A MODEL FOR INNOVATIVE, MULTI-COMPONENT, WEB-BASED PLATFORM FOR DEVELOPMENT, EXPLOITATION AND DISTRIBUTION OF INTERACTIVE E-LEARNING CONTENT AND KNOWLEDGE MANAGEMENT

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Abstract

This article analyses the processes and specific activities for creating and delivering e-learning content, and based on this analysis basic functionality requirements of different types of tools are outlined. Individual tools including Authoring tools, Learning management systems, Libraries of templates, components or ready to use content and Resources for virtual communication are grouped depending on the stage of e-learning provision. An analysis of the most popular and used software solutions has been performed. A model for innovative, multi-component, web-based platform for the development, exploitation and distribution of interactive e-learning content management has been developed. The main purpose of the model is to develop a platform that allows creation and distribution of specific, personalized and motivating learning content, leading to the enhancement of precisely defined competences or skills of the learner.

Keywords: e-learning platforms, complex e-learning infrastructure, e-learning integration.

1 INTRODUCTION

E-learning fully transforms the way knowledge is transferred and comprehended by the learners. Unlike the traditional method of teaching, e-learning makes absorbing the materials easy and effective. With the rapidly accelerating technological change, lifelong learning becomes a necessity. It can be addressed in the most adequate way by e-learning.

Summarizing all reviewed definitions authors define e-learning as using Internet to access learning materials, to interact with the content, teaching staff and other students, to get support and knowledge in study process and on the base of acquired knowledge make their own opinion [1].

Providing processes in the field of modern e-learning requires participants in this process, including subject-matter experts, Instructional designers, eLearning developers, trainers and administration and management of the training institution to have, in addition to competencies in the field of instructional design, a variety of skills in using the many different sophisticated tools to prepare a modern interactive online course. Curriculum developers and HR teams need to become graphic designers, video editors, and even web designers and developers to be able to build multimedia interactive learning accessible from different devices, browsers, and operating systems.

Creating and delivering effective and engaging user learning content requires the use of several key tools, including:

Authoring tools - To create a proper course for E-learning, you need an authoring tool to facilitate this work. The definition of authoring tool is a program that helps you write hypertext or multimedia applications and allows you to create a final application by linking objects, such as a paragraph of text, an illustration, or a song. By defining the objects' relationships to each other, and by sequencing them in an appropriate order, authors (those who use authoring tools) can produce attractive and useful graphics applications [2].

Learning Management Systems (LMS) - Throughout the distance learning process, Learning Management Systems (LMS) also known as the Virtual Learning Environments (VLE) or Learning Platforms have a significant role. The LMS could be defined as: “a software application or Web-based technology used to plan, implement, and assess a specific learning process” [3]. LMS are specialized training systems based on modern internet and web technologies [4]. On the other hand, it is believed that LMS arise due to the need to provide organizational, administrative and educational elements, as well as the inclusion of a variety of technological components [5].
Virtual Classrooms - A virtual classroom not only delivers course materials to the learners, but also provides a live, contextual and interactive environment for them. In addition, teachers can control the learning and teaching process as they do in the traditional classroom [6].

E-learning Assets Stock Sites – Dedicated sites that enable authors to use both video and audio elements, images, entire course templates, individual e-courses, and ready-to-use content.

Integrating all of these components into a single, integrated knowledge management system is not an easy task that requires a detailed analysis of all the necessary functionalities of the different types of users involved in the learning process. An additional challenge is to design a model to ensure integrity between modules/subsystems while at the same time making it easy to use.

2 METHODOLOGY

The methodology we use to develop an innovative, multi-component, web-based platform for the development, exploitation and distribution of interactive e-learning content and knowledge management is based on a detailed analysis of the necessary functionalities to ensure the different stages of e-learning. On the basis of the detailed functionalities, the degree of compliance of the proposed software solution with the requirements defined in the previous stage is assessed. After analyzing the missing components of the already developed products, a multi-component, web-based platform for development, exploitation and distribution of interactive e-learning content and knowledge management is developed to comprise and provide all key functionalities in one place.

2.1 Analysis of the processes of creating and delivering e-learning content

As a first step in building a model of a complex infrastructure for the preparation, creation, supply, communication, and reporting of online knowledge, an analysis of the processes and specific activities related to the creation and delivery of e-learning content has been carried out. Based on this analysis, the basic requirements for the functional capabilities of different types of instruments are also presented, the functional requirements being grouped according to the stage of e-learning provision. Four main stages have been identified that consistently represent the whole process of e-learning provision.

Stage 1 - Creating learning and evaluative content - the basis for quality and efficiency is the process of producing e-learning content. At this point, the learning tools, content libraries and stock banks and collaboration tools between the participants in the e-course preparation process (content authors, training designers, e-learning developers, trainers, etc.) are crucial.

- **F1 - Development and organizing of learning content (courses, modules, topics)** - tools for building learning content, multimedia and interactive resources, interacting to the maximum extent with the trainee.
- **F2 - Personalized/adaptive learning and gamifications** - tools for building and delivering customized learning content, customized user learning path.
- **F3 - Libraries with templates, elements or ready-to-use content** - online stores offering both interactive learning templates and ready-to-use e-learning content.

Stage 2 - Access management and integration - For the distribution of e-learning, learning management systems are used with one of the most important processes being access management. Of major importance for the entire learning process is the automation of access by different factors (user profile data, paid courses, results from other courses, etc.), flexible user rights management and access security.

- **F4 - Security, access control and speed optimization** - ensuring the security of personal data, providing access to different types of users, defining access rights, etc.
- **F5 - Integrity** - tools for building integration with other systems, SCORM support, billing modules, integration with human resources management systems and systems for authentication, etc.
Stage 3 - Conducting training - a real process of providing knowledge, apart from distributing the developed content from Stage 1, is also providing the opportunity for communication between the individual participants in the learning process. Also important are automatic notifications and notifications based on artificial intelligence AI. The main tasks of the e-learning systems and the virtual communication tools in them are related to the ability to effectively represent the communication processes from the conventional attendance training to the electronic one.

- **F6 - Communication** - tools for communicating and collaborating among users, simulating to the maximum extent the learning process in the present form.
- **F7 - Informing and notifications** - a virtual environment for receiving notifications and informing consumers about upcoming events, expiring deadlines, etc.

Stage 4 - Monitoring and completion of the training - the evaluation process (both ongoing and final) is crucial in conducting e-learning. Opportunities to use alternative interactive evaluation components and powerful tools to configure evaluation components and their weight in combination with performance monitoring tools (attendance and performance statistics, etc.) and tools for generating customized and automated reports are key to measuring the effectiveness and efficiency of eLearning.

- **F8 - Evaluation and certification** - a test complex that provides evaluation of the knowledge, skills and competences of the learners, provides them with feedback and provides administrators with tools for analyzing and processing the results.
- **F9 - Reports and statistics** - tools for reporting and analyzing the attendance, progress and success rate of the trainees for each of the training courses and for the system as a whole.
- **F10 - Portfolio management** – tools for the accumulation of illustrative material from the learner's presentation, such as coursework, projects, group assignments, results of evaluation components and accumulated elements of the gaming process.

2.2 Analysis of popular software solutions

An analysis of the most popular and used software solutions (paid or open source) has been performed for each of the individual tool groups, taking into account the degree of compliance with functional requirements for each of the stages defined in the previous section.

Analysis includes popular solutions that offer different parts of the eLearning process. Solutions are grouped into three main groups:

**For Authoring tools:** Adobe Captivate, Articulate Storyline, iSpring

**For e-learning systems:** Moodle, Docebo, Adobe Captivate Prime, TalentLMS, iSpring Learn, Blackboard, SAP Litmos

**For banks with specialized training elements and templates:** eLearning Brothers, eLearningArt, Adobe Stock

In conducting the analysis, the methodology used for the evaluation of e-learning management systems is based on the specific needs of the organization [7], and for the purposes of this analysis, all evaluation criteria have been defined with the same degree of influence. Table 1 below shows only the overall results of the evaluation of individual functional groups. For an objective evaluation, each of the functional groups is evaluated on a number of key attributes.
Table 1. Results of comparative analysis of complex e-learning solutions.

<table>
<thead>
<tr>
<th>Software solution</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Total (Max 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F1</td>
<td>F2</td>
<td>F3</td>
<td>F4</td>
<td>F5</td>
</tr>
<tr>
<td>Moodle</td>
<td>9.11</td>
<td>9.87</td>
<td>0.00</td>
<td>9.87</td>
<td>6.08</td>
</tr>
<tr>
<td>Docebo</td>
<td>9.87</td>
<td>9.62</td>
<td>1.27</td>
<td>10.89</td>
<td>7.59</td>
</tr>
<tr>
<td>TalentLMS</td>
<td>6.84</td>
<td>8.35</td>
<td>1.27</td>
<td>10.38</td>
<td>6.08</td>
</tr>
<tr>
<td>Blackboard</td>
<td>5.82</td>
<td>7.85</td>
<td>0.76</td>
<td>9.62</td>
<td>4.81</td>
</tr>
<tr>
<td>SAP Litmos</td>
<td>6.58</td>
<td>7.85</td>
<td>0.00</td>
<td>10.38</td>
<td>5.32</td>
</tr>
<tr>
<td>Adobe Captivate + Captivate Prime</td>
<td>9.87</td>
<td>9.62</td>
<td>2.28</td>
<td>10.38</td>
<td>7.09</td>
</tr>
<tr>
<td>iSpring + Learn</td>
<td>9.11</td>
<td>7.59</td>
<td>2.78</td>
<td>8.35</td>
<td>4.56</td>
</tr>
<tr>
<td>Articulate Storyline</td>
<td>10.89</td>
<td>2.28</td>
<td>6.33</td>
<td>0.00</td>
<td>1.27</td>
</tr>
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<td>eLearning Brothers</td>
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<td>8.86</td>
<td>0.00</td>
<td>1.27</td>
</tr>
<tr>
<td>eLearningArt</td>
<td>0.00</td>
<td>0.00</td>
<td>7.59</td>
<td>0.00</td>
<td>1.27</td>
</tr>
</tbody>
</table>

The results of the analysis show that there is no single integrated software solution available to offer all the tools needed by the individual participants in the process of creating, delivering, receiving and certifying accumulated knowledge through online training.

Individual software solutions are specialized and heavily crowded with many almost unusable features that greatly confuse consumers. There is currently no unified application to provide the process of preparing, creating, offering, providing, communicating, and reporting knowledge.

3 RESULTS

As a result of the implemented analyses we have developed a model of an innovative multi-component web based platform for development, exploitation and distribution of interactive e-learning content management for knowledge management. The main objective of the model is to develop a platform to allow the creation and distribution of specific, personalized and motivating learning content leading to the enhancement of precisely defined competences or skills of the learner, to be created, delivered, consumed and perceived in the most time-saving way possible for the customers. The model includes modules for: Learning Content Creation, Learning Management, Learning Content Sales and Order Module, Competency Management Module, Payment Management Module, Virtual Communication Module, User Profile Management Module, and Portfolio Management Module. Through the implementation of the multi-component web-based platform, the entire e-learning process can be implemented in one place, which will greatly facilitate all participants in the process.

A scheme of interaction and flow of information between the different modules of the integrated platform model has been developed as well as the basic functions of each of the modules.
**AT – Authoring Tool** – Learning Content Creation Module - The purpose of this module is to provide a set of tools that enable the creation of interactive, motivating learning content leading to the enhancement of precisely defined competences or skills of the trainee. Provides a means of communication between different types of participants in the learning process. The module should allow the use of developed content, both in the platform's LMS and in systems already used by the customer.

**Key Features:** Creating Interactive Multimedia Training Content, Linking Competences with a Learning Object, Creating Components for Verification and Validation of Competencies.

**Interaction with other modules:**

**FROM:**
- LMS – Instant Content Creation, CM - Accepts Purchased Content for Additional Editing, COM - Accepts Competences to Describe Training Content.

**TO:**
- LMS - Sending content to LMS for own purposes, CM - Sends content for sale and overflow, PM - Sends whole content or demo, Automatic portfolio update, VC - Sends message via VC for material changes, BM - Sends content for pricing, TP - Sends content to external systems.

**LMS - Learning management system** - The purpose of this module is to provide learning content to learners and to give learners control on the learning process. LMS serves to manage the learning process, to facilitate the communication between users, and to gather data for evaluation, reporting, statistics and providing personalized training. Through the LMS courses catalog (CC), a single place is created where all content authors can offer their training. Some of the data is transformed into a training file and transferred to PM - Portfolio Manager.


**Interaction with other modules:**

**FROM:**
- AT - Accepts content in LMS for its own purposes, CM - Accepts content for building courses, COM - Extracts competences for describing in the course cognition cube, BM - Notification of paid course.
CM - Content Market - Learning content market - The purpose of this module is to create a marketplace for offering and ordering learning content. In it, the various stakeholders can perform presentation, rental, hire, sale and purchase of learning content as well as the ability to order and develop training content on demand. The module should allow the use of purchased content in both LMS and external user systems.

**Key features:** Selling already developed content, Selling a configured course in LMS, Ordering new content, Selling templates, Selling interactive elements, Providing free resources.

**Interaction with other modules:**

**FROM:**
- LMS - Providing Content for Review, AT - Sends content for sale and reuse, BM - Accepts priced content for sale.

**TO:**
- LMS - Submit content for course building, AT - Sends purchased content for additional editing, PM - Sends entire content or demo, UM - Sends the user to pay for selected / ordered content, TP - Sends purchased or branded content or demo in external LMS, BM - Sends the user to pay for selected / ordered content.

BM - Billing management - The purpose of this module is to provide the ability to manage financial relationships both between users and the system owner as well as between users themselves. A key option is to provide payment infrastructure and online payment tools.

**Key features:** Paying for content and access, Receiving sales revenue, Configuring deductions, Automatic payments, Billing.

**Interaction with other modules:**

**FROM:**
- LMS - Course price / s, LMS access packet price, AT - Accepts content for pricing, CM - Accepts orders to pay for selected / ordered content

**TO:**
- LMS - Notifies LMS for Paid Course, CM - Sends priced content for sale

VC - Virtual Communication - The purpose of this module is to provide audio and video connectivity between users as well as additional tools such as whiteboard and screen sharing. This module provides the ability to quickly retrieve content from both the course library and instant purchase from the content exchange. This module also assists users in handling the system.

**Key features:** Providing LMS Dashboard Communication Panel, Message Management, Manage notifications, Manage calendars, Provide communication capabilities in LMS, Provide communication capabilities in AT, Provide communication capabilities in CM.

**Interaction with other modules:**

**FROM:**
- LMS - Automated course event coverage, AT - Receiving a VC message for changes of the material, PM - Acceptance of follow-up notification data to users.

**TO:**
- UM - Sends messages and notifications to the user's dashboard (created in VC or received from other modules)

UM - User Management - Managing Customers Profiles - This module aims to centralize personal information for users. All system modules are accessed from a single account, depending on user actions and access rights granted by the system administrator or third parties (existing users). A user can perform more than one role in the different modules of the system or in separate parts of the system.

**Key Features:** Access Rights Management, Dashboard, Statistics

**Interaction with other modules:**

**FROM:**
- LMS - accepts information to access course, CM - Sends the user for selected / ordered content, VC - Receives messages and notifications to the user's dashboard, PM - Sends statistics
TO: PM – Sends profile data.

**PM - Portfolio Manager** - Portfolio Management - This module aims to be a showcase for users. It serves as a demonstration and proof of the available knowledge and skills. Provides different portfolio types. They can be generated manually or created automatically by different user activities in other modules unless they explicitly disallow it.

**Key Features:** Automatic Portfolio Creation and Management, Manual Portfolio Creation and Management, Portfolio Impact, Portfolio Export.

**Interaction with other modules:**

- **FROM:** AT - Accepts entire content or demo, Automatic portfolio update, LMS - Accepts offered courses / recorded courses, Accepts acquired competencies/learning outcomes, COM - Accepts custom user competencies, UM - Accepts whole content or demo.
- **TO:** VC - Sends data for subsequent user notification, BM - Sends information about advertising revenue and paid services, TP - Sends content indexing to search engines, UM - Sends statistics.

**COM - Competence Management** - This module provides competence management cubes for different professions. The term "Competence" is used as a unifying concept of knowledge, competencies, skills, ability, motivation. Competence cubes are derived both automatically from standardized ones: OnetOnline (USA), ESCO (EU), and are built by consumers for those real-life activities that cannot be classified or developed too dynamically to be standardized. The module also allows the upgrade of standardized cube computations, with clear distinction of the type of each competence. Ultimate Competence Units are used to describe the learning outcomes when planning the course in LMS training courses and, on the other hand, to describe training content in AT (Content Accumulation and Content for Competency). In this way, you can visualize the coverage content of each training course and how much it covers / complements the crammed cube for the profession.

**Key Features:** Importing Competencies from Third Parties, Updating Competencies, Creating New Competency Cubes, Creating Competencies.

**Interaction with other modules:**

- **FROM:** LMS - Obtaining Competencies Used in the Competency Cube of the Course, AT - Obtaining Competencies Used to Describe Content.
- **TO:** LMS - Competence extraction to describe in the competence cube of the course, AT - Sends competencies for describing training content, PM - Sends data about customized competencies to users.

**TP - Third parties** - Out-of-platform systems that interact with the individual modules, in the context of the developed model, these are: Competence databases, Other e-learning systems, anti-plagiarism modules, etc.

The proposed in the model structure of a complex web-based Software as a Service (SAS) platform provides an environment for interaction between trainers and learners. The platform consists of a powerful Internet-based tool for building interactive multimedia learning content (AT), which is supplied with modules from the Sales and Order of Learning Components Module (CM).

The ready-to-use trainings can be delivered to the learners through an e-learning management system (LMS), which provides a learning environment for delivery of learning content and a virtual communication environment (VC). The eLearning Platform (LMS) can be used both for in-house training and for a wide range of electronic courses through the Integrated Public Course Catalog (CC), User Management Module (UM) and Integrated Payment Methods (BM) where trainers can effortlessly offer their training for sale.

### 4 CONCLUSIONS

This article analyses the processes and specific activities for creating and delivering e-learning content, and based on this analysis basic functionality requirements of different types of tools are outlined. Individual tools including Authoring tools, Learning management systems, Libraries of templates, components or ready to use content and Resources for virtual communication are grouped depending on the stage of e-learning provision.
An analysis of the most popular and used software solutions (paid or open source) has been performed for each of the different tool groups, taking into account the degree of compliance with the functional requirements defined in the previous step.

The results of the analysis performed in this article show that there is no available single integrated software solution which includes all the tools needed by the various participants in the process of creating, delivering, receiving and certifying received knowledge through online training.

Taking into account the analyses, a model for innovative, multi-component, web-based platform for the development, exploitation and distribution of interactive e-learning content management has been developed.

The main purpose of the model is to develop a platform that allows creation and distribution of specific, personalized and motivating learning content, leading to the enhancement of precisely defined competences or skills of the learner. The content has to be created, delivered, consumed and perceived by individual users in the most time-saving way.

Presented is a diagram of interaction and information flow between modules of the model of the integrated platform.

Through the implementation of the multi-component web-based platform model, the whole process of e-learning provision can be achieved in one place, which will greatly facilitate all participants in the process.

REFERENCES


