INTRODUCING "E-ME", THE HELLENIC DIGITAL EDUCATIONAL PLATFORM FOR PUPILS AND TEACHERS*

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Abstract

"*e-me*" is the Hellenic Digital Educational Platform to be provided by the Ministry of Education to the Greek K-12 community that includes more than 1,100,000 pupils and 120,000 teachers. It is currently under development by CTI Diophantus. *e-me* implements a social learning environment with a modern and intuitive user interface, where certified members of the primary and secondary education community can safely share content, connect and collaborate with peers, publish their work, use a large number of embedded applications, and interact with a wealth of digital learning resources. The article introduces the core concepts of *e-me*, the main goal and objectives for its implementation, and highlights the key elements of its software design and development.

Keywords: Digital Educational Platform, learning environment, PLE, LMS, social platform, K-12 platform, cloud-based platform, Hellenic school platform, *e-me*

1 INTRODUCTION

It is now widely accepted that students are asked not only to acquire knowledge and cognitive skills but to develop skills, competences and attitudes that will help them to adapt and survive in the constantly and rapidly evolving era of the 21st century. Thinking skills (problem-solving; critical, logical, numerical skills), communications skills (reading, writing, speaking, listening), teamwork skills, ability to learn independently, ability to adapt to changing circumstances, networking and social skills (ethics, positive attitude, responsibility) are some of the so called "21st century skills" [1].Traditional e-learning platforms and systems need to adapt accordingly and support the new approaches in learning, facilitating the development of such skills and competences.

Over the last decade, Learning Management Systems (LMS) adoption has become widespread, while for many people an LMS has been identical to e-learning. An LMS is defined as a *"software application for the administration, documentation, tracking, reporting and delivery of electronic educational technology*" [2]. Typically, an LMS provides teachers with tools to create and deliver learning material, organize courses and assess students' performance. It may also provide learners with discussion forums, file sharing and messaging.

There is a plethora of LMSs developed so far; an extensive list is given in [3]. Among the most popular ones that are provided with an open source software license is *Moodle* (moodle.org), a flexible, highly extensible LMS, with a very supportive online community, and no license fees, which however, requires significant technical expertise to make the most of it and imposes a steep learning curve even for the casual end-user. Other open source solutions include: *Chamilo* (chamilo.org), an easy-to-use learning management and collaboration system; *Canvas* (www.canvaslms.eu), a cloud-based LMS with grading and course content tools; and *Open eClass* (www.openeclass.org), an open source LMS which started as a customized and extended version of *Claroline* (www.claroline.net) and has now reached a stage of functional maturity due to its usage by most academic institutes in Greece.

Among the most well-established proprietary LMS solutions are *Blackboard* (www.blackboard.com), a powerful product which however hasn't been used widely in school education due to its high cost, and *Frog* (www.frogeducation.com), a flexible learning platform with more than 1,000,000 users in primary, secondary and higher education worldwide. Frog 'workspaces' facilitate active collaboration with other schools, both locally and internationally. Other LMSs that are worth mentioning are *Fronter* (https://eng.fronter.com/), having an interesting design based on the concept of rooms, a simple layout, and a good set of tools, and the *LP+* (http://www.lpplus.com/) that delivers a cloud-based learning platform based on Microsoft SharePoint and provides collaboration and communication tools, drag-and-drop resources, assignment management, and usage analytics.

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The next generation of LMSs, as described in [4], *"will need to be open, personal, social, flexible, support learning analytics, and properly support the move to mobile computing." Edmodo*, (www.edmodo.com) a very popular, free social platform for teachers, students, and parents is such an example; it provides content sharing, communication tools, and classroom management, and it is being used as an alternative to LMSs by schools and educational institutes all over the world.

Personal Learning Environments (PLEs) have emerged recently "as a response to an increased perception that Virtual Learning Systems (VLEs) and Learning Management Systems don't deal as well as they could with the needs of learners" [5]. Wilson termed the conceptual model for the new type of systems as the "VLE of the future" [6]. Chatti et al. in [7] stated that the LMS-centric model of learning has not succeeded in revolutionizing education and learning process; in the same work they analysed the various aspects that PLEs, in contrast to LMSs, are intended to support: *personalization,* placing learner at the center and providing a plethora of tools to select from; *informal learning and lifelong learning*: in a PLE, learning does not stop when a course ends; *openness and decentralization:* a PLE allows learners to operate in a distributed and less centralised environment; *bottom-up approach*: in contrast to a hierarchical top-down LMS, a PLE is driven by the learner needs and is based on sharing rather than controlling; and *ecological learning*: in contrast to structured and hierarchical communities of LMSs, a PLE offers the means to connect with other personal spaces for effective knowledge sharing and collaborative knowledge creation.

Schaffert & Hilzensauer in [8] stated that PLEs are based on the user-centered learning approach, using Social Software tools, i.e. software that connects people and ensures collaboration and communication, such as Wikis, Weblogs, instant messaging, social networking systems, and media sharing. According to them, the seven crucial aspects on the way from LMS towards PLE are: the role of learner as "prosumer" (i.e. not only consumers but active creators of content), a new perspective on personalization, content from peers and experts, social involvement and the role of community, the ownership and protection of learner's data, and the educational & organizational culture.

Regarding the development of PLEs, many approaches have been presented, from e-portfolios and desktop applications to aggregators of different services into a personalized space. An interesting approach is that of Attwell [9] saying that a *"PLE is not an application; a PLE is comprised of all the different tools we use in our everyday life for learning".* Examples of PLE implementations include PLEX – Personal Learning Environment (www.reload.ac.uk/plex/) and ROLE (www.role-project.eu/), aiming at supporting teachers in developing open personal learning environments for their students.

1.1 What the paper is all about

The paper introduces *"e-me"*, the Hellenic Digital Educational Platform for pupils and teachers in primary and secondary education. *e-me* provides a safe working space for pupils and teachers with a modern and intuitive user interface, to share their content, connect, communicate and collaborate with peers, publish their work, download useful apps, access and efficiently interact with learning resources (Fig. 1). Its name "*e-me*" refers to "my digital self" and, when pronounced, it resembles '*ειμί'*, the ancient Greek verb for existence and being, i.e. "I am, I exist, to be". *e-me* has been designed to serve as the main digital learning environment for the whole Greek K-12 community that includes more than 1,100,000 pupils and 120,000 teachers.

e-me was designed and is being developed by CTI "Diophantus" in the context of the "Digital School" large scale imitative of the Hellenic Ministry of Education (MoE) for the modernization of school education in Greece. It implements a core part of the digital infrastructure that is currently being developed for Greek schools of primary and secondary education. More particularly, *e-me* is one of the three key pillars of a five-year flagship project[†] for the school digital educational content, started in 2010 (dschool.edu.gr). The other two pillars are a) the creation of interactive e-textbooks for all school disciplines (e-books.edu.gr); this activity has triggered the development of some thousands of Learning Objects (Open Educational Resources - OERs), and b) the design, development and operation of an ecosystem of digital Learning Repositories under the name "Photodentro" (photodentro.edu.gr) [10], along with the Greek Aggregator of Educational Content, a national service for harvesting and accumulating educational metadata from various repositories.

[†] "Digital School Platform, Interactive Books, and Learning Object Repository" National Greek Program (Contract No 296441/2010-2015), co-financed by the European Union (ESF) and National funds in the context of Operational Programme "Education and Lifelong Learning" of the Greek National Strategic Reference Framework (NSRF), coordinated and implemented by the technical partner of the Greek Ministry of Education "Computer Technology Institute and Press - CTI DIOPHANTUS" (www.cti.gr), Strategy and Digital Educational Content Directorate.

e-me follows the concepts of Personal Learning Environments. It is an open source implementation of a PLE, targeting pupils and teachers in school education. *e-me* has a user-centered approach, where "pupil" is at the center. It provides social networking services to connect pupils and teachers, file sharing, blogs, wikis, messaging, and conferencing to ensure collaboration and communication, and a variety of tools and applications to support both formal and informal learning experiences.

To the best of our knowledge, this is one of the first, if not the first, open source implementation of a Personal Learning Environment for school education, that has been designed to be used on a country-wide level as the "official" digital working environment for pupils and teachers.

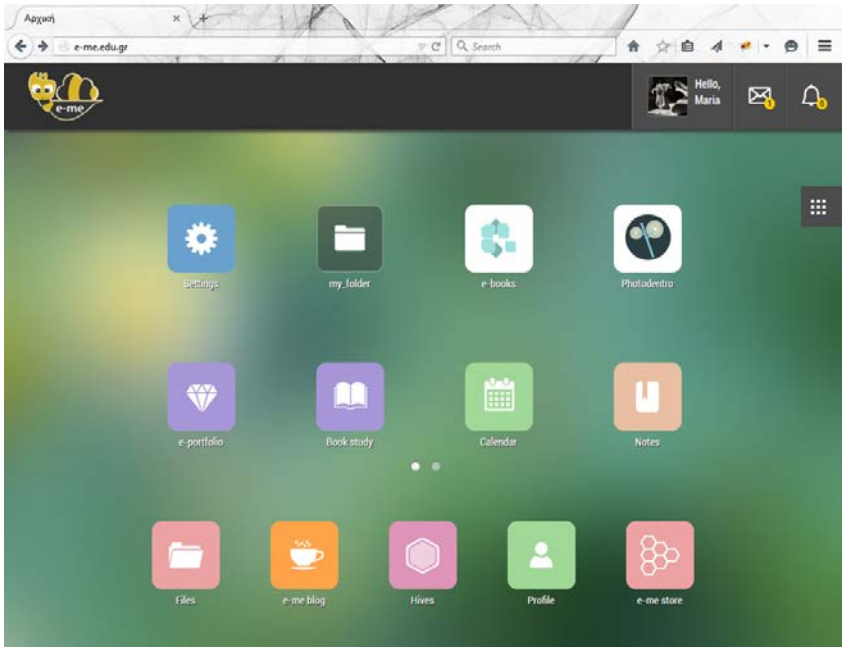

Fig. 1: *e-me*, the Hellenic Digital Educational Platform for pupils and teachers

The paper is structured as follows: the fundamental principles of *e-me*, the key design decisions, and the process of specifying *e-me* are described in section 2. Section 3 focuses on *e-me* functionality and features, while implementation issues, including the *e-me* computational cloud infrastructure, are presented in Section 4.

2 DESIGNING E-ME

As mentioned above, *e-me* is intended to serve the whole Greek K-12 community that includes more than 1,100,000 pupils and 120,000 teachers. Designing for such a large scale is a challenge itself. The design should be based on principles that guarantee broad acceptance and exploitation of the platform. Moreover, it should take into account the digital literacy skills and the e-maturity level of teachers and students and their dynamics, the existing computer infrastructure in schools and the penetration of PC and tablet equipment to pupils' homes, and the digital culture of the country in general. Furthermore, other conditions should be considered, such as the viability of such an investment, the maturity of the local market to take part in the venture, and the digital strategy of the education authorities.

2.1 *e-me* fundamental principles

The key design principles of *e-me* are:

- *Putting pupils first*: *e-me* should engage pupils first, appealing them to adopt it in their everyday lives; pupils will then "bring teachers in" the *e-me* world.
- *Smooth transition to the digital world*: *e-me* should provide the "space" and the "tools" for facilitating and upgrading what already happens in schools; *real-world metaphors* should be used to help users understand *e-me* structural concepts, bringing down rather than raising technology barriers, and avoiding new technological or artificial restrictions.
- *Sustainable model for growth and extension*: software systems and applications become obsolete very quickly; thus, when developing infrastructure with public funds, competing with the market is

not a sustainable model. Efforts should focus on the development of the underlying “framework”, providing an extendable platform ready to host third party applications, allowing therefore pupils and teachers to use tools that are familiar with. Sensitive data and apps can reside in regulated and controlled infrastructures while the sustainability model should encourage the software market and the educational community to contribute with apps that extend its functionality.

2.2 *e-me* vision

The vision of *e-me* can be summarized as follows: *e-me* is an integrated digital environment for pupils and teachers, safe, while at the same time open, for learning, communication, collaboration, and networking of all members of the school community; a personal working space for every pupil and teacher along with a set of tools to facilitate everyday learning activities; a personal repository for content and applications; a digital space for meeting and working together; and a place for publishing and demonstrating the work of pupils, teachers and schools. In one sentence, *e-me* is an open, safe social platform for pupils and teachers with strong support for sharing files and apps.

2.3 *e-me* design approach

Following the fundamental principles expressed above, *e-me*:

- was designed as a “**container**” for content and applications;
- along with a **social network** for connecting pupils and teachers, in a safe environment where access is limited only to authenticated members, taking advantage of the existing central directory services for user certification;
- with a **modern and intuitive user interface**, that adopts the look and feel of tablets and smart devices to attract pupils;

and is delivered with some basic functionality for pupils and teachers:

- to store, organize and share their content, offering them **personal storage** and **cloud-based file sharing** services (similar to Dropbox, Google drive, or Microsoft OneDrive);
- to **connect and develop networking and social skills,** allowing them to make “friends” and write on "walls" (like a “safeguarded” Facebook);
- to **communicate and collaborate**, offering a Skype-like audio & video based communication tool, as well as asynchronous and synchronous text-based tools (messages and on-line chat);
- to create **working groups** (hives) and join **communities**, thus developing **teamwork skills,**
- to **publish** their work and communicate their achievements to the world outside *e-me* (e.g. using Blogs), developing in parallel their reading and writing **communication skills,**

while it supports:

- a **trusted store of free *e-me* apps** that are created by educational institutions, teachers, or the market that extend its functionality (like Apple’s App Store or Google Play).

Furthermore, *e-me* aspires to evolve along with the familiarization of its user community and the increasing demands. The design approach that reflects this decision is that of a “blank canvas”: the home user environment consists of a minimum set of basic apps and key functionality.

2.4 *e-me* specification process: Open call for user requirements

The key source of insight for the specification of functional requirements for *e-me* has been the dialogue with the Greek K-12 educational community. To this end an open call for ideas, suggestions, and feedback was launched on the platform’s web page. The results of these open consultation activities were more than satisfactory: a large set of ideas, suggestions, descriptions of intended usage, scenarios of typical operation and integration in the daily activities of pupils and teachers were collected.

3 E-ME FUCTIONALITY & FEATURES

3.1 *e-me* structural concepts

3.1.1 The e-me social network: e-me members, personal contacts, and working teams

The *e-me* platform, while open and extensible, is a safe, closed environment in terms of user participation. In that sense it resembles the concept of a club, where members participate in an "invitation-only" mode and need to certify their membership upon entrance. In order to participate in *e-me*, any member of the Greek K-12 community can use their account of the central user authorization system for schools of the Greek MoE and the associated single sign on (SSO) mechanism.

As soon as they enter *e-me*, members find peers who are already in the *e-me* world, either via direct search or through their participation in common activities. Each member has a personal profile, which is configurable to provide only as much information as one is willing to share publicly (Fig. 2a). While viewing a peer's profile, members can ask to connect and become "contacts", which requires the acceptance of both parties. Each member has thus a personal set of contacts (Fig. 2b), who can receive more information through the member's profile, can participate in private or group discussions, can directly share files and folders, etc.

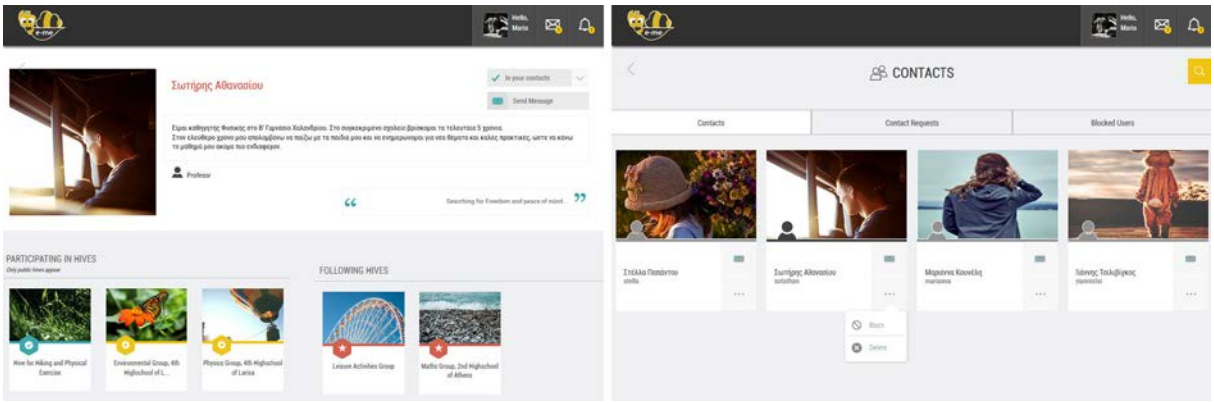

Fig. 2: *e-me* member's profile page (left) and personal contacts (right)

3.1.1 e-me hives

A key structural concept of the *e-me* world is that of "hives", which accommodate smaller, self-contained social learn-places (Fig. 3). Hives can be created by teachers, as regulated spaces for pupils of a classroom, or directly by pupils as closed collaboration spaces and workgroups around a certain topic. Hives are therefore the main work environment for pupils and teachers. They consist of members, a configurable working space that accommodates the preferable look and feel of their creator, a social wall, shared files, and apps. Moreover, hives can take the form of "open communities, where members can opt to join in a public space of common interest.

In terms of members, each hive has (i) a leader who is the initial creator of the hive and can administer all options and moderate content; (ii) assistants, being typical members that participate in the hive with increased rights that allow moderation of selected content; and (iii) members who are either invited or request participation from the hive's leader. The hive's Wall (Fig. 5b) is the main channel of communication among all members. It is open to all to add new posts or comment to existing ones.

The setup of a new hive triggers the automatic creation of a set of files and folders that are shared among all its members with appropriate access rights: a "work" folder is the common place where all members can share and collaboratively work on their files; other "private" folders are only accessible to each member and the hive's leader; a "public" folder can be used by the hive's leader to make publicly available selected files and demonstrate the outcomes and achievements of the members' work. The leader can also opt to install *e-me* apps according to the specific needs and relevance of each app to the hive's objectives. The hives' apps are made available for all members of the hive and can interact with the data and files of the hive.

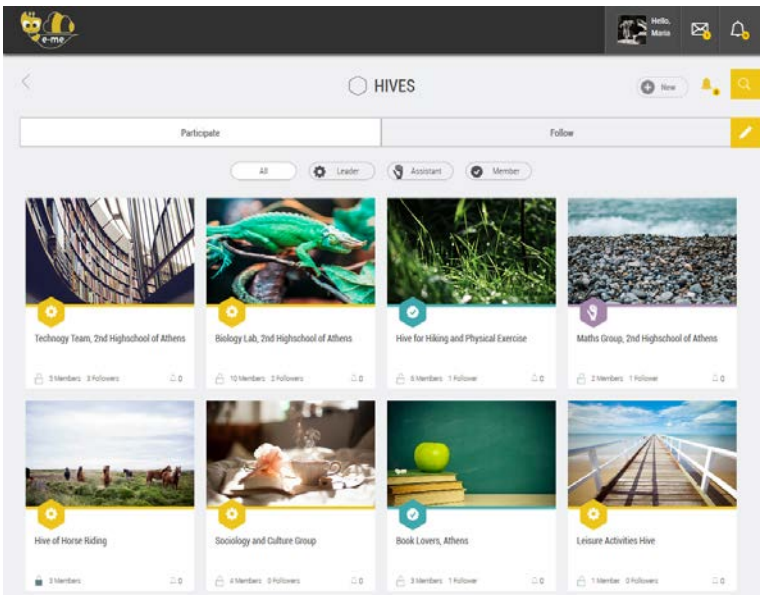

Fig. 3: *e-me* hives

3.1.3 e-me apps

e-me apps extend the functionality of *e-me* in various ways. Similarly to the concept of apps of smart-devices, *e-me* supports the integration of HTML5 applications, which *e-me* members can select to "install" from the "*e-me app store"* and use directly inside the platform.

3.2 Basic *e-me* functionality

3.2.1 e-me Home

The main digital work environment of "*e-me*" is implemented by the *e-me Home,* a web page that resembles the functionality and look-and-feel of smart mobile devices (Fig. 1). Upon successful login, members are redirected to their personal Home, with a customisable, familiar, and intuitive environment that provides quick access to some of the most important features of the platform: icons for installed apps, notifications for new messages or join requests from Hives, direct access to the member's profile, settings and contacts. The arrangement of icons can be tailored according to each member's preferences, together with other parameters like the background image, colours, etc. (see Fig. 4). When space is limited and as the number of apps grows, new "pages" are created to paginate among apps, while members can also opt to arrange related apps into folders. Furthermore, up to five apps can be pinned to the bottom part of *Home.*

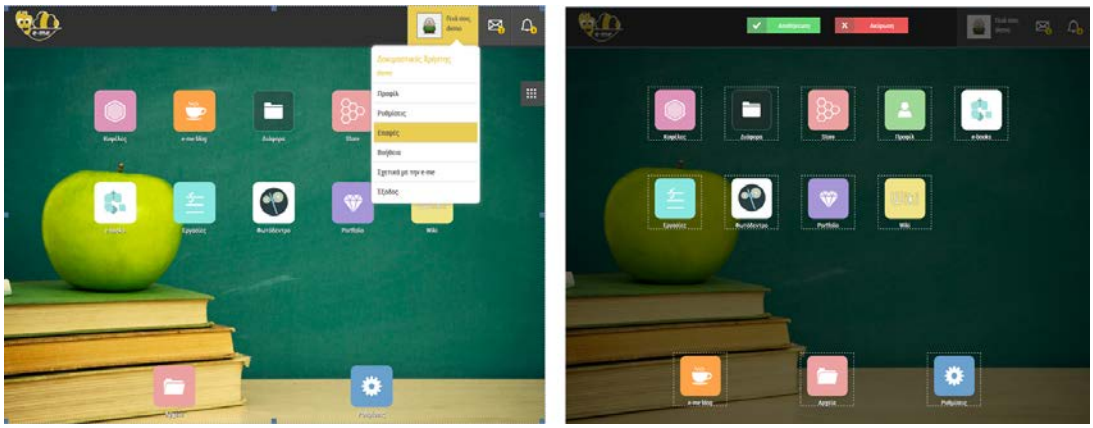

Fig. 4: *e-me* Home in normal (left) and edit mode (right)

3.2.2 e-me files

e-me files provide a Dropbox-like functionality, which facilitates members to store their personal files on a cloud-based storage and share them with their contacts and peers in hives. The stored files are accessible either through the integrated web interface or directly synced in the members' computers or

mobile devices. Each member can then share files or folders with their contacts, take advantage of the collaborative editing features for documents in .odt and .doc format, or use the preview capabilities of *e-me* to preview pdf files, images, text files, Open Document, and Word files directly in their browser.

3.2.3 Communication: messaging, the hives' Wall, chat, and Skype

e-me members can communicate with each other both synchronously and asynchronously (Fig. 5). Through the integrated instant messaging functionality, any *e-me* member can send messages to one or more of their contact(s). A history of messages is maintained and made available as "conversations". *e-me* members can opt out of receiving messages from specific contacts by "blocking" them.

The hive's Wall is the main communication channel among *e-me* hive members. It incorporates similar user interface and functionality to message walls familiar in many social media platforms. Hive members can post or comment on the hive's Wall. The Wall also integrates social moderation by giving the ability to members to report posts or comments they find offensive. Additionally, a direct, text-based synchronous communication channel is offered through the "Chat" *e-me* app. Available only within hives, Chat allows all hive's members to safely exchange real-time messages.

More *e-me* apps will support other types of synchronous communication, while external communication and collaboration services will be also a choice, as these services become connected to *e-me* through the designed connectors and APIs. Indeed, the first of such external services, which *e-me* is already starting to utilize as its main audio-video communication channel, is Microsoft's Skype.

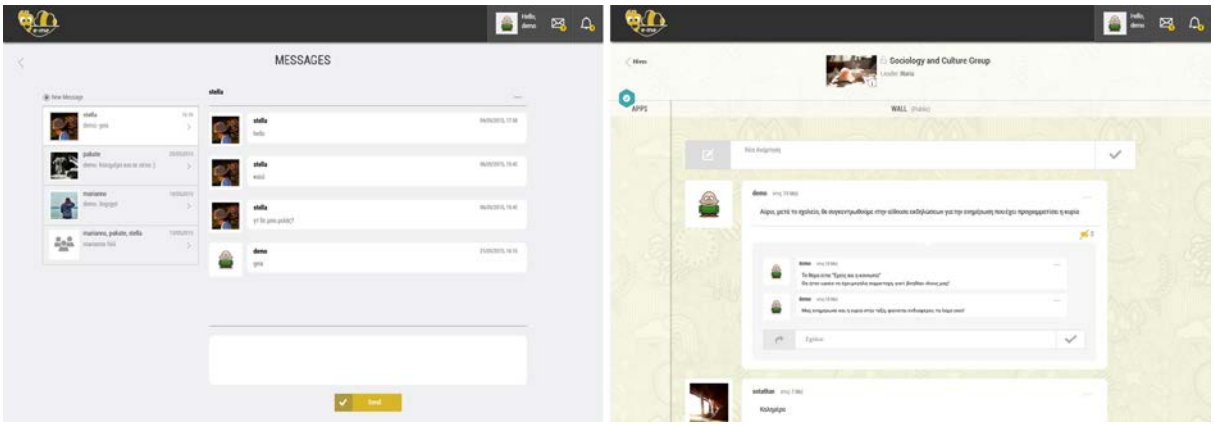

Fig. 5: *e-me* private messaging system (left) and hive's Wall (right)

3.2.4 Publishing, Creation and Co-creation: Blogs, OneNote and Wikis

Addressing one of *e-me*'s key design approaches, to support the creation and publication of pupils' work, a set of Web 2.0 tools have been integrated into the platform. Those tools operate either as embedded *e-me* apps, or through external services seamlessly integrated with *e-me*. A first such tool, based on the integration of the WordPress blogging platform, will allow all pupils and teachers to create their own blogs and publish their work either as individuals or as teams in hives. The published blogs will be optionally publicly available.

In terms of collaborative content creation and note taking, *e-me* will integrate the web-based version of Microsoft's OneNote, which allows the creation of "Notebooks" with one or more pages, each one holding a number of "tabs". Notebooks will be easily shared with contacts or peers inside a hive, allowing co-authoring and collaboration. Content will also be easily clipped and imported from virtually any web page, as well as from multimedia and office files. Furthermore, OneNote will promote collaborative content creation allowing *e-me* members to build Wikis, with easy linking across notebooks, pages, and tabs, versioning support, authoring information, etc.

3.2.5 e-me portfolio

e-me members are able to build and showcase their work through the e-Portfolio *e-me* app. The app relies on an RSS (Rich Site Summary) feed parser that collects and displays the members' achievements by incorporating links to personal files, blog posts, or wikis. A section of the e-portfolio is optionally visible in each member's profile, providing a live stream of activity to all member's contacts.

3.3 Extending *e-me* functionality: *e-me* apps

e-me apps, being a structural design concept of the platform, allow for authorized HTML5 apps created by external parties to gain control of *e-me*'s operational environment, interact with the members' files and data, and overall provide a seamless user experience inside the *e-me* canvas. *e-me* members continue to use the familiar *e-me* environment to interact with content, using consistent user interface, controls, notifications, etc. The well-documented Application Programming Interface (API) of *e-me*, along with emphasis on the support of programmers who wish to create new apps, promotes the development of an ecosystem of "*e-me* apps" that shall be able to operate inside *e-me*. In that context, an *e-me* app becomes a component of a bigger distributed system that grows and expands along with its users' needs.

Along with the creation of the *e-me* API and the associated functionality of the *e-me* app store, even from the early stages of development, a small set of tech-savvy teachers were invited to suggest new *e-me* apps and were encouraged to develop them. The results were more than satisfactory and a small number of *e-me* apps, created from external programmers, is already available. Additionally, selected "core" *e-me* apps have been developed internally. Furthermore, another set of *e-me* apps can integrate external network applications, that exchange data and metadata through open protocols and specifications. Thus, members of *e-me* can use their applications of choice, while their data, personal profiles and contacts still remain inside the private, protected environment of *e-me*.

4 IMPLEMENTING E-ME

In terms of implementation, *e-me* is being developed using Agile development principles and practices that promote adaptive planning, evolutionary development, early delivery, continuous improvement, and encourage rapid and flexible response to change [11]. Furthermore, software development of *e-me* is based on modern Web 2.0 technologies and approaches, enabling an intuitive and mobile-friendly user experience. It makes extensive use of HTML5, Free and Open Source Software (FOSS), open protocols, and specifications. The key elements of the system's architecture are shown in Fig. 6 and described in the following paragraphs along with the development methodology and the arrangement of the hardware infrastructure for the deployment of *e-me.*

4.1 *e-me* system architecture

The system architecture of *e-me* follows the cloud computing paradigm, relying on sharing of resources to achieve coherence and economies of scale. Furthermore, *e-me*'s architecture makes use of concepts from the Service-Oriented Architecture (SOA) architectural pattern, to decompose the system's operation into semi-autonomous services that can be weaved together to provide the complete functionality of the software platform. The core components of the system have been built using the *node.js* open source framework (nodejs.org) for scalable network applications. Persistent data is managed by a distributed *MongoDB* NO-SQL database (mongodb.org), while volatile information such as notifications and session details are handled with a *Redis* data structure server (redis.io). The cloud-based file storage is implemented on-top of the *OwnCloud* open source software (owncloud.org). Usage tracking and analytics are collected and managed using the *PiWiK* analytics server (piwik.org).

Additionally, as already discussed, *e-me* adopts the container architectural paradigm, and the inversion of control software engineering design pattern, allowing custom-written portions of external *e-me* apps to receive the flow of control from the main user interface and safely interact with data of the platform. This is achieved through a well-documented REST API (Representational State Transfer Application Programming Interface), which can be used by authenticated *e-me* apps. Along with the REST API, *e-me* provides a standards-based authentication scheme and authorization mechanism, which allow for efficient interconnection to publicly available services, such as Microsoft Office365, Google Drive, etc.

4.2 *e-me* agile development

The essential characteristic of the agile approach is its explicit focus on creating business value for the intended users. The development process itself becomes a value creation process that relies on active participation of all key stakeholders. The value creation is ensured both through the final product as well as through the process itself [12]. Moreover, agile methods seem to be most effective in respect to keeping low the development times, as well as in respect to the harmonization of project goals with the project deliverables. The user-centered design of *e-me* was emphasized even from the design stage through the requirements elicitation process, to be easily perceived by early adopters who

participated in the pilot trials and the interactive feedback activities. The development team benefited from the agile approach, both in terms of the valuable motivation as a result of immediate visibility of their work and the direct insight concerning the intended usage and the expected functional characteristics of the end product.

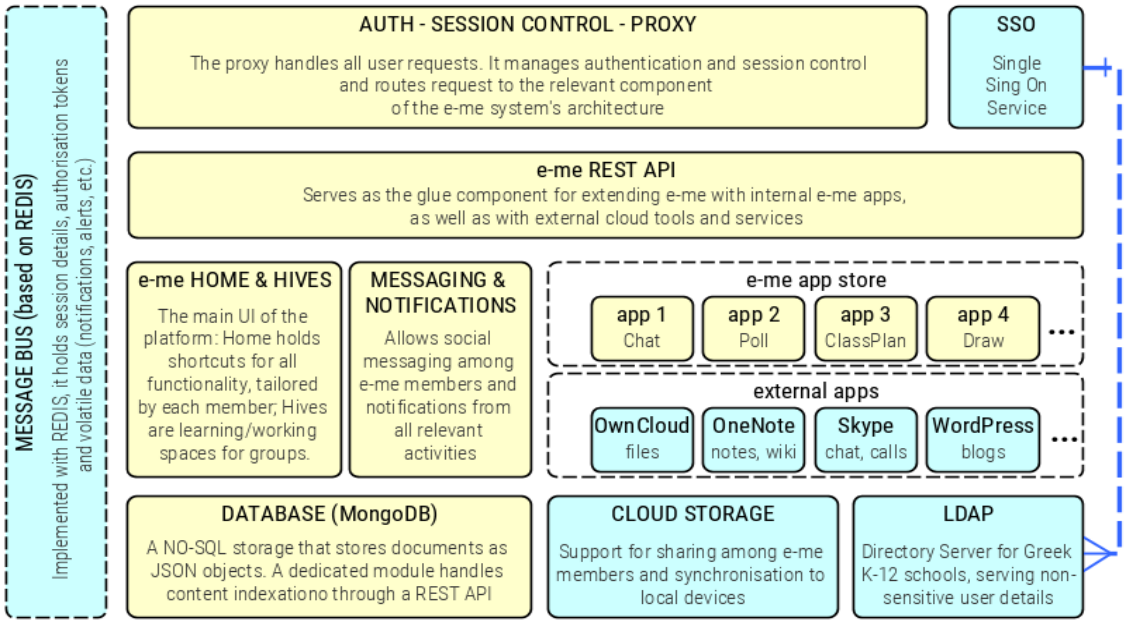

Fig. 6: The main components of *e-me* system architecture

4.3 Infrastructure (Pilot Deployment)

The software deployment for the pilot launch of *e-me* utilized the cloud resources of the ViMa (Virtual Machines) service of the Greek Research Network (GRNET), which allows the deployment of virtual machines (VMs) on-demand [13]. The suitable arrangement of VMs, operated by Debian GNU/Linux, was designed and implemented for the deployment of the components of *e-me*'s system architecture for serving the pilot launch of the platform (Fig. 7).

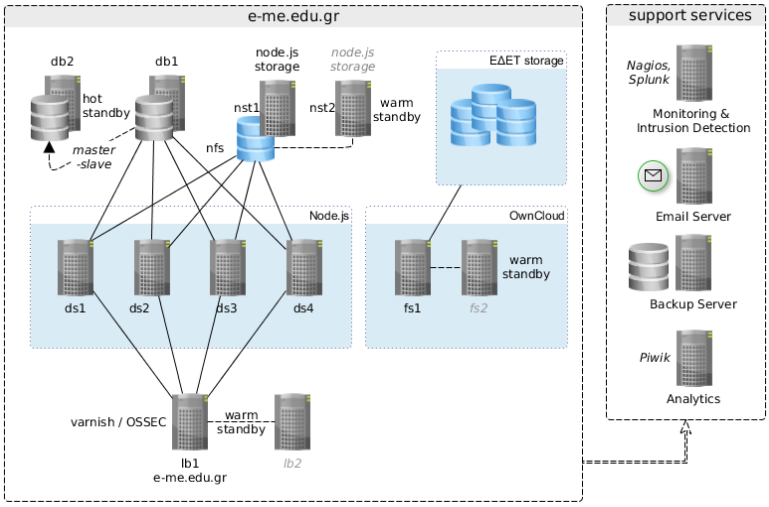

Fig. 7: Cloud-based infrastructure of virtual machines for the pilot deployment of *e-me*

The cloud-based storage subsystem of *e-me*, built on top of OwnCloud, operates on a VM (fs1), while another VM (fs2) has been configured as a warm-standby and can be used as a fail-over in case of outage of fs1. The core components of *e-me*, based on the node.js framework, are deployed on a cluster of lean, though efficient, VMs with limited memory, medium CPU power, small and fast disk storage based on solid state drives. The cluster contains an elastic number of VMs (ds1, ds2, …) that are made readily available according to the usage rate of the platform, operating behind a load-balancer. The load-balancer is based on the Varnish FOSS and makes use of a primary VM (lb1) and a secondary one (lb2) as a warm-standby. All VMs of the cluster have common access to a networked

attached filesystem, shared with the NFS distributed filesystem protocol from a couple of VMs (nst1 as primary and nst2 as warm-standby). The shared filesystem allows for the immediate access to shared resources, as well as for the efficient deployment of new code by the development team using an efficient continuous integration approach based on git (git-scm.com). The operation of the database component is similarly based on a primary VM (db1) and a secondary one (db2), which operates in parallel with the primary one and can directly offer resources and services in a “hot-standby” manner, when the demand reaches a certain threshold or if an outage of the primary VM occurs.

5 FUTURE WORK

After the successful launch of *e-me* and the feedback from its pilot usage, the next steps towards large-scale deployment involve: (i) development of more *e-me* apps, encouraging the software market and the educational community to contribute; (ii) enhancement of the *e-me* API to allow integration of more external services and tools; (iii) sizing and employment of load balancing techniques to increase the scalability of the platform, and (iv) deployment of *e-me* on an infrastructure with the capacity to host an increasing number of members from the Greek K-12 community.

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REFERENCES

[1] Trilling, B. and Fadel, Ch. (2009). 21st Century Learning Skills: Learning for Life in Our Times. Partnership for 21st Century Skills, San Francisco, CA: John Wiley & Sons.

[2] Wikipedia contributors (2015). Learning Management System. Wikipedia. Revised 28 Apr. 2015. http://en.wikipedia.org/wiki/Learning_management_system (retrieved: 5/2015)

[3] Capterra free service. Top LMS Software. http://www.capterra.com/learning-management-system-software/ (retrieved: 5/2015)

[4] Stone, D. and Zheng, G. (2014). Learning Management Systems in a Changing Environment. In Handbook of Research on Education and Technology in a Changing Society.

[5] Harmelen, M. (2006). Personal Learning Environments. Sixth IEEE International Conference on Advanced Learning Technologies (ICALT06) (pp. 815-816).

[6] Wilson, S., Liber, O., Johnson, M., Beauvoir, P., Sharples, P., Milligan, C. (2007). Personal Learning Environments: Challenging the dominant design of educational systems. Journal of e-Learning and Knowledge Society. Vol.3, No 2.

[7] Chatti, M. A., Agustiawan, M. R., Jarke, M., & Specht, M. (2010). Toward a Personal Learning Environment Framework. Int. Journal of Virtual and Personal Learning Environments. 1(4).

[8] Schaffert S. and Hilzensauer W. (2008). On the way towards Personal Learning Environments: Seven crucial aspects. eLearning papers (www.elearningpapers.eu), Nº 9. ISSN 1887-1542.

[9] Attwell, G. (2007). Personal Learning Environments-the future of eLearning? eLearning papers (www.elearningpapers.eu), Vol 2, No 1. ISSN 1887-1542.

[10] Megalou, E. and Kaklamanis, C. (2014), PHOTODENTRO LOR, the Greek National Learning Object Repository. In Proceedings of INTED2014, Valencia (Spain), March, 2014.

[11] Agile Alliance. What is Agile Software Development? http://www.agilealliance.org/the-alliance/what-is-agile/ (retrieved: 18/4/2015)

[12] Paasivaara, M.; Durasiewicz, S.; Lassenius, Ce. (2009). Using Scrum in Distributed Agile Development: A Multiple Case Study. Global Software Engineering, ICGSE 2009. pp.195204.

[13] Koukis, V. Venetsanopoulos, C., and Koziris, N. (2013). Synnefo: A Complete Cloud Stack over Ganeti. USENIX, Vol. 38, no. 5, Oct. 2013.