The layout of the store is also new with the left side navigation removed and tabs added to show the different areas of the store.
- The four buttons above the widget display area change the widgets that are displayed in this front page.
- My Favourites will be empty until you have chosen some favourites (see below).
- Most Recent show the 50 most recently created widgets with small icons.
- All Widgets shows all the widgets in the store as small icons.
2.2 Navigation
The usability research undertaken at the end of year 3 of the project showed the need to change the navigation. The new interface to the store offers tabs which take the user to the different sections of the store. These tabs are always displayed no matter which section you are in and they also indicate which section you are in by the highlight state.

2.3 Categories
Several different users from different user groups requested better searching and categories. The response to these requests was combined in a categories faceted search facility. Implementation of this has involved:

- Addition of twenty-four categories to the store. The creator of the widget can categorize widgets in the my widgets section which is described below.

- The categories section allows widgets to be discovered in a way which is intended to be more meaningful to the user, and perhaps simpler. The categories are divided into three groups.

- Within each group of categories the discovery is accumulative, and between the groups it is subtractive. This faceted approach allows users to tailor the discovery of the widgets to best suit their needs. It acts as way of filtering down to the subjects, skills and age ranges in which you are interested.
2.4 Favourites

Discussions within the team about how the store had been used by the pilot groups led us to add a favourites facility, to support sharing between users. This section is where the user can see the favourites that other people have chosen. It shows a list of users. Clicking a Favourites button will bring up a dialog with a list of that user’s favourites.
Here the user can add a widget to their own favourites if they choose.

The user can add any widget to their favourites by viewing it on the widget view page. Clicking on a widget icon on the Widget Store front or from search results accesses this.
There is a button at the bottom of the widget viewer. Clicking this button will add the widget to your favourites and take you to the list of your favourites on the front page.

The user can also remove widgets from the favourites collection:
2.5 My Widgets

The “My Widgets” section has been completely changed since the last release of the store. The original version had on two tools. This was an attempt to give a more complete set of tools allowing the user to manage their own widgets. It now shows the widgets in a table list with tools to publish, categorize, edit and delete your widgets.
From here the user can view their widget.

The widget can be set as published or unpublished. In the final version of the iTEC Widget Store direct publication is in the hands of the user, following the iTEC philosophy of open, crowd-sourced, community based publishing. However, workflow controls exist within the system to insert an administrative check and stop for widget publication requests.

The user can categorize their widget with multiple categories. Clicking the categories button will bring up a dialog box in which they can add categories to a widget.
If a widget has been created by the user themselves, using the embed or web address tool, they can now edit the widget. A click on the pencil for that widget brings up a form with the data originally entered for that widget which can then be changed and saved.

The only difference is that the name cannot be changed here.
2.6 Creator

In the previous version of the widget store this section was called “Upload”. This name was for historical reasons, as originally uploading new widgets was all you could do. In the present version, however, there are more widget creation tools than upload tools so the name was changed in line with this.

The original release version of the store had an embed tool, the imports and the W3C widget upload tool. Additional tools have been added. The Web Address tool creates a widgets from a web url. This effectively creates a mashup portal to another web site.

The web folder tool expects a zipped up folder that contains a mini web site. Meta information is required as with all of the tools to name the widget and specify a width and a height. The tool converts the site into a W3C widget and deploys it.

There is, however, one major process change. You can now overwrite widgets you have created of the same name. A dialog box warning you that you are about to overwrite the widget comes up.
This works for Embed, Imports and Web Folder. The update management for W3C widgets is based upon the W3C specification for updating widgets based upon their id. A discussion about this is beyond the scope of these release notes.

At the moment it is recommended that, unless users are W3C widget developers, they should use the other tools to create widgets.

3. Server Side and Code Base Configurations

3.1 LTI
The widget store now supports native LTI apps. The administrator must set up the interface to this, as the control information for LTI is secret. LTI apps can be added individually in the LTI configuration files maintained on the server.

The store can be included in an LTI host application, the security information for LTI is contained on the store server in the store configuration files, which must be supplied to the host application for the embed to work.
3.2 Language Support

Multiple languages are supported in the user interface for the store. This is a UI translation and does not have any bearing on the language of the content of the store.

The configuration of different languages is within the code of the widget store user interface so some programmer support is required for this at least at the level of recompiling the user interface widget. The language translations are implemented as javascript language files which are in a specific folder in the store ui hierarchy: <widgetstore_base>/js/lang/language_code.js.

The filename language_code refers to the ISO 639-1 language code specifications so the language file for English, for instance, is called “en.js”.

Widget Store Development Team - The University of Bolton

August 2014
Appendix 3 - Deployment and testing

The testing and evaluation of iTECs technical outputs took place throughout the project to inform the design process and test the hypotheses developed regarding the potential value of the services delivered. Technical work package leaders oversaw the testing process to support design decision making with coordination of cross project workshop opportunities organised by the project coordinator. As regards the validation of the educational value and related barriers, work package 5, led by Manchester Metropolitan University, coordinated data gathering from the classroom pilots. Data relating specifically to the user experience of iTEC technologies were collected (September 2011 to June 2014) as follows:

A teacher survey was administered to all participating teachers in all five cycles. In total, 1,399 responses were received. In the first three cycles the main body of questions concerned the impact of the implementation on teachers’ classroom practices. In the final two cycles, as more iTEC technologies were introduced, the focus of questions changed to the potential of iTEC technologies (TeamUp, ReFlex, Widget Store), as well as pedagogical and technological differences and the impact on student learning outcomes. The numbers of teachers who reported using each technology in C4-5 were: TeamUp (394); ReFlex (55); Widget Store (166).

68 implementation case studies were conducted over all five cycles. Qualitative data collection was semi-structured through the use of semi-structured interview schedules (teacher, head teacher, students, ICT co-ordinator). This include questions on teachers’ use of iTEC technologies.

18 teacher focus groups focusing on teachers’ use of iTEC technologies were held in C4-C5. These were conducted by NPCs following guidance provided by WP5.

Three countries carried out a full Edukata Case Study in C5, which included questions on the use of the Composer. Two of these countries had used the Composer to support Learning Activity design. A further country provided feedback on the Composer via the workshop facilitator survey.

A focus group with NTCs was held in January 2014 to gather further feedback on the Composer.

An online survey was used to gather user perceptions of the P&E Directory. This was promoted via iTEC mailing lists and a total of 132 respondents were received, representing 48% of the total number of registered P&E users at the time of the survey.

To capture additional data on the use of the iTEC Widget Store, NTCs in countries where it was implemented in C5 were asked to either take part in a Skype interview or to respond to a set of questions via email. Four countries participated in this activity.
Shells and Composer (Work Package 7)

As far as the shell-integrated Composer is concerned overall 19 small-scale evaluation activities have been carried out. Early evaluation activities mainly consisted of open expert interviews from which a better understanding of the problem definition was derived. At a later stage these activities were used to iteratively revise the requirements. The evaluation events mostly involved pedagogical experts. Early evaluations were documented in the form of action logs resulting in concrete changes to requirements. In the case of the Composer the main findings relate to: (a) a simple user interface, (b) private areas within the collaborative, wiki-style tool, and (c) better integration with mobile devices like tablets.

Widget Store (Work Package 8)

Since its launch, iTEC Widget Store has been deployed as a service hosted by European Schoolnet. It forms part of the iTEC cloud, which manages authentication. For exploitation purposes a version of the Store has been created which manages its own user authentication processes, so that it can be deployed as a standalone system. Three types of activities have been carried out with users.

a) Formative evaluations and feedback. The development team have actively sought feedback from users which has informed revision of the user interface, and suggestions for new features and their prioritisation (see in particular D8.3). Some of this work involved the organisations of evaluation sessions with users, either as formal testing sessions, or as workshops followed by evaluation. While this work was important, of greater significance, perhaps, was the ongoing exchange of ideas and requests between the development team and users, which took place as part of the maintenance of the service, both within the formal pilots and beyond. Participants included both teachers and national coordinators, and the latter also provided summative feedback at the end of pilot programmes. These exchanges led directly to the establishment of new development priorities, and the identification of problems with the user interface.

b) Pilots. The Widget Store has been developed as a contribution to the wider efforts of the iTEC project, and consequently the principal means of evaluation of the Store has been through the use of the system in the cycles three, four and five of the pilots. The results are provided in the annual evaluation reports produced by the project. The number of users involved in evaluation by both the development team and in the pilot programme is shown in the following table.

<table>
<thead>
<tr>
<th>Users involved in evaluation of the Widget Store</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Prototype testing, year 2</td>
<td>50 (approx.)</td>
</tr>
<tr>
<td>UI testing, year 3</td>
<td>135</td>
</tr>
<tr>
<td>National coordinators</td>
<td>15</td>
</tr>
<tr>
<td>-----------------------</td>
<td>----</td>
</tr>
<tr>
<td>Pilots, evaluation report 2013</td>
<td>126 respondents</td>
</tr>
<tr>
<td>Pilots, evaluation report 2014</td>
<td>39 respondents</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>365</strong></td>
</tr>
</tbody>
</table>

c) statistical analysis. The results of formative evaluations and pilots have been triangulated against statistical analysis of the use of the server. The development team have ensured that rich data is available.

**People and Events Directory (Work Package 9)**

Teachers and education experts participating in the pilot study were asked to respond to surveys and provide information about their experience with the P&E Directory. This study was conducted in three workshops and during the final stage of the pilot study. The researchers carried out two different surveys, the System Usability Scale (SUS)\(^4\), and a survey specifically designed to address the assessment of the directory.

A visual analytics software tool developed in collaboration with the University of Oviedo was integrated in the last versions of the P&E directory with the goal of allowing obtaining and displaying usage and social information. The analytics engine complemented and contrasted the qualitative evaluation by measuring the use of the P&E directory during the pilot phase. Usage and user data stats can be consulted from the P&E website: http://itec-directory.eun.org/itec-directory/main/en/panelUsage.html

In the last days of the pilot, the P&E Directory complemented these usage and social analytics by also adopting the Google Analytics\(^5\) to track visitors’ traffic on the website. Google Analytics for the P&E Directory was made available as from mid-May 2014.


\(^5\) [http://www.google.com/analytics/](http://www.google.com/analytics/)
Google analytics of the iTEC People and Events Directory during the pilot study.

Visual analytics are very relevant for this evaluation because they indicated, in an objective way, the real figures for the total traffic and activity registered during the pilot phase of this project. These measures enhanced our understanding of the information and results obtained. From a user perspective, data visualisations can motivate and engage teachers and experts to use the system more effectively.
Appendix 3 – D9.4: Report on Lessons Learned from Directory Maintenance

This report deals with the evaluation of the pilot phase and elaborates on the lessons learned from the maintenance of the iTEC People & Events (P&E) Directory. The evaluation has been approached from different perspectives. First, it presents a list of perceived potential benefits revealed from the initial analysis with stakeholders. Then, it reports how the outcomes of the pilot phase were assessed by means of quantitative and qualitative measures, including usability evaluation, as well as usage and social metrics. The report also includes an analysis of the technical feasibility and maintenance requirements. Finally, it summarizes the results and lessons learned from the pilot study and points out areas for further consideration and further development of the P&E Directory.

The report has been produced by a collaboration of: Victor Alvarez, KU Leuven; Frans Van Assche, KU Leuven; Douglas Armendone, CTIE; and Sarah McNicol – MMU.

Part A

Introduction

The iTEC People & Events (P&E) Directory - a social networking website for Education - promotes collaboration and community-mindedness and aims to provide teachers with a rich source of people and events that can offer valuable support in the design and implementation of learning activities. iTEC teachers from all cycles, as well as ‘experts’ linked to the project, were encouraged to register with the P&E Directory in spring/early summer 2014.

The aim of the ‘People’ section of the iTEC P&E Directory is to make it possible to find an individual with a specific profile who may not easily be found via other existing social media platforms and online communities. It is claimed that the feature that distinguishes the P&E Directory from other directories (like Facebook, Twitter or LinkedIn) is the possibility it offers of finding someone (for example, an expert in Biology) who speaks a specific language and who can be reached by a chosen tool or platform (such as Skype).

The ‘Events’ section of the Directory harvests event listings likely to be relevant to teachers from various organisations suggested by partners. In addition, iTEC partners, and teachers were also invited to create webinars lasting around 5-10 minutes which would provide information to help other teachers innovate in their teaching practice.

The People and Events (P&E) Directory is one of the components of the iTEC Cloud, which is an integrated network of technical components developed to provide complete support to the pedagogical scenarios and life-cycle process of the iTEC project. The pilot
experience with the P&E Directory has already enabled a community of practice where users can connect, share and interact with one another.

![Welcome to the iTEC Directory for searching People & Events](http://itec-directory.eun.org/itec-directory/main/en/)

**Figure 1: Presentation of the People and Events Directory at the iTEC Closing Conference (May 2014).**

**PURPOSE AND SCOPE OF THE TASK LEADING TO D9.4**

This task is concerned with the evaluation of the Persons and Events directory, a web application supporting the sharing of information about persons and events following the release, metrics, deployment and use tasks 9.2 and 9.3.

**RELATIONSHIP WITH OTHER TASKS**

WP9 has as main task to provide the iTEC directory for persons and events. As such it relates to a number of other WPs in the project.

- WP3, WP6, WP7, WP8 and WP10 provided further contributions for the modeling of persons and events as well as the functional requirements

- An intense collaboration happened with WP7 about the iTEC UMAC system as there is a strong relationship between users and the persons stored in the iTEC directory. Moreover, the iTEC directory was the first application to use the UMAC system, which was instrumental in getting UMAC operational.
Users of the iTEC directory are:

- WP3 when they run the pre-pilots and elaborate the pre-pilots
- WP4 and WP6 when running the pilots
- WP5 will rely on the directory for getting usage data.
- WP7 and WP8 are interfacing with the iTEC directory for providing the iTEC Composer functionality.
- WP10 is taking the information stored in the iTEC directory as a basis for the SDE data storage. Data in the iTEC Directory will be periodically transferred to the SDE, to be transformed and enriched using a semantic representation. Therefore, a complete binding will be provided between information models used in both systems.

**STRUCTURE OF THE DOCUMENT**

Section 2 presents a list of perceived potential benefits revealed from the initial analysis with stakeholders. Sections 3 and 4 report how the outcomes of the pilot phase were assessed by means of quantitative and qualitative measures, including usability evaluation, as well as usage and social metrics. Section 5 presents an analysis of the technical feasibility and maintenance requirements. Finally, section 6 summarizes the results and lessons learned from the pilot study and points out areas for further consideration and further development of the P&E Directory.

**POTENTIAL BENEFITS OF THE iTEC PEOPLE & EVENTS DIRECTORY**

An initial analysis carried out with stakeholders revealed that the P&E directory could have a series of potential benefits for teachers and students attending a teacher training institution and for people in the education area in general. The potential benefits, split in three groups for better readability and comprehensibility, are the following:

**Find resources to improve your teaching practice**

1. Find support in developing advanced learning design skills, while improving the use of information and communication technologies (ICT) in the classroom.

2. Identify and make use of events during learning activities: a way to make students more interested in the topics they are studying.

3. Identify trainings and continuing professional development (CPD) opportunities in your region.
Promote your initiatives and publish your resources

4. Gain visibility by promoting a favourite technology, service or technical tools you use in the classroom.

5. Promote self-organised events or activities taking place at your school (e.g. competitions, fairs, etc.).

6. Event organizers can promote regional and national events.

7. Post links to videos through which you share your experience and teaching practices.

Become a member and benefit from networking

8. Be part of a dynamic multi-cultural community. Easily identify and contact (or be contacted by) peers and experts outside the school (locally or from other countries), willing to contribute to teaching and learning activities.

9. Persons traditionally not involved in the learning activity can more easily express their willingness to participate in the learning process.

10. Become part of a teachers’ network and be contacted to take part in a wide range of training opportunities from across different European Schoolnet (EUN) projects (including workshops, courses, summer schools, and online or face-to-face events offered at the Future Classroom Lab). Teachers may also receive invitations to participate in new EUN projects.

11. Be invited to become a certified Future Classroom Ambassador in your country.

A quantitative and qualitative evaluation was designed in order to better understand and describe the influence of the P&E directory in real educational settings, as it is described in the next sections.

USABILITY EVALUATION

Teachers and education experts participating in the pilot study were asked to respond to surveys and provide information about their experience with the P&E Directory. This study was conducted in three workshops and during the final stage of the pilot study. The researchers carried out two different surveys, the System Usability Scale (SUS) ⁶, and a survey specifically designed to address the assessment of the directory.

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Preliminary study

The usability of the P&E Directory was first evaluated using the SUS during two workshops. Together, these workshops had a mixed audience of 46 participants. The simplicity and proven effectiveness of the SUS has made it a widely used reference in usability evaluation.

By comparing the data of the two workshops, it is possible to observe how the P&E Directory scored much better with teachers than with non-teachers (i.e. authors, counsellors, experts, learners, managers and others) on the question "I think that I would like to use this system frequently". In order to validate the consistence of the answers, an intended user mismatch was introduced in the questionnaire. It is interesting to see that the answers of people that filled in the questionnaire carefully resulted in a much higher SUS score (72.13) than for people with inconsistent answers (59.47). Taking into account the number of valid answers, the current usability of the P&E Directory could be labelled "OK" to "Excellent" using an adjective rating scale7.

Similarly, it is clear that the intended audience finds the P&E Directory much more usable than the non-intended audience. A closer look also revealed that teachers without previous knowledge of the iTEC project and its set of tools had more trouble to understand the purpose of the P&E Directory, which scores higher with teachers that are familiar with the iTEC approach of scenarios. In addition, the influence of other factors such as: teachers from small countries are more inclined to use resources from abroad than teachers from big countries, can make a European wide choice of resources be appreciated differently. These observations may have an influence on the mainstreaming of the P&E directory.

iTEC workshop

In a second stage of the usability study 18 experts in other areas of the iTEC project were asked to interact and perform tasks with the P&E directory. Following, they were requested to fill out an online survey (see Part B1) specifically designed to address the assessment of the directory as a “proof of concept”, rather than a product, thus focusing on the potential benefits when developed into a full system.

In this study, the respondents highlighted the value of using the P&E directory to identify peers and experts outside the school environment willing to contribute to teaching and learning activities, over finding information about educational events, or promoting teaching and learning events they are involved in. This finding stresses the importance of forming a community of practice around the P&E directory. It suggests as well that a few actions are necessary to improve the way events are introduced and presented to users in the current version of the system.

In terms of perceived advantages in comparison to using other social networking sites, over 47% of the respondents remarked the aim on pedagogical purposes and the simplicity to find very particular information about education and educational networking, while 21% valued the structuring of data, improved search functions and filtering of information.

**Final usability study**

In the last stage of the pilot, the user interface of the P&E directory included an evaluation tab with links to an online survey available in nine languages. The following reproduces the final usability report developed at Manchester Metropolitan University.

**Methodology**

The majority of the findings reported here were collected via an online survey (see Part B1) that was delivered via SurveyMonkey and promoted by WP9 via various iTEC mailing lists. The P&E survey was open between 21st May and 20th June 2014 and was available in nine languages (DE, EN, ES, FL, FR, HU, IT, TR, PT). Responses were included only
if respondents had completed the survey at least as far as question 5 (the first question directly about the use of the P&E Directory).

Across all languages, a total of 132 respondents completed sufficient questions to be included in the analysis. This figure represents 48% of the total number of registered P&E users at the time of the survey. 65% of respondents (n=132) were teachers; 12% were teacher educators; and 7% were experts. Head teachers (5%); counsellors (5%); managers (3%); trainee teachers (2%); learners (1%) and authors (1%) were also represented. Teachers (and head teachers, teacher educators and trainee teachers) were asked questions focused on the use of the Directory for teaching and learning in addition to the more general questions asked of all respondents.

Analysis was carried out using Excel. For open-ended responses in languages other than English Google Translate was used, which may have resulted in occasional errors in translation. Where this was the case, it was not possible to obtain a sufficiently meaningful translation to allocate responses to a category. For the open-ended questions, responses were coded according to the main themes emerging for each question. Respondents may be counted under more than one category if their response covered more than one theme. Additional data was obtained from a small number of teacher comments relating to the P&E Directory in notes/transcripts from technology focus groups and pilot case studies.

The P&E Directory and social media

Among survey respondents, Facebook was the most commonly used social media network for professional purposes (83%; n=132). Around half the respondents used Twitter (51%) and a slightly smaller proportion used LinkedIn (42%).
When asked what, if any, potential advantages the People and Events Directory offers in comparison to other social networking sites (e.g. LinkedIn), by far the most frequent response was that it was focused on education and the needs of teachers (47 responses):

"Sites as such LinkedIn are too general. This is for teachers."
"It is a more specific network it is connected to education."

12 respondents felt the structure of the P&E Directory was better than existing sites:

"Easier to sort and find people."
"The people network on the P&E Directory is structured"

Other benefits mentioned were: allowing easy contact between people involved in iTEC (and other European projects) (6 respondents); the quality of information provided (e.g. currency, consistency and depth of detail) (3 respondents); the range of contact options offered (2); and the fact that people listed were likely to be willing to help if contacted (2). Nine respondents said they did not feel the P&E Directory had any advantage over existing social networking sites.

Training and support

![Bar chart showing the use of training and support materials and sessions](chart)

*Figure 3: Use of other social networking sites (n=132).*

*Figure 4: Use of training and support materials and sessions (n=132).*
43% of respondents (n=132) had used the P&E Directory Manual to learn about the Directory. Around one-third (30%) had received a training session from a national coordinator and 14% had received one-to-one-support. However, 26% did not indicate that they had received any training or guidance in using the Directory.

63% agreed or strongly agreed that the information and support they had received provided all the information necessary to understand and use the People and Events Directory effectively.

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**Figure 5: Perceived quality of training and support materials and sessions (n=132).**

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Using the P&E Directory

- Overall, respondents (n=131) indicated that location-based searches were seen as the most useful ways of using the ‘events’ section of the P&E Directory:
  - Finding information about regional or national events (59% ranked 1st, 2nd or 3rd).
  - Finding information about local events (59% ranked 1st, 2nd or 3rd).
  - Finding information about international events (58% ranked 1st, 2nd or 3rd).
Other ways of finding events (by audience and subject) were less popular and the facility for respondents’ promotion of their own events was seen as the least useful function:

- Finding information about events on particular subjects (48% ranked 1st, 2nd or 3rd).
- Finding information about events aimed at particular audiences (44% ranked 1st, 2nd or 3rd).
- Promoting events you are involved in (32% ranked 1st, 2nd or 3rd).

Please order the following possible ways of using the 'events' section of the P&E Directory from 1 (most useful) to 6 (least useful)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Promoting events you are involved in</td>
<td>16%</td>
</tr>
<tr>
<td>2</td>
<td>Finding information about events on particular subjects</td>
<td>14%</td>
</tr>
<tr>
<td>3</td>
<td>Finding information about events aimed at particular audiences</td>
<td>18%</td>
</tr>
<tr>
<td>4</td>
<td>Finding information about local events</td>
<td>21%</td>
</tr>
<tr>
<td>5</td>
<td>Finding information about events on particular subjects</td>
<td>10%</td>
</tr>
<tr>
<td>6</td>
<td>Finding information about events aimed at particular audiences</td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>Finding information about local events</td>
<td>14%</td>
</tr>
</tbody>
</table>

Figure 6: Perceived usefulness of the events section in the P&E Directory (n=131).

The 'events' section of the P&E Directory had been used by a number of teachers to discover new technologies and design new learning activities. 23% of teachers (n=91) said they had discovered a new technology or learning activity from the teacher videos available within the P&E Directory and 60% of this group (n=20) had used this technology or activity within their own teaching, or planned to do so. 20% of teachers (n=92) said they had used information or contacts from the P&E Directory to design a learning activity. When asked how they had used information or contacts within their learning design, respondents gave a wide variety of answers including:

"I published information in my blogs, shared by Facebook, twitter, e-mail."

"Utilised in the design of a MOOC and also used in the creation of articles on ICT."
“Put my students in contact with an expert in a specific area.”

“The inclusion of references to events acted a guide for tasks carried out within a learning activity (searching, referencing...).”

11% of respondents (n=108) said they had attended an event they discovered through the People and Events Directory.

Turning to the ‘people’ section of the Directory, the facility to identify collaborators, at all levels was seen as the most useful way to use the Directory (n=121):

- Identifying potential collaborators regionally or nationally (65% ranked 1st, 2nd or 3rd).
- Identifying potential collaborators locally (64% ranked 1st, 2nd or 3rd).
- Identifying potential collaborators internationally (63% ranked 1st, 2nd or 3rd).

The Directory was seen as less useful as a method of identifying experts. This may perhaps be because respondents felt less need to contact experts, or because the number of experts listed was very small. The facility to search for someone who could communicate in a given language was seen as being of limited use:

- Identifying local experts in a particular subject or field (48% ranked 1st, 2nd or 3rd).
- Identifying national or international experts in a particular subject or field (42% ranked 1st, 2nd or 3rd).
- Identifying people who can communicate in a given language (18% ranked 1st, 2nd or 3rd).
Figure 7: Perceived usefulness of the people section in the P&E Directory (n=131).

Overall, the ‘people’ section of the Directory appeared to have been less well used than the ‘events’ section to date. Only 8% of teachers (n=91) said they had contacted, or been contacted by, an expert or collaborator they identified through the P&E Directory. Just one of the other stakeholders (n=16) said they had contacted, or been contacted by, a teacher (or other collaborator) through the Directory. When asked to describe what happened and how they had worked together, two teachers mentioned email and another referred to a seminar. One other stakeholder said they were using WebEx.

Benefits of the P&E Directory

- When asked to assume that the Directory had been developed into a mature product with sufficient People and Events available, at least four-fifths of respondents agreed with the following statements:
  - 84% agreed users become part of a teachers’ network (n=114)
  - 84% agreed teachers and learners have access to videos of ideas, technologies and practices posted by other teachers and experts (n=113)
• 84% agreed teachers and learners can more easily contact (or be contacted by) peers and experts outside the school willing to collaborate (n=113)

• 82% agreed users can be part of a dynamic multi-cultural teacher community (n=114)

• 81% agreed teachers and learners can more easily identify peers and experts outside the school willing to contribute to teaching and learning activities (n=113)

• 79% agreed teachers can identify events to use during their lessons (n=114)

• 75% agreed teachers and learners can promote self-organised events or activities taking place at their school (n=114).

The only statement with less than 70% agreement was:

• 65% agreed stakeholders traditionally not involved in the learning activities can more easily express their willingness to participate in the learning process (n=113).

Assuming that the Directory has been developed into a mature product with sufficient People and Events available, to what extent do you agree...

![Chart showing percentage agreement for various statements](chart.png)

*Figure 8: Perceived benefits of the P&E Directory (Section 1) (n=114).*
Assuming that the Directory has been developed into a mature product with sufficient People and Events available, to what extent do you agree...

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Users become part of a teachers’ network</td>
<td>6%</td>
<td>44%</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Users can be part of a dynamic multi-cultural teacher community.</td>
<td>6%</td>
<td>42%</td>
<td>40%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managers can promote regional and national events.</td>
<td>4%</td>
<td>18%</td>
<td>38%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>Teachers and learners can promote self-organised events or activities...</td>
<td>5%</td>
<td>13%</td>
<td>40%</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>Teachers can identify training and continuing professional development...</td>
<td>5%</td>
<td>7%</td>
<td>15%</td>
<td>35%</td>
<td></td>
</tr>
<tr>
<td>Teachers can identify events to use during their lessons</td>
<td>5%</td>
<td>14%</td>
<td>43%</td>
<td>36%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 9: Perceived benefits of the P&E Directory (Section 2) (n=113).

When asked to describe the further potential benefits of the P&E Directory, the most common answer was improving contact with other teachers, and experts with an interest in education (17 responses):

“Creating a big community of teachers, learners and experts.”

“Belonging to a large family”

Twelve referred to the capacity of the P&E Directory to act as a platform for sharing innovative ideas aimed at improving pedagogy:

“ We can improve our classes by collaborating with schools around Europe.”

Closely related to this, nine referred to the establishing of a European community capable of strengthening "interaction between cultures". According to six respondents, another benefit could be improvements in ICT skills as "stakeholders will improve their ITC competences".

69
Sustainability

81% of respondents (n=106) said they would be likely to use the P&E Directory again, assuming it is developed into a mature product with sufficient people and events available. When asked for what purposes they were likely to use the P&E Directory again, respondents’ answers can be categorised as: use of ‘People’ (either teacher or ‘experts’) (38%; n=86); use of ‘Events’ (21%) and to generally improve their knowledge or teaching practice (36%):

“I want to know more about new technology and to improve my teaching.”

“To find inspiration for designing learning activities, to contact experts to invite them to participate in interactive activities with my students, to find partners for collaborative projects, ...”

“I will search for events and colleagues for my projects.”

When asked why there were unlikely to use the P&E Directory again, just two respondents gave reasons. One felt there was “not enough information and sharing” and the other could not see a use for it, describing it as “inapplicable”.

Furthermore, 80% of teachers (n=89) said that they would recommend the Directory to other teachers (again on the assumption that it became a mature product). 94% of other stakeholders also said they would be likely to recommend the Directory to their colleagues and other contacts.

Suggested improvements

Teachers (including head teachers, trainee teachers and teacher educators) were asked how the Directory could be improved to make it more valuable for teaching and learning. The most frequent response was that it needed to be more widely publicised to expand the number of listings (24 responses):

“Be promoted at a national level, better known.”

“Including more people.”

Seven respondents wanted to see improvements to the interface, in particular changes that would make it easier to use:

“Make it easier and quicker to register People and Events.”

A further seven felt the site could be improved through more use of multimedia resources, and perhaps through links to external resources:

“Pictures, an illustration of teachers’ work.”
“Examples of good/bad practice should be included.”

Six respondents said they would like to see collaboration being more actively supported:

“More opportunities for collaboration.”

Teachers also called for improvements to the search facility and categorisation scheme, allowing them to identify useful people and events more easily (5 responses).

“Refining the categorisation of some items in the descriptions of people and events.”

Four respondents raised concerns about data security, especially if student contact details were available via the site. Three wanted to see the site translated into other languages.

There were also two people who wanted an alert service to notify them when new listings were added which matched their search criteria.

Experts and other stakeholders were also asked how the Directory could be improved to make it more valuable for people in similar roles. Although a number felt they did not have sufficient experience of using the Directory to be able to comment, six thought that the design should be improved by, for example, making it more interactive and incorporating multimedia content, or simply changing the colour scheme and layout:

“the interface design and it’s too formal colour and frame designs ... may cause negative bias for some users who may expect... more dynamic and interactive interface.”

Three respondents said they would like to see more listings included and a further three thought the Directory could be improved by linking to other services or platforms:

“RSS feeds from other websites that promote training events or learning communities”

“An API for Integrated into other platform - e.g. other things/people you may be interested in after a search.”

Other suggestions were an internal messaging or chat system (2 respondents) and more detailed information about people included in the listings (1).

Qualitative data
In addition to the P&E survey, a limited amount of qualitative feedback was received from the technology focus groups (9) and pilot case studies (8). In the teacher focus groups,
teachers’ use of the P&E Directory had been limited. Most had registered with the site and some had added an event.

Some teachers felt that the P&E Directory duplicates existing tools that provide information about people and events (2 focus groups). Others felt it has potential but needs to include more resources, especially at a local level (3 focus groups). Some teachers experienced technical/administrative issues such as problems logging in (2 focus groups). Suggestions to improve the Directory included a forum/chat facility; allowing RSS feeds; improved categorisation of learning stories/activities to help teachers find relevant resources; a rating system for experts and events; and training and support in the use of the Directory.

Only one teacher in the pilot case studies had made sufficient use of the P&E Directory to be able to comment on the tool, but even they admitted, “I didn't work with it enough to have a well-founded opinion”. This teacher thought more content was needed and welcomed the idea of an alert service to make them aware of new people/events that might be of interest.
USAGE & SOCIAL EVALUATION

A visual analytics software tool developed in collaboration with the University of Oviedo (see Part B3) was integrated in the last versions of the P&E directory with the goal of allowing obtaining and displaying usage and social information. The pilot study using data analytics was conducted from the 28th of January to the 28th of May 2014. The analytics engine enabled us to complement and contrast the qualitative evaluation by measuring the use of the P&E directory during the pilot phase. Visual analytics are very relevant for this evaluation because they indicate, in an objective way, the real figures for the total traffic and activity registered during the pilot phase of this project. This measure enhances thus our understanding of the information and results obtained. From a user perspective, data visualisations can motivate and engage teachers and experts to use the system more effectively.
Usage dashboard

The usage dashboard complements traditional data analytics for a web site with specific usage analytics for the iTEC P&E Directory. Such approach is meant to make visualizations easily interpreted by any user, and particularly for those used to work with this type of analytics. The indicators are designed as simple data representations, including the following:

- Session, search and action indicators.
- Data representations for entity creation, search, action, and funnels browse – edition for people and events.

During the period of this study, almost 200 registered users from at least 20 countries used the iTEC P&E Directory to perform more than 7100 searches on People and Events, and over 32 thousand total actions (Figure 11).

Overall, these figures confirmed previous results, such as the importance of improved search functions and filtering of information, and the highlighted value of using the P&E directory to identify peers and experts: 4198 searches on 192 persons (ratio: 21.86) versus 2924 searches on 1659 events (ratio: 1.76). The figures also allow us to map the use of P&E features and the social connections (i.e. know and trust a person, and like an event) made by each participant country.
Social dashboard

The social data dashboard aims at drawing conclusions about how the use of the P&E directory can be related to social variables, with an analysis of country-level participation rates. The design of this dashboard includes data representations for:

- “Trust” and “know” connections for people, and “like” for events.
- Entity creation and social action share per country
- Social actions rate with respect to total actions per country.

Figure 11: Social analytics of the iTEC People and Events Directory.
The results highlight the overall important contribution of our Turkish, Lithuanian, Portuguese and Spanish partners during the study, and how the average proportion of social actions, 2.77 over 14.80 total actions (18.7%), is disparate when analysed per country.

**Google analytics**

In the last days of the pilot, the P&E Directory complemented the usage and social analytics dashboards by adopting also Google Analytics to track visitors’ traffic on the website. Google Analytics for the P&E Directory was made available as from mid-May 2014.

![Google Analytics of the iTEC People and Events Directory.](image)

**Figure 12:** Google Analytics of the iTEC People and Events Directory.

Google analytics stats are not visible from the P&E Directory, they are only available from Google’ website⁸ and require a previous user registration. The figures we obtained (Figure 13) matched their counterparts in the usage dashboard, this time with a focus on website traffic, and a visual representation familiar to mainstream Internet users.

For a complete description of statistics and visual analytics used in this analysis, please see Part B3.

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⁸ [https://www.google.com/analytics/](https://www.google.com/analytics/)
TECHNICAL FEASIBILITY

The pilot phase of the project, including development and refinement of existing features, has confirmed the scalability of the system. The pilot phase also indicates that the P&E Directory could be easily developed into a production system thanks mainly to the use of proven scalable technologies.

The technical challenges and maintenance requirements of the People & Events directory are resumed in the following subsections.

Federated access to learning resources

The P&E Directory has a federated architecture. As such, the directory obtains its data from different sources. The P&E Directory reads RSS channels from existing educational repositories such as those from Ministries of education, European portals and educational institutions. In addition, the P&E Directory is harvesting from other repositories such as the iTEC Scenario and Development Environment (SDE) repository9, which scrapes existing web sites, transforms it into web 2.0 data structures and exposes it in either RDF triples or JSON data structures. As an example, events are scraped from CEN/ISSS, the open education portal. Finally, registered users can also submit new entries to the directory.

Figure 13: The Federated Architecture of the People and Events Directory

The list of technical components that need to be taking into account in this federated architecture are:

- A search engine for People and Events, implementing the combination of a full text search with a faceted search.

9 http://www.itec-sde.net
• An RSS harvester for the ingestion of events from external sources.
• A harvester for ingesting collections of iTEC formatted events from other iTEC components, such as the SDE repository.
• A harvesting target such that other authorized systems can harvest information from the P&E Directory.
• A vocabulary handler that ingest and handles multi-lingual vocabularies from the Vocabulary Bank for Education\(^{10}\) (VBE).
• Facilities to manually submit new and enrich harvested entries about Persons and Events.
• A usage data logger implementing an application profile of the Experience API\(^{11}\) (xAPI)
• Visual analytics tools.

**Search engine**

The search options adopted and investigated in the framework of the iTEC project has led to a faceted search for People and Events, which uses filters that are usually not available on other established social networks. These search filters allow to find people in a European multilingual network based on a specific country, by the language(s) they master, subjects of expertise, and a series of contact channels to reach them. Similarly, events from across Europe can be found using the following filters: country, language, subject, category, and place. The events may also come from different sources and be of different types.

\(^{10}\) [http://aspect.vocman.com/vbe/home](http://aspect.vocman.com/vbe/home)

Future implementations can make use of P&E users’ search information to enrich their profile information, allow them to subscribe and get notifications about people and events, and create recommendation systems based on pre-configured search criteria. In this way, for example, a teacher interested in Biology events in Switzerland in which French and Italian are the working languages can subscribe and receive notifications about related people and events in multiple ways. The P&E directory would perform specific searches on behalf of the users using the database of people and events and inform them about the results they are interested in via the website, email or any other electronic means.

Automatic harvesting of events.

Manual gathering or editing of events data has been envisaged for the piloting phase of the implementation of the P&E directory only. It should be possible in future, too, but not as the main method for data collection, albeit that even with automating the ingestion of new events, there will be a role for humans to manually or semi-automatically ‘tag’ the items with the relevant ‘subject’, ‘location’, and possibly ‘age range’ and ‘target audience’ labels using controlled vocabularies.

Long-term sustainability of the database can only be secured if the gathering of all data is done using automated processes. Among sources to be taken into account we include the following:
- Event databases on MoE's national or regional web portals Visual analytics tools.
- RSS-feeds offered by various educational institutions
- Social media channels
- Websites run by relevant institutions
- Webcasts
- Blogs

Figure 15: Automatic harvesting of events in the P&E directory.

Our experience with a variety of RSS sources for Events, has shown how different patterns and XML labeling schemes are using for the feeds, making them very heterogeneous and, thus, difficult to harvest and match with existing vocabularies or ontology-based dictionaries. This indicates that semantic interoperability would be greatly enhanced, if an application profile would be developed for the RSS specification targeted to Events for learning.

Data collection and database storage

All the information about people and events that is manually generated from the directory, as well as the automatic data collected from various educational sources, are organised and stored in the system database (see Part B2). Maintenance of the data requires setting
a system’s scheduled task (cron job) to automatically populate new events, and to maintain a proper backup system of the database and other sensitive data.

**Log and system files**

All the information about system activity and state, as well as data that would be inappropriate for storage in a database is kept in logs and system files. In the pilot version of the directory, this includes a daily log with a record of every action performed in the directory (/data/usage) and reports of the results of scheduled tasks for automatic events population and analytics data collection (/logs/iTEC_*). Maintenance of log files requires using syslog, logrotate or an equivalent scheduled task to improve performance and avoid generating large system files.

**Security and privacy concerns**

The registration and access to the P&E Directory is based upon iTEC-UMAC\(^\text{12}\) access policies. Users do not necessarily need a European Schoolnet account to access the People and Events Directory. It is also possible to access the P&E Directory using a Google, Yahoo, or Facebook account. Initial access did not include any security or privacy statement. Later on, the P&E website adopted the following disclaimer:

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**User Privacy & Personal Data, Terms & Conditions**

The following terms and conditions apply to all visitors or users of the iTEC P&E Directory. By accessing the P&E Directory, the user acknowledges acceptance of these terms and conditions. European Schoolnet (EUN) reserves the right to change these terms and conditions from time to time at its sole discretion. In the case of any violation of these terms and conditions, EUN reserves the right to seek all remedies available by law and in equity for such violations. These terms and conditions apply to all visits to the iTEC P&E Directory website, both now and in the future.

1. You will not use the P&E Directory for anything not related to or for the purpose of education.
2. You will not post or send unauthorized commercial communications (such as "promotions" or spam) on or through the P&E Directory.
3. You will not use harvesting bots, robots, spiders, or scrapers in order to collect users’ content or information, or otherwise access the P&E Directory.
4. You will not register someone else under your login (every user is responsible for his/her own registration with the service).
5. You will not solicit login information or access an account belonging to someone else.

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\(^{12}\) [http://itec-umac.eun.org](http://itec-umac.eun.org)
6. You will not use the P&E Directory to do anything unlawful, misleading, malicious, or discriminatory, nor anything that could disable, overburden, or impair the proper working or appearance of the P&E Directory.
7. European Schoolnet might contact you in the future using the data you are providing hereby in the framework of future projects.

When you publish content or information using the iTEC People & Events (P&E) Directory, it means that you are allowing everyone registered as a user to access and use that information, and to associate it with your contact information.

Table 1: User Privacy & Personal Data, Terms & Conditions in the P&E directory.

This disclaimer has been made available exclusively in English, but users using the P&E interface in any of the 9 languages in which it is available are also able to access it. In the future, this privacy statement should not be specifically linked to the P&E Directory, but rather included in a more global policy and statement for the whole set of iTEC tools and services. At the same time, the way security and privacy terms are communicated, i.e. pop-up windows or other means to make it more evident to users as they register/access iTEC services, should be taken into consideration.

Additional security and privacy concerns that have been discussed during the pilot phase, and should be considered for future implementations, are: evaluation and communication of website security/privacy risks, prevention and management of intentional misuse, such as publication of false information, protection and encryption of sensitive data, and use of digital signatures and authenticators.

Opportunities for promoting educational activities

One of the perceived benefits of the P&E Directory for teaching and learning has been stated as “Promote your initiatives and publish your resources”. The importance of promoting professional identities and educational activities is corroborated by the use of the P&E directory during the pilot study, where the contents of people and events highlight professional roles and educational practice both at individual and group level.

These opportunities could be enhanced in the future by optimising the design of the user interface, providing better profile information, creating unique URLs, and enabling push and pull data strategies for people and events. In addition to this, linking both people and events could also have an additional value. One could imagine that a person’s profile could be linked to an organisation and to a series of events to which the person is linked to, either playing an active roles (i.e.) or because this person will be attending the event in question.

Backward compatibility with client software
The P&E Directory makes use of modern Web technologies, and it has been tested for last versions of web browsers (i.e. Google Chrome, Microsoft Internet Explorer, Mozilla’s Firefox and Apple’s Safari) including support for HTML5, CSS3 and JQuery. However, as reported from the Ministry of Education in Portugal, some of the participant schools in the pilot study did not have access to updated versions of the web browsers and found it difficult to use some of the features of the directory. Future releases of the directory should take compatibility issues into consideration, to assure that users could use the P&E Directory to its full potential independent of the software they are using. In addition to that, schools should receive support to make sure they can update their software to avoid security and technical problems.

Related social network features and educational sites

The P&E Directory has been envisaged as a specialized educational networking site and some of its features have close resemblance with professional networking sites that have a more general scope like LinkedIn. At a more particular educational level, it is possible to see similarities and a common trend with projects focusing on providing social networks for teachers and educational experts, such as the case of Prof-Inet in Quebec\textsuperscript{13}, Canada. Thus, although the P&E Directory has been conceived to provide unique and specialized features like federated access to learning resources, and improved search functions and filtering of educational information. Conversations with users of the P&E Directory showed the importance of taking into account and investigating the main characteristics and features provided by similar tools. Users seem to expect similar interface, design principles and features which they can already find in other social networking and educational sites.

Integration with iTEC activities and other learning tools

The P&E Directory has been integrated with other iTEC tools i.e. by harvesting from other iTEC sources of information, such as the iTEC SDE repository, and it provides a RESTful API encoded as JSON strings over HTTP to access the information about People and Events. Consumers of the P&E API need to be able to send HTTP POST requests and be authenticated upon iTEC-UMAC.

iTEC tools have also been classified in groups, and the P&E directory is now part of iTEC Eduteka along with the Composer, the Widget Store and the SDE. However, the various iTEC technical outputs, which have been initially carried out in the framework of different work packages and as separated tools, can be further integrated for the benefit of iTEC users and the educational community. It seems, teachers and educational experts could take advantage of a more holistic and comprehensive view of the various iTEC tools, and multiple products, inside and outside iTEC. They could also benefit from the integration of the whole set of technologies available and the current information in P&E Directory.

\textsuperscript{13} \url{http://www.prof-inet.com/a-propos-de-nous/qui-sommes-nous/}
Compliance with standards and valuable information for standards bodies

In order to assess the compliance with existing information systems, the P&E Directory has supported its development in the use of de jure and de facto standards and commonly used technologies. This includes: The Experience API (xAPI), ISOs codes (639-1, 639-2, 3166), European Schoolnet’s Vocabulary Bank for Education (VBE), REST API, RSS, Java, JSON, HTML5, CSS3 and JQuery.

More standards have been discussed to extend and refine the functionality of the P&E Directory. I.e. the use of ATOM was considered for harvesting events and allows working with multiple languages and adding more information to each entry/event. However RSS 2.0 and RSS 1.1 were finally adopted in order to keep the compatibility with formats currently used by the great majority of institutions, if not all, involved in iTEC and contacted to be content providers.

Although the development has adopted existing standards and not proposed new ones, it could be interesting for technology providers and standards bodies to analyse the accomplishments of this work package regarding information integration and federated exchange of learning resources. More in particular it could be useful to develop an RSS application profile for the harvesting of events.

Conclusions

iTEC is a large-scale European pilot that increases the current scope of openness and emphasizes the importance of providing open access to resources beyond content. One of the available outputs of this project is the iTEC People Events (P&E) Directory, which brings together information about the various components (e.g. actors (persons), tools, services, and contents) that are required to compose and carry out different teaching and learning activities. The P&E directory has an added value in the structuring information and knowledge at the European level as it enables extracting information from existing repositories and uses semantic-enhanced information to combine data from multiple heterogeneous sources and enhance search results through filtering.

The successful integration of open resources into learning activities depends largely on establishing an educational network. The P&E directory has already enabled a community of practice where users perform over a hundred daily searches to find persons and browse events that can contribute to their learning activities. The initial evaluation confirms the improvements over existing networks, asserts the interest of teachers, and provides an overview of the benefits of integrating the P&E directory into everyday educational practice.

Feedback on the P&E Directory demonstrates the enthusiasm among iTEC teachers for greater collaboration locally, nationally and internationally to enable them to improve their knowledge of new pedagogies and technologies and to help create a community of
innovative teachers who can support each other. Although the P&E Directory was felt to duplicate existing social media networks to some extent, there was notable enthusiasm for a dedicated portal for teachers and educators. There may be potential for other educational 'experts' to play a role in such a community, but the limited number of experts currently available in the P&E Directory meant it was not possible to explore this possibility. Teachers were also keen to find new resources to use in their teaching and felt that such a community offered them a possible means to do that.

Although the P&E Directory has not been widely used to date and feedback is preliminary, responses suggest that interest in using of the Directory to find ‘events’ (in the traditional sense) is limited. However, teachers do see a value in using it to identify other teachers they can work with and to find resources that can be incorporated into their teaching and can support their professional development. Of course, this is dependent on sufficient collaborators and resources being available through the Directory.

The issues addressed during the project provide the foundation to identify areas for future work. The use of a federated architecture along with proven scalable technologies facilitates its future expansion and integration with other educational systems and repositories. However, our experience using a variety of sources for events shows the difficulty of harvesting and matching existing information with ontology-based dictionaries, and remarks the importance of using metadata and application profiles to improve semantic interoperability. The strategy towards a further integration of the P&E directory with other educational services includes the development of “The Future Classroom Toolkit”, which will integrate the key elements from across the iTEC project with other toolkits to provide a series of activities, processes, resources, tools and guidance. In parallel to the development of this toolkit, EUN has developed a teacher continuing professional development programme to support the development of future classroom scenarios and learning activities.

In addition to being of assistance to WP9, these findings may also have relevance for other partners who provide national or company-based teacher support forums.

PART B

USABILITY SURVEY

Introductory note
Connecting with peers and sharing experience is essential for teachers who want to develop their own skills. The iTEC People & Events (P&E) Directory promotes collaboration and community-mindedness and aims to provide teachers with a rich source of people and events that can offer valuable support in the design and implementation of learning activities. Through the iTEC P&E Directory, it is possible to find an individual with a specific profile and who may not be easily findable or reachable by means of other existing social media platforms and online communities.

We would be grateful if you could help with our evaluation of the People & Events Directory by completing a short questionnaire. This will enable us to better understand its potential benefits for teaching and learning, as well as areas which require further development. The questionnaire should take around 20 minutes to complete. For open-ended questions, please provide as much detail as possible. Many thanks for your help. If you have any queries about the questionnaire, please contact ContactName (email address).

**Content of the Questionnaire**

1) Which of the following best describes you (please select one only)?
   - Teacher
   - Head teacher
   - Trainee teacher
   - Teacher educator
   - Learner
   - Manager
   - Expert
   - Author
   - Counsellor
   - Other
   If other, please give details

2) Which social media networks do you regularly use for professional purposes?
   - LinkedIn
   - Twitter
   - Facebook
   - Pinterest
   - Other (please specify)

3) Which of the following have you used to learn about the People and Events Directory?
   - P&E Directory Manual
   - Training session by NPC/NTC
   - One-to-one support from NPC/NTC
   - Other (please specify)

4) The information and support I received provided all the information
necessary to understand and use the People and Events Directory effectively:
(SD: Strongly Disagree, D: Disagree, N: Neutral, A: Agree, SA: Strongly Agree)

• SD
• D
• N
• A
• SA

At present, the People & Events Directory is a prototype tool. ‘People’ and ‘Events’ are being added gradually, so coverage may be limited in some areas, and some minor technical problems may be experienced. However, when answering the following questions, please imagine that the Directory has been developed into a mature product with ample People and Events information available.

5) Please order the following possible ways of using the 'events' section of the P&E Directory from 1 (most useful) to 6 (least useful).
   (You can either drag and drop or use the drop down options.)
   • Finding information about local events
   • Finding information about regional or national events
   • Finding information about international events
   • Finding information about events aimed at particular audiences
   • Finding information about events on particular subjects
   • Promoting events you are involved in

6) Please order the following possible ways of using the 'people' section of the P&E Directory from 1 (most useful) to 6 (least useful).
   (You can either drag and drop or use the drop down options.)
   • Identifying potential collaborators (eg other teachers) locally
   • Identifying potential collaborators (eg other teachers) regionally or nationally
   • Identifying potential collaborators (eg other teachers) internationally
   • Identifying local experts in a particular subject or field
   • Identifying national or international experts in a particular subject or field
   • Identifying people who can communicate in a given language

7) What, if any, potential advantages does the People and Events Directory offer in comparison to other social networking sites (eg LinkedIn)?

8) Assuming that the Directory has been developed into a mature product with sufficient People and Events available, to what extent do you agree with each of the following statements:
(SD: Strongly Disagree, D: Disagree, N: Neutral, A: Agree, SA: Strongly Agree)
• Teachers and learners can develop advanced learning design skills, while improving the use of ICT in the classroom.
• Teachers and learners can more easily identify peers and experts outside the school willing to contribute to teaching and learning activities.
• Teachers and learners can more easily contact (or be contacted by) peers and experts outside the school willing to collaborate.
• Teachers and learners can gain visibility by promoting a favourite technology or technical tools they use in the classroom.
• Teachers and learners have access to videos of ideas, technologies and practices posted by other teachers and experts.
• Stakeholders traditionally not involved in the learning activities can more easily express their willingness to participate in the learning process.
• Teachers can identify events to use during their lessons (for example to engage students by linking the curriculum to things happening in the real world).
• Teachers can identify training and continuing professional development opportunities in their region.
• Teachers and learners can promote self-organised events or activities taking place at their school.
• Managers (e.g. event organizers) can promote regional and national events.
• Users can be part of a dynamic multi-cultural teacher community.
• Users become part of a teachers’ network (for example, they may receive invitations to take part in training or to participate in new projects).

8a) The People and Events Directory has further potential benefits in addition to those described above.
(SD: Strongly Disagree, D: Disagree, N: Neutral, A: Agree, SA: Strongly Agree)
• SD
• D
• N
• A
• SA

9) How could the People and Events Directory be improved to make it more valuable for teaching and learning?

10) Have you used information or contacts from the People and Events Directory to design a learning activity?
    • Yes
    • No

11) Have you attended an event you discovered through the People and Events Directory?
    • Yes
    • No

12) Have you contacted, or been contacted by, an expert or collaborator you identified through the People and Events Directory?
    • Yes
    • No
13) Have you discovered a new technology or learning activity from the teacher videos available within the People and Events Directory?
   • Yes
   • No

13a) Which technology or learning activity was new to you? (If you have discovered more than one, please describe the one you found most useful).

13b) Have you used this technology or activity within your own teaching, or do you plan to do so?
   • Yes, I have already used the new technology/learning activity
   • I have not used the new technology/learning activity yet, but I plan to do so
   • No, I have not used the new technology/learning activity and I have no plans to do so.

14) Assuming that the People and Events Directory will be developed into a mature product with sufficient People and Events available, how likely are you to do the following: (Very unlikely, Unlikely, Neutral, Likely, Very likely)
   • Use the People and Events Directory again

14a) For what purposes are you likely to use the Directory again?

15) Assuming that the People and Events Directory will be developed into a mature product with sufficient People and Events available, how likely are you to do the following: (Very unlikely, Unlikely, Neutral, Likely, Very likely)
   • Recommend the People and Events Directory to other teachers

End note

Thank you for completing our survey!
### B2: DATABASE

#### SQL Tables and Index Data Structure

```
-- Table structure for table `id_with_provider_tb`

CREATE TABLE IF NOT EXISTS `id_with_provider_tb` (
    `user_id` int(11) NOT NULL,
    `provider` varchar(45) NOT NULL,
    `id_with_provider` varchar(250) NOT NULL,
    PRIMARY KEY (`user_id`,`provider`) ) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

```
-- Table structure for table `json_object_tb`

CREATE TABLE IF NOT EXISTS `json_object_tb` (
    `object_type` char(3) NOT NULL,
    `id` int(10) NOT NULL,
    `guid` varchar(250) DEFAULT NULL,
    `name` varchar(250) DEFAULT NULL,
    `last_mod` bigint(20) NOT NULL,
    `last_op` tinyint(4) NOT NULL DEFAULT '1',
    `public` bit(1) NOT NULL DEFAULT b'0',
    `json_string` longtext,
    PRIMARY KEY (`object_type`,`id`),
    KEY `OT_GUID` (`object_type`,`guid`) ) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

```
-- Table structure for table `permission_tb`

CREATE TABLE IF NOT EXISTS `permission_tb` (
    `user_id` int(11) NOT NULL,
    `role` varchar(64) NOT NULL COMMENT '5: superadmin; 15:admin; 25:owner; 35:grantee; 45:teacher; 55:learner; 65:anonymous',
    `object_type` char(3) NOT NULL,
    `object_id` int(11) NOT NULL DEFAULT '-1',
    `typed_set` bit(1) NOT NULL DEFAULT b'0',
    `last_mod` bigint(20) NOT NULL DEFAULT '0',
```
`last_op` tinyint(4) NOT NULL DEFAULT '1',
PRIMARY KEY (`user_id`,`role`,`object_type`,`object_id`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8;

CREATE TABLE IF NOT EXISTS `user_tb` (  
`id` int(11) NOT NULL DEFAULT '0',  
`given_name` varchar(45) DEFAULT NULL,  
`family_name` varchar(60) DEFAULT NULL,  
`directory_name` varchar(100) DEFAULT NULL,  
`mbox` varchar(100) DEFAULT NULL,  
`login_name` varchar(45) DEFAULT NULL,  
`open_id_eun` varchar(255) DEFAULT NULL,  
`time_zone` varchar(100) DEFAULT NULL,  
`language` varchar(10) DEFAULT NULL,  
`picture_url` varchar(255) DEFAULT NULL,  
PRIMARY KEY (`id`)  
) ENGINE=InnoDB DEFAULT CHARSET=utf8

Database Model

Figure 9: Database model for the P&E
B3: VISUAL ANALYTICS

This section shows how data analytics and visualisations have been integrated to create a more comprehensive web environment, allow for better understanding and provide mechanisms to evaluate the pilot phase by extending and giving suitable visual representations to quantitative information about the usage and social interaction with the People and Events Directory.

A brief introduction to learning and academic analytics

In recent years, learning analytics and visualisations for learning have emerged as an active research area in the field of technology enhanced learning. Using data analytics and visualisations can help understanding the interactions with educational systems. Evaluation and decision making in learning environments find support in the use of technologies that allow for data collection, analysis, presentation and interpretation such as Educational Data Mining and Learning Analytics. EDM is a discipline concerned with developing methods for exploring the data obtained from different types of educational contexts. Learning analytics is the measurement, collection, analysis and reporting of data about learners and their context, for purposes of understanding and optimising learning and the environments in which it occurs. Learning analytics emphasizes the importance of feedback and providing visual support to enhance the understanding of learning processes. This research field is also commonly referred as academic analytics when the main focus is on the application of business intelligence to education and academic outputs other than learning.

Data collection and information modeling

The first part of the analytics process takes responsibility for providing the mechanisms to identify and collect usage and social data from the P&E directory, as well as modeling and storing the information using a persistence layer. The iTEC directory information model describes all the information that can be recorded in and retrieved from the iTEC directory.

Among the alternatives considered for data modeling and persistence are:

- Edx Insights
- Experience API (xApi)
- Activity Streams

We decided to base the information model on Experience API, and tailoring it to fit the requirements of the P&E scenario. In this model, the term “paradata” refers to data about

14 http://www.solaresearch.org/mission/about

The following shows the complete list of usage and social paradata in the P&E Directory.

Registered actions:

<table>
<thead>
<tr>
<th>Usage paradata</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Entities (Persons and Events)</strong></td>
</tr>
<tr>
<td>Clear index</td>
</tr>
<tr>
<td>Create / Register</td>
</tr>
<tr>
<td>Delete</td>
</tr>
<tr>
<td>Get / Get list</td>
</tr>
<tr>
<td>Get user</td>
</tr>
<tr>
<td>Get widget content</td>
</tr>
<tr>
<td>Harvest</td>
</tr>
<tr>
<td>Language detail</td>
</tr>
<tr>
<td>Logout</td>
</tr>
<tr>
<td>Migrate</td>
</tr>
<tr>
<td>Pull Current / Pull User</td>
</tr>
<tr>
<td>Reindex</td>
</tr>
<tr>
<td>Search entity</td>
</tr>
<tr>
<td>Submitted / Submitted by user</td>
</tr>
<tr>
<td>Translate</td>
</tr>
<tr>
<td>Update</td>
</tr>
</tbody>
</table>
Visualisation tools

Data can be processed and communicated to the user in a visual or other form of representation. The goal of visualisation is to aid our understanding of data by leveraging the human visual system’s highly tuned ability to see patterns, sport trends and identify outliers. Visualisations should be relevant to users, and emphasise easy-to-understand and usable feedback by providing suitable visual representations, as well as appropriate and statistically correct information, facilitating fast visual interpretation. At the same time, visualisations can give users controls to focus selectively on a range of parameters, such as date, processing group, and type of data. Additionally, attractive and well devised graphical designs can help users to visualise the concepts and understand the information. The challenge is to create effective and engaging visualisations that are appropriate to the data.

Widely used techniques for visualising and interacting with diverse data sets include:

- Histograms and Column Charts.
- Bar and Line Charts.
- Grouped / Stacked Multi-Bar and Horizontal Multi-Bar Charts.
- Scatter and Bubble Charts.
- Pie and Donut Charts.
- Combo Charts, Area Charts, Stepped Areas and Candlesticks.
- Timelines and Treemaps.
In many situations, using simple data graphics is preferable. In other cases, more sophisticated and unusual techniques can enable visualising more complex data sets.

Among the technical alternatives considered for the design and development of the visualisations are:

- Google Charts
- D3.js and plugins
- JQuery plugins
- CanvasJS

After a thoughtful analysis of the alternatives, we decided to use D3.js, a software library that is very resourceful for handling and drawing basic graph shapes, and the complement NVD3, which facilitates graphical representation. Although the combination D3.js + NVD3 doesn’t provide as many pre-built graphs as Google Charts and CanvasJS, the number of resources for visual representation are very large, and it offers a greater versatility and maintainability, properties that were very desirable for the development of the P&E Directory visual analytics tool.

The following shows the complete set of graphs for the developed usage and social analytics dashboards, as well as Google Analytics stats.
Usage Analytics Dashboard

Date Range Manual vs All-Time Creation Entities

Searches

Entities Creation Evolution

Search Evolution
Social Analytics Dashboard

From 2014-01-28 to 2014-06-02

Trust Connection

Know Connection

Like Connection

Social Evolution

Entities Creation Share

Social Actions Share
Google Analytics

Overview

- Sessions: 395
- Users: 240
- Pageviews: 2,127
- Avg. Session Duration: 00:08:52
- Bounce Rate: 30.13%
- % New Sessions: 52.41%

Demographics

<table>
<thead>
<tr>
<th>Country / Territory</th>
<th>Sessions</th>
<th>% Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Turkey</td>
<td>96</td>
<td>24.30%</td>
</tr>
<tr>
<td>2. Belgium</td>
<td>78</td>
<td>19.75%</td>
</tr>
<tr>
<td>3. Hungary</td>
<td>51</td>
<td>12.91%</td>
</tr>
<tr>
<td>4. Switzerland</td>
<td>47</td>
<td>11.90%</td>
</tr>
<tr>
<td>5. Slovakia</td>
<td>26</td>
<td>6.58%</td>
</tr>
<tr>
<td>6. Estonia</td>
<td>20</td>
<td>5.06%</td>
</tr>
<tr>
<td>7. Spain</td>
<td>12</td>
<td>3.04%</td>
</tr>
<tr>
<td>8. Lithuania</td>
<td>11</td>
<td>2.76%</td>
</tr>
<tr>
<td>9. Canada</td>
<td>7</td>
<td>1.77%</td>
</tr>
<tr>
<td>10. United Kingdom</td>
<td>5</td>
<td>1.27%</td>
</tr>
</tbody>
</table>