

INCLUDE

INTELECTUAL OUTPUT 2

Toolkit 2

Platform architecture, development and deployment



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1 Executive Summary

The INCLUDE platform will be designed pointing out a clear software implementation framework. We will examine the state-of-the-art for folders and personalized systems presented, investigating the adaptation of different approaches to INCLUDE goals. INCLUDE architecture is expected to combine design concepts from multi-tier service oriented systems, distributed systems, and blackboard style systems. The system will be deployed in the form of Software as a Service (SaaS) in a cloud platform. We plan to deploy the INCLUDE E-platform as a cloud application hosted in the High Performance Computing cluster at GRNET (<https://hpc.grnet.gr/en/>). The deployment will allow multiple users to access and use the INCLUDE platform over a multitude of devices (tablets, desktops, mobiles).

This deliverable presents the above-mentioned information, offering, at the same time, some initial guidelines for INCLUDE School Managers and Teachers.

2 Introduction

Nowadays, many educational Learning Management Systems (LMS) are available, making difficult to select the appropriate LMS and adapt it in order to fulfill our requirements.

Online learning appears to have reached a tipping point. The most recent Distance Education Enrollment Report from Digital Learning Compass revealed that 30 percent of students at U.S. degree-granting, higher-education institutions enrolled in at least one online course, and nearly half of that population enrolled entirely in online courses. Meanwhile, the most recent Inside Higher Ed Survey of Faculty Attitudes on Technology found that 42 percent of faculty respondents had taught a fully online course for credit—that's up three points from last year and nine from 2018 [1]

Online education can take many forms. Some online courses can integrate online work into in-person courses, while others are fully online. The online material can be a mix of real-time (synchronous) and pre-recorded (asynchronous) lectures, activities, and assessments. In all different formats, educators and administrators use some kind of LMS to develop and assign course content, track

student progress, and measure and report student outcomes. Most LMSes are responsive, highly interoperable, and cloud-hosted.

In order to choose the appropriate LMS, we should take into account the strengths and limitations of each tool or platform, in relation to our requirements. Especially K-12 category faces a unique set of challenges. School districts tend to embrace online education via in-person instruction inflected with digital work. Teachers and administrators choose tools and platforms.

The available LMSes have different penetration in the online learning market. Schoology boasts 20 million users across 50 states of USA and 130 countries. Google brands Classroom as mission control for the 70 million students and teachers who use G Suite for Education. Edmodo tallies more than 87 million members, while, in the US, 50% of high school students and one-third of college students use Quizlet. Moodle, on the other hand, is most popular among colleges and universities, but it has also been embraced by high schools seeking a modular, open-source platform that can scale beyond Schoology or Edmodo [2].

3 Learning Management System

3.1 What is a Learning Management System?

A learning management system (LMS) is a software application for the administration, documentation, tracking, reporting and delivery of educational courses, training programs, or learning and development programs [1]. Learning is the core of delivering any educational or training program by an individual. Management is the stem of the learning program which manages all the schedules for each and every individual. System is nothing but an e-platform to deliver the learning programs [2].

A Learning Management System can be accessed through a web browser using a log-in procedure. An LMS can provide interaction with learners in two modes: online or blended. In case of INCLUDE platform, we will have a blended learning, where teachers and students of each of the partners' schools will be met physically and use the LMS to support learning by providing a space for

material's storing and organising, assessments, electronic activities and resources. In addition, a LMS can deliver learning via computer, tablet and smartphone, making learning procedure affordable and accessible for everybody.

3.2 How does a learning management system work?

As the primary role of a learning management system is to deliver learning to students, typically, there should be at least three different types of log-in (admin, teacher, student). In INCLUDE platform, we will setup five different types of log-in as School Manager (ROL-01), Teacher (ROL-02), Student (ROL-03), Consortium Member (ROL-04) and Administrator (ROL-05). Their role and rights have been described in detail in T1.

3.3 The benefits of a Learning Management System

Technology has the potential to engage and motivate learners more than ever before, supported by the use of an intuitive learning management system, which improves both interaction and results. A modern LMS provides a more efficient and effective way for the education process, employing faster or simpler working methods. The learning management systems encourage interaction between students and teachers, leading to more engaged students, a better quality of education, and higher results.

On the other hand, a teacher using LMS software can produce a complete educational procedure by planning and organizing a course, creating and providing educational e-contents and resources to her/his student in a smooth way, assessing and monitoring student learning rate.

The LMS software can track student activities, such as discussion and collaboration, automatically assess activities and accumulate and present the grades. The LMS environment provides a measure of authentication, security, and privacy. An LMS software also provides information about student activities that can be analyzed to detect patterns that might suggest how students can be better supported.

It can be also used to support traditional face-to-face instruction, as well as blended and online educational environments.

4 Technical Requirements

In the duration of the 1st transnational meeting of INCLUDE project, the requirements for the INCLUDE platform have been discussed among the members of the consortium, taking into account users' needs. The following table describes the functional and non-functional technical requirements for INCLUDE platform. Based on these requirements, the best Learning Management System will be adopted.

ID	Type	Short name	Description
PLT-REQ-01	Functional	Open Source Platform	The LMS should be free to use for everyone and can be setup on private servers.
PLT-REQ-02	Functional	Educational Philosophy Background	The LMS should be built based on a modern pedagogical approach, using a learner-centric system.
PLT-REQ-03	Non Functional	Trusted Worldwide	The LMS that will consist the basis of INCLUDE Platform must be used worldwide, from many and different organizations/communities/e.t.c.
PLT-REQ-04	Functional	Support Teaching and Learning	The LMS should provide a variety of learner-centric tools and collaborative learning environments that empower both teaching and learning.

PLT-REQ-05	Look and feel	Easy to use and up to date	The LMS should provide a simple interface, drag-and-drop features, and well-documented resources, along with ongoing usability improvements, facilitating any user (teacher, student, etc) to work with it. New and updated versions, provided by the open source LMS community, will be periodically adopted.
PLT-REQ-06	Functional	Flexible and customizable	The LMS should be able to be customized to individual needs. The LMS design should allow developers to create plugins and integrate external applications to achieve specific functionalities. Many different types of activities will be available through the platform, such as quizzes, choices (polls), forums, glossaries, wikis, assignments, interactive tools like H5P, etc.
PLT-REQ-07	Functional	Documentation, community and forum support	The LMS should provide community and forum with support and detailed documentation.
PLT-REQ-08	Functional	Language Options	The platform layout should be available (at least) in all the languages of INCLUDE consortium, to be used by any student of these countries.
PLT-REQ-09	Functional	International Standards Compliant	The LMS should be compliant with the following international standards: a) Open Source Initiative (OSI), b)IMS LTI™ Certified and c)SCORM-ADL
PLT-REQ-10	Functional	Interoperability	The LMS should exchange data using open industry standards for web deployments and supports. The LMS must follow the IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata, to set metadata for each educational folder in order to facilitate content' s search and use.



PLT-REQ-11	Functional	Creative Commons licenses	The LMS should accompany the content by Creative Commons licenses.
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5 State-of-the-art for Learning Management System (LMS)

An LMS platform covers almost all the major markets like schools, educational institutions, corporate, government companies, private tuition, institutions, industry, etc., changing the learning perspective of every individual, as all the educational material can now be shared online and be more interactive (video tutorials, quizzes, gamification tools, H5P tools etc.).

An LMS solves all the major learning issues and tracks the progress of individuals, saving a lot of time and money for the organizations. Courses can be created for different topics and can be used to enhance personal skills, to track individual development progress, to reduce the learning cost and time of travel and space arrangements.

In general, the different LMSs have a lot of advantages, some of them are listed below:

- Saves time for the instructors so that they can focus more on each individual's progress and on updating the educational content.
- It gives the freedom to the user to learn from anywhere, according to their will.
- Protect the environment from paper consuming.
- Learning becomes more interesting with the e-tools.
- Easy effective management and information accessibility.

While some of LMS disadvantages are the following:

- Many things that need to be physically done could not be accomplished.
- The impact of face-to-face interaction is reduced.

Different LMS platforms are available in the digital market. In order to decide which of these is more suitable for the INCLUDE platform, we have done some market research for the available LMSes.

5.1 Knowmax

The Knowmax ([Knowmax: Knowledge Management Software For Enterprises](#)) can support large customer teams for effective training. Knowmax enables a consistent knowledge flow across user's assisted channels such as contact center, field, retail as well as Digital Channels such as Website, Mobile App, Chatbots to ensure that customers and support advisors are able to find the right information at the right time.

Knowmax pricing starts at \$12.99 per month, per user. There is not a free version of Knowmax but only a free trial. The deployment could be on Cloud or as an Open API.

5.2 TalentLMS

TalentLMS ([TalentLMS: Cloud LMS Software - #1 Online Learning Platform](#)) is a very flexible learning management system, developed to create a compact, most instinctive, simple and hassle-free learning experience. It is an online e-platform, which is instantly available and provides great scalability and power to spare. The setup of learning programs and materials is not robust enough and there is no control on language variations.

It can be deployed either as Cloud-Hosted or as Open API. The pricing ranges from US \$29 to US \$349 per month when billed annually. A free version is also available, for up to 5 users and 10 courses.

5.3 Moodle

Moodle ([Moodle - Open-source learning platform | Moodle.org](https://moodle.org)) is a popular learning management system developed to provide tutors, administrators, and customers with a single strong, safe and secure integrated platform for developing customized learning platforms. It offers multiple dynamic programs to learn anywhere, anytime.

Moodle offers a free version for its customers and a customized version by quote. It has a customizable site design and layout, embeds external resources, handles the user's responsibilities and permissions. It comes with multilingual capability, multimedia integration, multiple progress tracking functions, and outcomes & rubrics. It has a personalized dashboard, peer and self-assessment, a safe authentication process and mass enrollments with support for open standards. It is not capable of allowing learning programs to be assigned to different categories. It can be deployed on Cloud-Hosted or as an Open API.

5.4 Edmodo

Edmodo ([Edmodo](https://edmodo.com)) offers the best collaborative learning for individuals. The pricing politics varies between \$1 – \$2500 USD per year. It also offers a free trial for its customers. Edmodo is one of the largest learning networks for K-12 students, teachers, and administrators. It is capable of engaging customers throughout the learning program.

It offers a free administrator account which the customer can activate and helps to speed up the learning programs, while it provides assessments, using awards badges, to each student. It helps to create polls for students and creates a community network for better learning and communication. The flexibility to customization needs further improvement. Its deployment can be either on Cloud-Hosted or as an Open API.

5.5 Blackboard

Blackboard ([Blackboard.com](https://blackboard.com)) provides students with a portfolio and has a powerful collaborative integration mechanism and data management for students. It provides good social learning, retention center, enrollments of programs, dynamic contents and active collaboration. The latest upgraded version has some issues with tutor and learner connection setup. The support team cannot provide any help online, unless the local support team has checked first. It offers a free trial for customers to get its functionality flavors, while the price per year for school is US \$2500. Its deployment can be either on Cloud-Hosted or as an Open API.

6 INCLUDE Architecture

6.1 From requirements to architectural considerations/specs

Requirements constitute the foundation of an architectural representation. When architecture has to be designed, project requirements are there to determine the designing technique and the structure goal. Architecture is putting all the pieces together to form a system.

The Technical Requirements presented in the current deliverable, along with the User Requirements, presented and analysed in toolkit 1 are the core requirements which form the whole INCLUDE approach. We included specific functionalities that derive as necessary capabilities from the above requirements, clarifying INCLUDE platform's objectives (design concepts from multi-tier service oriented systems, distributed systems, and blackboard style systems).

Based on requirements' analysis and the defined functionalities, INCLUDE decided to use Moodle, the world's most popular open source Learning Management System with more than 100 million users all over the world, because of its strong community and pedagogical design [5],[6],[7],[8].

The main reasons for choosing Moodle are presented below:

- Truly Open Source : Moodle is free to use for everyone. Moreover, the user is free to take the data and move her LMS to any other platform.
- Sound Educational Philosophy: While tool-centric LMSs provides the user with a list of tools as the interface, Moodle builds the tools into an interface that makes the learning task central. Moodle is built on Social Constructionism pedagogy, including the tools which are truly required in an online learning environment.
- Proven And Trusted Worldwide: Moodle is trusted by institutions and organizations large and small (e.g. Shell, London School of Economics, State University of New York, Microsoft, the Open University).
- Designed To Support Both Teaching And Learning: Moodle delivers a powerful set of learner-centric tools and collaborative learning environments that empower both teaching and learning.
- Easy To Use: A simple interface, drag-and-drop features, and well-documented resources along with ongoing usability improvements, make Moodle easy to learn and use. It also supports mobile version.
- Always Up-To-Date: Moodle is continually being reviewed and improved on to suit the current and evolving needs of its users.
- Community Support: Moodle has the biggest community of developers, teachers, and designers working all around the globe for making improvements to the product named Moodle. In 2015, Moodle Users' Association was formed to facilitate the individual Moodle users to propose and participate in adding new features into Moodle core.
- Great Documentation And Forum Support: Moodle has a thorough documentation for every topic and a lot of community members to support the user through Moodle forums.
- Highly Flexible And Fully Customizable: Moodle's modular setup and interoperable design allows developers to create plugins and integrate external applications to achieve specific functionalities.
- Language Options: Moodle is available in all of the popular languages.
- International Standards Compliant: Moodle has achieved and is compliant with the following international standards: a. Open Source Initiative (OSI), b. IMS LTI™ Certified, c. SCORM-ADL compliant, d. Open Badges.
- Interoperability: Moodle platform is designed to exchange data using open industry standards for web deployments and supports.

6.2 Overview of the architecture

An overview of how the Moodle works, at a technical level, is presented in Figures 1 and 2, while more details are presented in the rest of the section.

Figure 1 depicts the software architecture of Moodle which is based on Client- server model and can be installed in the most famous operating systems (Linux, Windows, Mac) . It needs a Sql database as MySQL and a web server (like apache). The core system uses a scripting language (php) for all of its functionalities. Via http protocol a client can access the moodle site

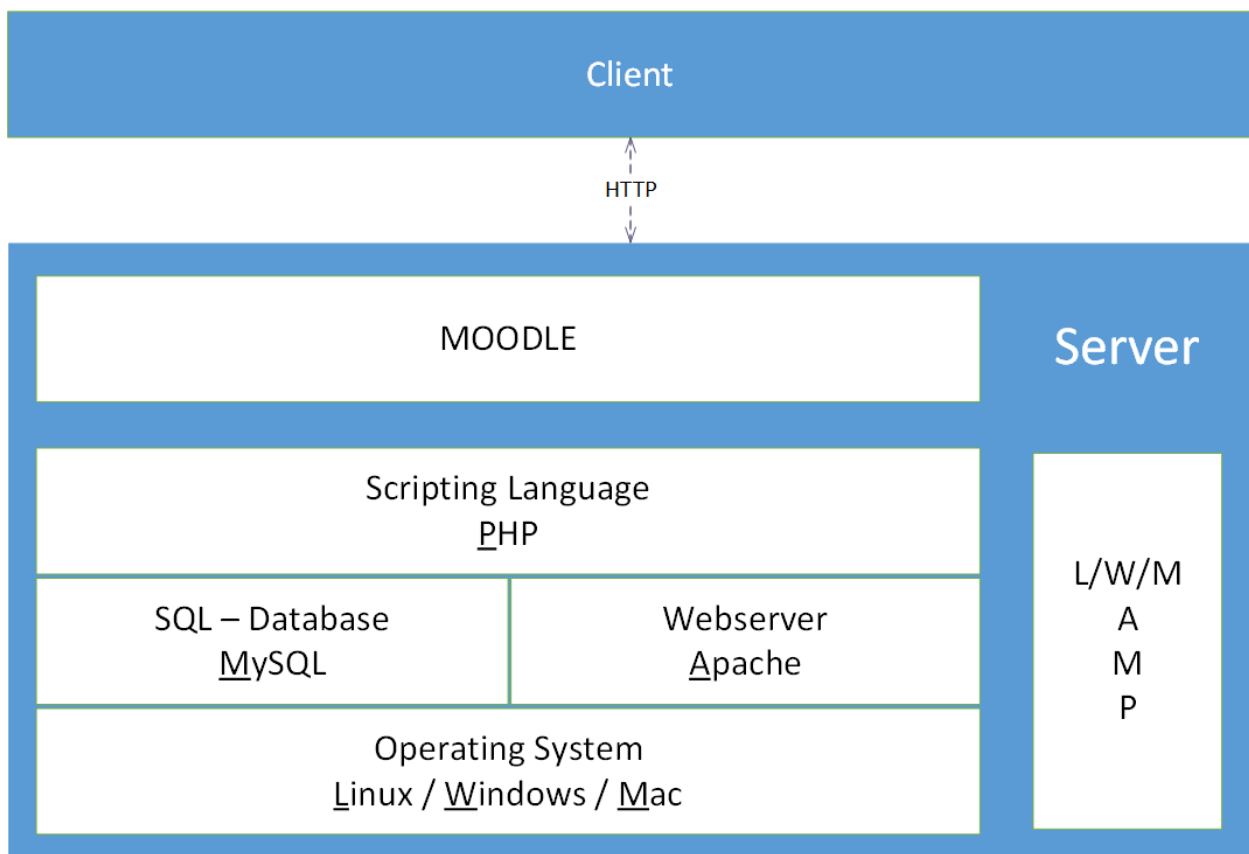


Figure 1: Moodle -Client Server model

(Re: [Moodle documentation: Where is the software architecture documentation?](#))

6.2.1 What is Moodle?

Moodle is open source software which is written in PHP and can run on most common web servers. It requires a database and works with MySQL, PostgreSQL, Microsoft SQL Server or Oracle.

The Moodle project was started by Martin Dougiamas in 1999, while he was working at Curtin University, in Australia. Version 1.0 was released in 2002 and the technologies available at that time were PHP4.2 and MySQL 3.23, creating limits for the architecture of the first version. The current release is the Moodle 3.x series.

Moodle is an open source Learning Management System (LMS) giving teachers and students the tools they need to teach and learn. It comes from a background of Social Constructionist pedagogy [3], [4], however, it can be used to support any style of teaching and learning.

Moodle provides a place online, where students and teachers can come together to teach and learn. A Moodle site is divided into courses. A course has users enrolled in it with different roles, such as Student or Teacher. Each course comprises a number of resources and activities. A resource might be a PDF file, a page of HTML within Moodle, or a link. An activity might be a forum, a quiz or a wiki. Within the course, these resources and activities may be grouped into logical topics, or into weeks on a calendar.

Generally, Moodle tries to interoperate gracefully with other systems that provide other areas of functionality, while it is also possible to use Moodle as a stand-alone system, without integrating it with anything else.

In Moodle, copyright is owned by individual contributors, not assigned to a single entity, although the company Moodle Pty Ltd in Perth Australia, owned by Moodle's founder Martin Dougiamas, manages the project.

6.2.2 Overview of a Moodle installation

A Moodle installation comprises the Moodle code executing in a PHP-capable web server; a database managed by MySQL, PostgreSQL, Microsoft SQL Server, or Oracle; and a file store for uploaded and generated files (the moodledata folder). All three parts can run on a single server; or they can be separated with many load-balanced web-servers, a database cluster, and a file-server.

Moodle is designed to be simple to install on any server that meets these basic requirements. Moodle self-installs once the code has been copied to the web server and a blank database created. Similarly, Moodle can always self-upgrade from one version to the next.

6.2.3 Moodle as a modular system

Like many successful open source systems, the moodle structured as a core system, surrounded by numerous plugins to provide specific functionality.

Plugins in Moodle are of specific types. That is, an authentication plugin and an activity module will communicate with Moodle core using different APIs, tailored to the type of functionality the plugin provides. Functionality common to all plugins (installation, upgrade, permissions, configuration, ...) are, however, handled consistently across all plugin types.

The standard Moodle distribution includes Moodle core and a number of plugins of each type, so that a new Moodle installation can immediately be used to start teaching and learning. After installation a Moodle site can be adapted for a particular purpose by changing the default configuration option, and by installing and removing plugins. A Moodle plugin is a folder of PHP scripts (and CSS, JavaScript, etc. if necessary). Moodle core communicates with the plugin by looking for particular entry points, often defined in the file lib.php within the plugin.

6.2.4 An overview of Moodle core

Moodle core provides all the infrastructure necessary to build an LMS. It implements the key concepts that all the different plugins will need to work with.

Courses and activities

A Moodle course is a sequence of activities grouped into sections. Courses are organised into a hierarchical set of categories within a Moodle site.

Users

Every Moodle user has her own account (see Section 6.3.1) that provides her with all the necessary functionalities.

Groups and cohorts

A cohort in Moodle is a way to organize a collection of users and control their enrollment in a series of courses via the cohort sync enrollment method. A single list of users is maintained and the enrollments will be dynamically updated within any course the cohort has been mapped to. Alternatively, a cohort can be manually enrolled in a course.

Activities and resources

Activities and resources are the individual items that make up a course, the main tools for teaching and learning (e.g. forum, wiki, quiz, page, url and IMS content package). They are installed in the mod folder. Activities are by far the largest type of plugin in terms of amount of code. A forum or wiki system could be a software project in its own right.

Blocks

Blocks are small bits of functionality that can be added to the sides (normally) of other pages and can be found at the blocks folder. Many blocks provide views of data that is available elsewhere.

Themes

The overall visual style of a Moodle site, or of a particular course, or all courses in a category, can be changed by selecting a different theme. Themes can be found at the theme folder and are listed in the [Themes database](#)

Language packs

Moodle is internationalised, so it contains language packs for many different languages. Language packs are normally downloaded and installed via the Moodle administration screens, but they can also be downloaded manually.. Administrators can also change any of the standard user-interface strings, if the terms used in the installed language pack are not appropriate.

Course formats

The different formats (/course/format) control how the structure of the course, a sequence of activities grouped into sections, is presented to the users.



Authentication plugins

Authentication plugins (/auth) control how users log in. Moodle can manage usernames and passwords itself, or use those stored in LDAP or another database. Alternatively, Moodle can use a number of single-sign-on schemes.

Enrolment plugins

Enrolment plugins (/enrol) control which users are enrolled in which courses. Again this can be by synchronising with another system, perhaps a student information system, or it can be tracked internally by Moodle.

Repository plugins

With the repository plugins (/repository), the users can get content (files) into Moodle, either by uploading from their hard drive, or by getting the file from another location on the Internet.

6.2.5 The Moodle database

The Moodle database comprises many tables (more than 250) because the whole database is an aggregate of the core tables and the tables belonging to each plugin. Fortunately, this large structure is understandable, because the tables for one particular plugin typically only link to each other and a few core tables. The Moodle database structure is defined in install.xml files inside the db folder in each plugin.

6.3 Description of different functionalities

6.3.1 Creation of user account

To create a user account, the Moodle administrator can provide authentication. The administrator can create user accounts manually one at a time or upload users in batches with a CSV file. This is the Manual authentication and is enabled by default on a site. The administrator can lock certain fields, set password expiry dates and many other settings.

The other option of authentication is to activate an email-based self-registration. The email-based self-registration authentication method enables users to create their own accounts via the 'Create new account' button on the login page of Moodle. They then receive an email at the address they specified in their account profile to confirm their account.

6.3.2 Spare storage for each user account

Moodle can manage personal storage per user. The Moodle administrator can determine the storage for every user. A teacher can decide the largest size of file that her/his students can upload to a course. In addition, the Moodle administrator can determine sizes available for the teacher to select. Editing teachers or other users may be allowed to upload files larger than the maximum size.

6.3.3 Content organization

A course is a space on Moodle where teachers can add learning materials for their students. A course can display its materials in a number of ways such as weekly sections or named topic sections.

6.3.4 Interface

The Moodle interface is following the chosen template. Most Moodle interfaces divide the browser window in four parts: Header, Navigation bar, Main content area and Footer.

The main heading of the page, usually contains either a navigation menu or the user login info. The navigation bar contains a breadcrumb menu. The Main content area actually displays the educational content, while the footer area can provide info about the Moodle site.

6.3.5 Enhanced with appropriate activities

An activity is a general name for a group of features in a Moodle course. Usually an activity is something that a student will do, interacting with other students and or the teacher. There are many different types of activities in the standard Moodle such as: Assignments, Chat,

Choice, Forum, Glossary, Quiz, SCORM, Survey, etc. Moreover, the Moodle community provides additional plugins which can be installed on the Moodle site.

In the framework of INCLUDE project and because the INCLUDE project supports standalone tools that leads teachers to produce autonomous scenarios, it is strongly recommended to install [H5P – Create and Share Rich HTML5 Content and Applications](#) suite plugin. H5P suite (see Toolkit 1 of IO2) provides interactive tools which are based on a large variety of HTML-based content and technologies. H5P makes it easy to create interactive content by providing a range of content types for various needs. Using these tools, content creators can easily create, deliver and publish HTML5 content on different learning or content management systems and other frameworks.

7 Deployment and development of the platform

The system will be deployed in the form of Software as a Service (SaaS) in a cloud platform. INCLUDE e-platform will be deployed as a cloud application hosted in the High Performance Computing cluster at GRNET (<https://hpc.grnet.gr/en/>). As analysed in the previous sections, it will be based on Moodle, an open source Learning Management System to support INCLUDE community in creating educational folders containing the corresponding educational objects (activities and resources).

8 Guidelines for INCLUDE School Managers and Teachers

Toolkits for INCLUDE School Managers and Teachers will be provided after the installation of INCLUDE platform.

The INCLUDE School Manager toolkit will describe how a school manager can create and modify one individual user account or bulk user accounts in the INCLUDE platform. It will provide guidelines about the control of user preferences and about the creation of cohorts and the enrolment of s of

users in specific cohorts. Guidelines will be also provided regarding how a School Manager can generate reports for the entire team or for a specific team member and how to create assessments and Training Plans and how to access the Content Library and view analytics for her/his team.

The INCLUDE Teacher toolkit will provide information about the creation of courses, and sections and the use of activities and resources of Moodle platform. More guidelines will be provided regarding the use of standalone e-tools and of the INCLUDE educational folders. In addition, the INCLUDE Teacher toolkit will provide information about how to add metadata in the created educational resources and activities. A list of standalone e-tools is provided in Toolkit 1 of IO2.

The educational folders, created in the framework of INCLUDE, will be accompanied with copyright licenses. The INCLUDE consortium will define different types of license which should accompany the content of the INCLUDE educational folder. The [Creative Commons copyright licenses](#) and tools give everyone a simple, standardized way to grant copyright permissions to their creative work.

There are different types of copyright licenses that the Creative Commons provides but all Creative Commons licenses have many important features in common. Every license helps creators to retain copyright while allowing others to copy, distribute, and make some uses of their work — at least non-commercially-, but also ensures creators that they get the credit for their work.

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9 Conclusions-Next steps

The current document describes the initial approach of INCLUDE regarding the platform architecture, development and deployment. Taking into account user and technical requirements and state-of the art, we decided to deploy INCLUDE e-platform as a Moodle-based cloud application hosted in the High Performance Computing cluster at GRNET. The main features of Moodle have been described in the previous sections, along with the main features of the state-of the art.

INCLUDE platform refinement & maintenance will be constantly taking under consideration the evaluation output.

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