Octopus: A Collaborative Environment Supporting the Development of Effective Instructional Design

By

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Abstract

Instructional designers and teachers share a common goal: making instruction appealing, effective and maximizing the learning outcome. Towards this goal their roles are complementary and integral. However, despite the technology for instructional design available (standards and tools), instructional designers and educators are still working separately, leading to poor instructional design that can result in ineffective encounters, inefficient activities, and finally unmotivated learners. A main reason for that is that current technology (e.g. standards and tools) does not meet their needs and expectations. On the one hand the IMS Learning Design standard is very complex for instructional designers and teachers to understand and use as a common language and on the other hand current tools, especially those close to the standard are not highly usable. This calls for usable tools or environments supporting the educator and instructional designers' needs and collaboration among them, while staying compatible with standards. In this thesis, we present Octopus, a web application providing an environment to support the collaboration of instructional designers and educators and the development of educational templates and scenarios, that can be used and reused in different educational contexts. Octopus pays special attention on the users' needs (instructional designers and teachers), while it stays compatible with standards. Thus, usability studies have been performed from the earliest development steps, while a number of workshops have been organized with the participation of pedagogy experts and teachers. Octopus has been used in three EU projects, where a large number of educational templates and scenarios have been developed. Furthermore, Octopus has been used to implement the laboratory section of an educational design course at the Pedagogical Department of Pre-school education of the University of Crete. During this course 240 students (80 students per semester for three semesters) used Octopus to design their educational practice sessions and document their implementation.

Publications & Technical Reports

A number of papers presenting work performed in the context of this thesis have been published in the following Conference Proceedings:

1. Octopus: A Collaborative Environment Supporting the Development of Effective Instructional Design Publication Authors: **Mylonakis M**., Arapi P., Moumoutzis N., Christodoulakis S., Ampartzaki M. Publication Info: In Proceedings of International Conference on E-Learning and E-Technologies in Education (ICEEE2013), Lodz, Poland, on Sept. 23-25, 2013.

2. "Metadata Management and Sharing in Multimedia Open Learning Environment (MOLE)"Publication Authors: **Mylonakis M.**, Arapi P., Pappas N., Moumoutzis N., Christodoulakis S.Publication Info: In Proceedings of Metadata Semantics and Research Conference 2011 (MTSR2011) - Special track on Metadata & Semantics for Learning Infrastructures, Izmir, Turkey, October 2011

3. The Multimedia Open Learning Environment (MOLE)" Publication Authors: Pappas N., Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S. Publication Info: In Proceedings of EDEN2011 Open Classroom Conference, Athens, Greece, October 2011

4. COLearn: Supporting Collaborative Learning on top of Existing Learning Infrastructures. Publication Authors: Stylianakis G., Moumoutzis N., Arapi P., Mylonakis M., Christodoulakis S. Publication Info: Bulletin of the IEEE Technical Committee on Learning Technology, Volume 17, Number 1-2, April 2015 Publication Type: Journal Publications

5. COLearn and open discovery space portal alignment: A case of enriching open learning infrastructures with collaborative learning

capabilities Publication Authors: Stylianakis G., Moumoutzis N., Arapi P., Mylonakis M., Christodoulakis S. Publication Info: 2014 International Conference on Interactive Mobile Communication Technologies and Learning (IMCL) 2014 Publication Type: Conference Publications

6. “The IQTOOL Project: Developing a Quality Assurance Tool for Elearning” Publication Authors: Moumoutzis N., Christoulakis M., Arapi P., **Mylonakis M**., Christodoulakis S.Publication Info: In the Proceedings of LOGOS Open Conference `New Technology Platforms for Learning - Revisited`, Budapest, Hungary, January 19-20, 2009

7. “Design, Implementation and Experimental Evaluation of a Pedagogy-Driven Framework to Support Personalized Learning Experiences” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Stylianakis G., Theodorakis G., Christodoulakis S.Publication Info: In the Proceedings of the 2nd LOGOS Open Workshop on Cross-Media and Personalized Learning Applications with Intelligent Content (LAIC 2008) in conj. with AIMSA2008 Conference, Varna, Bulgaria, September 2008

8. “A Framework and an Architecture for Supporting Interoperability between Digital Libraries and eLearning Applications (1)” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S.Publication Info: In the Proceedings of the DELOS Conference on Digital Libraries, Tirrenia, Pisa, Italy, February 2007

9. “A Pedagogy-driven Personalization Framework to Support Adaptive Learning Experiences” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S.Publication Info: In the Proceedings of the 7th IEEE International Conference on Advanced Learning Technologies (ICALT 2007), Niigata, Japan, July 2007

10. “Supporting Personalized Learning Experiences within the LOGOS Cross-Media Learning Platform” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Theodorakis G., Stylianakis G.Publication Info: In the Proceedings of the Workshop on Cross-Media and Personalized Learning Applications on top of Digital Libraries (LADL2007) in conj. with ECDL2007 Conference, Budapest, Hungary, September 2007

11. “A Framework and an Architecture for Supporting Interoperability between Digital Libraries and eLearning Applications” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S.Publication Info: Book chapter in Digital Libraries: Research and Development, Lecture Notes in Computer Science, Springer Berlin/Heidelberg, Volume 4877/2007, pp. 137-146 2007

12. “A Pedagogy-driven Personalization Framework to Support Automatic Construction of Adaptive Learning Experiences” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Theodorakis G., Christodoulakis S.Publication Info: In the Proceedings of the 6th International Conference on Web-based Learning (ICWL 2007), Edinburgh, United Kingdom, August 2007

13. “Interoperability of eLearning Applications with Digital Libraries” Publication Authors: Christodoulakis S., Arapi P., Moumoutzis N., **Mylonakis M.**, Patel M., Kapidakis S., Papatheodorou C., Arahova A., Vagiati B., Konsolaki H.Publication Info: Poster on the 10th European Conference on Research and Advanced Technology for Digital Libraries (ECDL 2006), DELOS Research Activities 2006, C. Thanos (Eds.), DELOS Network of Excellence: pp. 83-85, Alicante, Spain, September 2006

Moreover, several parts of this work have been included in the following technical reports of Natural Europe and ODS Project projects:

ODS Project (2013D7.5). D7.5: Pilot Deployment of an Open Linked Learning Content Infrastructure. First Version, March 2013. CIP-ICT Policy Support Programme – 297229

ODS Project (2015D7.5). D7.5: Pilot Deployment of an Open Linked Learning Content Infrastructure. Third Version, September 2015. CIP-ICT Policy Support Programme - 297229

Dedicated to my family and my friends

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Chapter 1. Introduction

1.1. General

One of the main challenges that teachers are facing is “what” and “how” to teach learners (with different needs and characteristics) to keep them motivated and maximize the learning outcome. The Instructional Design field focuses on these questions. As a process, instructional design is an engineering activity for which the artifact is some instructional product to help a learner acquire some knowledge or skill (Merrill, 2001). This activity takes into account theories, models, methodologies and tools for instruction and applies strategies and techniques derived from them to the solution of instructional problems (J. Bourdeau, and R. Mizoguchi, 2002). Instructional design is a systematic and reflective process of translating principles of learning and instruction into plans for instructional materials, activities, information resources and evaluation (P.L. Smith, and Ragan T.J). The sound practices and models provided by Instructional Design, once modified for use by working teachers, can be used to design effective instruction in any content area (P. L. Rogers, 2002).

Instructional designers and teachers share a common goal: making instruction appealing, effective and maximizing the learning outcome. Towards this goal their roles are complementary and integral. However, instructional designers and teachers are still working separately. In most cases, the instructional design process is performed completely by teachers lacking time and advanced pedagogical knowledge. That leads to poor instructional designs, where a sound pedagogical approach (the “how” to teach) is absent and the focus is mainly on “what” to teach. This can result in ineffective encounters, inefficient activities, and finally unmotivated learners. Putting learning needs on the sidelines can have serious long-term effects.

Technology could function as a common language between instructional designers and teachers providing effective communication between them as well. Standards could provide a common conceptual model and

representation for instructional designs and ensure interoperability and reusability of educational templates and scenarios in diverse systems and contexts. This could significantly increase the effectiveness of the instructional design process by reducing the cost and time needed for instructional design and at the same time improving the quality of instructional designs.

However, despite the technology available (standards and tools) for instructional design, instructional designers and teachers insist not using it extensively. One reason for that, especially for the older instructional design users, is the fear of changing the way they are used to work to organize instruction (e.g. working alone, using paper format, PowerPoint presentations etc.). But even the most brave and eager of them are skeptical and not willing to use technology for designing instruction.

The dominant standard for instructional design is IMS Learning Design (IMS LD). IMS LD has been criticized many times due to its complexity (D. Griffiths et al, 2005) (D. Sampson et al, 2005) [27]. Tools that expose this complexity to the user (e.g. the RELOAD editor [19], CopperAuthor [29] and ReCourse [10]) remain untapped. These tools focus on supporting the standard and put user needs on the background. Supporting standards are definitely important and necessary. However, users (in this case teachers and instructional designers) little care about them. They want tools that will make their lives easier and improve the way they work.

Consequently, appropriate applications exploiting IMS LD while, at the same time, hiding its complexity, are needed to enable instructional designers and teachers use a common language for collaboration, development and sharing of educational templates and scenarios that can be used, adapted and further reused in new educational contexts. To be successful, such tools should put user needs in the foreground. To do so, usability studies can be employed from the beginning of their development.

It is clear that there is a need for usable applications supporting instructional designers' and educators/teachers' needs and collaboration between them, while staying compatible with standards. This requires a transition from the traditional editor-like tools to environments supporting a number of requirements: 1) collaboration between instructional designers and teachers

(and designers-designers and teachers-teachers as well), 2) development and reusability of educational practices (educational templates) and educational scenarios, 3) standards support to ensure interoperability with other systems, 4) connection with other environments, repositories exploiting available designs but also sharing educational practices and scenarios developed within the system with the wider educational community.

In the rest of this chapter, we introduce the concept of instructional design, we refer to a number of instructional design tools and their main problems, and we continue with the definition of the scope of this thesis as well as its goals and objectives.

1.2. Instructional Design

Action psychology states that human behavior is directed towards plan-based accomplishment of goals. Plans are hierarchically arranged. Background knowledge and the environment interact in plan creation and execution. Considering goal priorities and dependencies when deciding what to learn and how to coordinate multiple learning strategies improves the effectiveness of learning in a system with multiple goals. Learning strategies, represented as methods for achieving learning goals, can be chained, composed, and optimized, resulting in dynamic learning plans that are pursued in a flexible manner [25].

The way that a learning experience should be organized in terms of its structure and content to support a Learner with specific learning characteristics is named “Instructional Design”. Instructional Design is part of Instructional Science, which encompasses theories, models, methodologies and tools for instruction [Mizoguchi & Bourdeau, 2000]. Instructional Design is an engineering activity for which the artifact is some instructional product to help a learner acquire some knowledge or skill [Merrill, 2001]. This activity applies strategies and techniques derived from behavioral, cognitive, and constructivist theories to the solution of instructional problems [Mizoguchi & Bourdeau, 2000]. Instructional Design is a methodology for systematic

planning and developing curriculums, courses and educational media. It helps teachers, educators and training professionals to design effective, efficient and appealing instruction that meets requirements of specific learning goals, learners' characteristics and organizational needs.

Instructional Design theories are prescriptions for designing instructional products to optimize the learning outcome [Merrill, 2001]. They describe methods of instruction together with situations in which those methods should be used [Reigeluth, 1999]. According to [Dick, Carey, and Carey, 2000], the underlying questions about instructional design are from a pragmatic viewpoint 1) what to teach, and 2) how to teach.

In order for the learner to acquire higher order cognitive skills (analysis, synthesis, and evaluation), the need for instructional design, which facilitates, promotes and supports activity based learning, must be realized. Learning Activities typically consist of some form of task(s), associated tools which could be used to perform the task(s), and appropriate learning content.

However, although there is a variety of "instructional design" guidelines and approaches in theory, these have not appropriately linked with practice.

Pedagogical patterns (or educational templates) are prescriptions for designing instructional products to optimize the learning outcome. Pedagogical Patterns capture best practice in particular educational domains, assisting teachers to outline the strategies to surpass common difficulties and problems, such as how to motivate students, how to introduce new concepts or how to sequence activities [7]. The teachers, based on these patterns, can create a number of educational scenarios for various educational contexts. There is an obvious relation with architectural design patterns, as described by Alexander [1], where "a pattern language gives each person who uses it, the power to create an infinite variety of new and unique buildings, just as his ordinary language gives him the power to create an infinite variety of sentences". Fig. 1 presents an educational template for the problem-based learning approach, while Fig. 2 presents an educational scenario developed using this template.

1.3. Scope of this thesis

It is clear that there is a need for usable applications supporting instructional designers' and educators/teachers needs and collaboration between them, while staying compatible with standards. This requires a transition from the traditional editor-like tools to environments supporting a number of requirements:

1) collaboration between instructional designers and teachers (and designers-designers and teachers-teachers as well),
2) development and reusability of educational practices (educational templates) and educational scenarios,
3) standards support to ensure interoperability with other systems,
4) connection with other environments, repositories exploiting available designs but also sharing educational practices and scenarios developed within the system with the wider educational community.

Consequently, appropriate applications exploiting IMS LD while, at the same time, hiding its complexity, are needed to enable instructional designers and teachers use a common language for collaboration, development and sharing of educational templates and scenarios that can be used, adapted and further reused in new educational contexts. To be successful, such tools should put user needs in the foreground. To do so, usability studies can be employed from the beginning of their development.

1.4. Goal, objectives, and contribution of this thesis

In this thesis we present Octopus, a collaborative environment allowing instructional designers and educators work together towards their common goal; creating effective instruction. Specifically, it facilitates instructional designers to develop learning strategies in the form of pedagogical patterns (or educational templates), as prescriptions for designing instructional products to optimize the learning outcome.

Sharing of educational templates and scenarios is supported in workspaces, as well as reusability of educational scenarios and parts of them (e.g. activities, activities structures) in other scenarios with an easy way from within the Octopus. This adds a social dimension in the process of instructional design. Instructional designers and educators can easily find and use learning

activities or structures of them residing in templates or scenarios developed by other users.

Octopus pays special attention in the user needs and the instructional design process itself, while it stays compatible with standards. Octopus supports IMS LD Level A since it seems to be the most understandable and suitable for instructional designers and teachers, if they know the correspondence of its concepts with the concepts that they are familiar with [11][24][27]. Extensive usability studies have been performed from the earliest development steps, while a number of workshops have been organized with the participation of pedagogy experts and teachers. Octopus has been used in three EU projects. Improvements of the tool have been made after the continuous feedback of users in a number of tool releases.

Different Learners have different individual learning needs and preferences (e.g. learning style, educational level, previous knowledge etc.). Consequently they learn best in different ways and need different workflows of “how and what” to teach/learn, while in parallel may need to master different objectives in order to achieve the same learning goals. The process of creating these learning workflows is called Instructional Design. Instructional design is an engineering activity for which the artefact is some instructional product to help a learner acquire some knowledge or skill (7). This activity takes into account theories, models, methodologies and tools for instruction and applies strategies and techniques derived from them to the solution of instructional problems (8). According to (9), the underlying questions about instructional design are from a pragmatic viewpoint

1. what to teach, and
2. how to teach.

However, the instructional design process is usually performed completely by regular teachers lacking advanced pedagogical skills resulting in scenarios, where a sound pedagogical approach (the "how") is absent and the focus is mainly on "what" to teach (and finally not to learn...). As a matter of fact, these scenarios put the learners and their individual learning needs on the sidelines and this has a negative learning outcome. If we could let instructional design experts to design the “missing part” (the “how”), this would help the teachers,

educators and training professionals to design effective, efficient and appealing instruction that meets requirements of specific learning goals, learners' characteristics and organizational needs.

Towards this end, the role of the instructional designers is to create pedagogical patterns (learning designs without specific learning content), as prescriptions for designing instructional products to optimize the learning outcome. Pedagogical Patterns capture best practice in particular educational domains (10), assisting teachers to outline the strategies to surpass common difficulties and problems, such as how to motivate students, how to introduce new concepts or how to sequence activities, for example. These pedagogical patterns are based on instructional design theories, which describe methods of instruction together with situations in which those methods should be used (11). The teachers, based on these patterns (educational templates), can create a number of educational scenarios (educational pathways) for various educational contexts. This involves the creation of learning activities and their connection with relevant learning contents. There is an obvious relation with architectural design patterns, as described in (12), where "a pattern language gives each person who uses it, the power to create an infinite variety of new and unique buildings, just as his ordinary language gives him the power to create an infinite variety of sentences".

In order for these educational templates (or derived educational pathways) to be reusable, shareable and accessible from the educational community, these should be represented in a standard and interoperable way. Moreover, these educational templates and their integral parts are described with learning metadata (LOM) and stored in a repository that beyond common repository functionality (CRUD), implements the OAI-PMH service interface. In the area of Technology-enhanced Learning, the key specification that provides a standard notation language for the description of learning designs is IMS Learning Design (13), as it is the only existing interoperability specification which supports the definition and orchestration of teaching and learning activities involving multiple roles and complex activity flows. As a modelling language, IMS LD is intended to provide a means of defining a wide range of pedagogical strategies.

1.5. Thesis Structure

In addition to the introduction, the preliminaries, the related work, the conclusion and the appendixes, this thesis is comprised of four more parts. The first is related with the instructional design process through Octopus tool, the second is related with the system implementation, while the last describes the deployment the use and the evaluation of the Octopus. Chapter 3 describes the instructional design process through Octopus environment. More precisely the thesis is structured as follows:

- Chapter 2, presents interoperability standards, tools and research that are most relevant to the issues addressed in this thesis.
- Chapter 3, focuses in octopus tool, its underlying model, the system architecture and the process of instructional design
- Chapter 4, presents the architecture of the system, the technologies were used for the implementation of the tool, the educational design process through Octopus along with along with the users interfaces have been developed for the interaction with the end users in the form of a tutorial.
- Chapter 5, presents the activities related with the deployment and use of Octopus Tool as well as the different methods followed in the evaluation of the system.
- Chapter 6, describes the interoperability capabilities of the Octopus infrastructure
- Chapter 7, describes the future work
- Appendix A, provides information about the web services offered by the infrastructure
- Annex 1, provides the results of the pluralistic walkthrough

Chapter 2. Related Work

2.1. Introduction

In this chapter, we present the work that is directly or indirectly related to this thesis. This chapter is composed of three main parts: The first part focuses on the interoperability standards and specifications that have been used in this thesis coming from the eLearning and digital libraries/repositories domain. The second part has to do with repository interoperability standards. The third part presents tools related with the instructional design.

2.2. Interoperability standards, specifications and protocols

In this section some of the most important standards and specifications in eLearning and digital libraries domain will be presented and their role in this thesis will be explained.

2.2.1. Educational Modeling Language (EML)/IMS Learning Design (IMS LD)

Nowadays, the need for eLearning systems supporting a rich set of pedagogical requirements has been identified as an important issue in the field of distance learning [Capuano et al., 2005]. Several initiatives take place in order to meet this need. The most important of these initiatives seems to be IMS Learning Design [IMS LD, 2003] that provides a framework to depict pedagogies.

IMS Learning Design specification [IMS LD, 2003] is a development of the Educational Modeling Language [Hummel, Manderveld, Tattersall and Koper, 2004] (designed by the Open University of the Netherlands (OUNL) to enable flexible representation of the elements within online courses; not just the materials but also the order in which activities take place, the roles that people undertake, key criteria for progression, and the services needed for presentation to learners. The learning design specification does not detail how the course material itself is represented but rather how to package up the overall information into a structure that is modeled on a play, with acts, roles (actors) and resources.

The IMS Learning Design specification supports the use of a wide range of pedagogies in online learning. Rather than attempting to capture the specifics of many pedagogies, it does this by providing a generic and flexible language.

This language is designed to enable many different pedagogies to be expressed. It allows different pedagogical approaches to be integrated into a single “learning design” where different approaches may be appropriate for different types of learners. The approach has the advantage over alternatives in that only one set of learning design and runtime tools need to be implemented in order to support the desired wide range of pedagogies.

The IMS Learning Design specifications (Figure 6.4) are structured in three levels. Level A includes activities, roles and environments. Activities (learning activities or support activities) can be grouped into activities structures and executed into specific environments. An environment is formed by learning objects and services provided to users during activity execution. Users are classified into roles (learners, teachers, tutors, etc.). Nowadays, learning objects are educational contents by which learners acquire knowledge and services are functionalities invoked during learning process in order to communicate with tutors or other learners. Level B adds properties (storing information about a single person or a group) and conditions (setting constraints upon the flow of activities) to the first level. Level C adds notifications (mechanism to handle messages passing between users) to the framework.

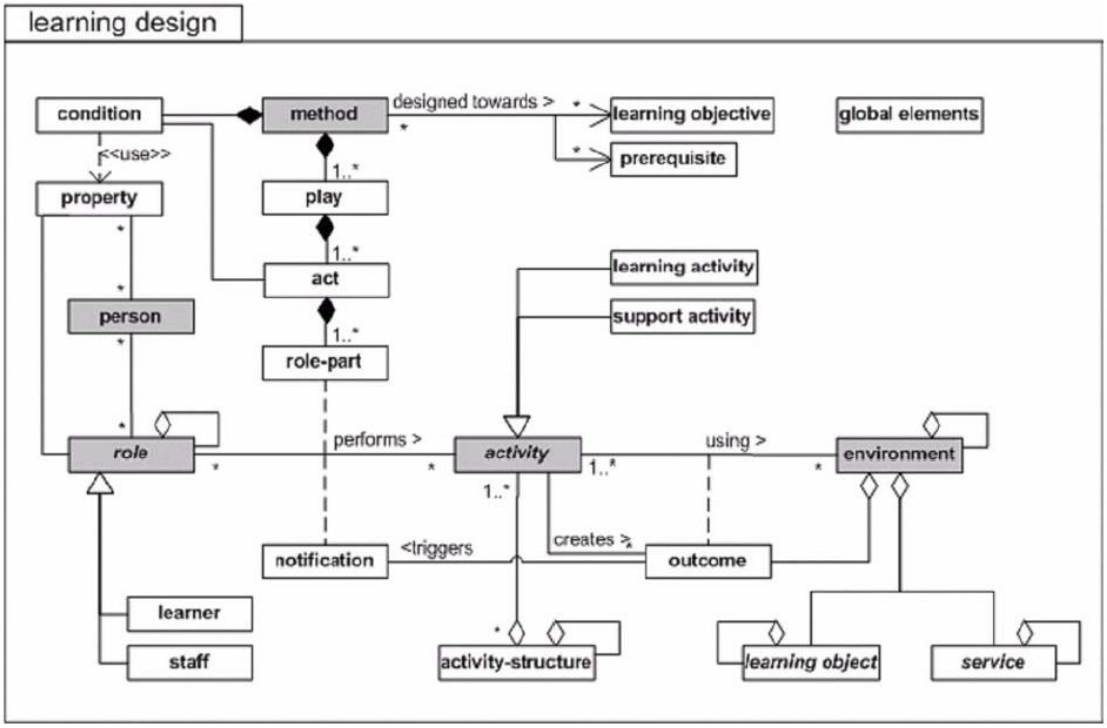


Figure 2.1 Conceptual model for overall IMS Learning Design (from [IMS LD, 2003])

IMS LD has been criticized many times due to its complexity [11][24][27]. IMS LD Level A seems to be the most understandable and suitable for instructional designers and teachers, if they know the correspondence of its concepts with the concepts that they are familiar with [11][24][27].

2.2.2. Learning Object Metadata (LOM)

The IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata [IEEE LOM, 2002] is an internationally recognized open standard (published by the Institute of Electrical and Electronics Engineers Standards Association) for the description of "learning objects". The IEEE working group that developed the standard defined learning objects as being "any entity, digital or non-digital, that may be used for learning, education or training", a definition which has struck many commentators as being rather broad in its scope. IEEE 1484.12.1 is the first part of a multipart standard, and describes the LOM data model. The LOM data model specifies which aspects of a learning object should be described and what vocabularies may be used for these descriptions; it also defines how this data model can be amended by additions or constraints. Other parts of the standard are being drafted to define bindings of the LOM data model, i.e. define how LOM records should be represented in XML and RDF (IEEE 1484.12.3 and IEEE 1484.12.4 respectively).

LOM content model consists of four aggregation levels or levels of functional granularity [IEEE LOM, 2002]. These include:

- **Level 1**: The smallest aggregation level, such as raw media or fragments
- **Level 2**: A collection of Level 1 learning objects, such as a lesson.
- **Level 3**: A collection of Level 2 learning objects, such as a course.
- **Level 4**: The largest level of granularity, such as a collection of courses.

Some of the main things that are achieved with the use of LOM are:

- Creation of well structured descriptions of learning resources. These descriptions should help facilitate the discovery, location, evaluation

and acquisition of learning resources by students, teachers or automated software processes.

- Sharing of descriptions of learning resources between resource discovery systems. This should lead to a reduction in the cost of providing services based on high quality resource descriptions.
- Tailoring of the resource descriptions to suit the specialized needs of a community. This may include choosing suitable controlled vocabularies for classification, reducing the number of elements that are described or adding new ones from other resource description schemas.
- Creators and publishers may use the LOM along with other specifications to “tag” learning resources with a description that can be associated with the resource. This will provide information in a standard format similar to that found on the cover and fly-page of a text book.

Data elements describe a learning object and are grouped into categories. The LOMv1.0 Base Schema consists of nine such categories (Figure 2.2):

1. The **General** category groups the general information that describes the learning object as a whole.
2. The **Lifecycle** category groups the features related to the history and current state of this learning object and those who have affected this learning object during its evolution.
3. The **Meta-Metadata** category groups information about the metadata instance itself (rather than the learning object that the metadata instance describes).
4. The **Technical** category groups the technical requirements and technical characteristics of the learning object.
5. The **Educational** category groups the educational and pedagogic characteristics of the learning object.
6. The **Rights** category groups the intellectual property rights and conditions of use for the learning object.
7. The **Relation** category groups features that define the relationship between the learning object and other related learning objects.

8. The **Annotation** category provides comments on the educational use of the learning object and provides information on when and by whom the comments were created.

9. The **Classification** category describes this learning object in relation to a particular classification system.

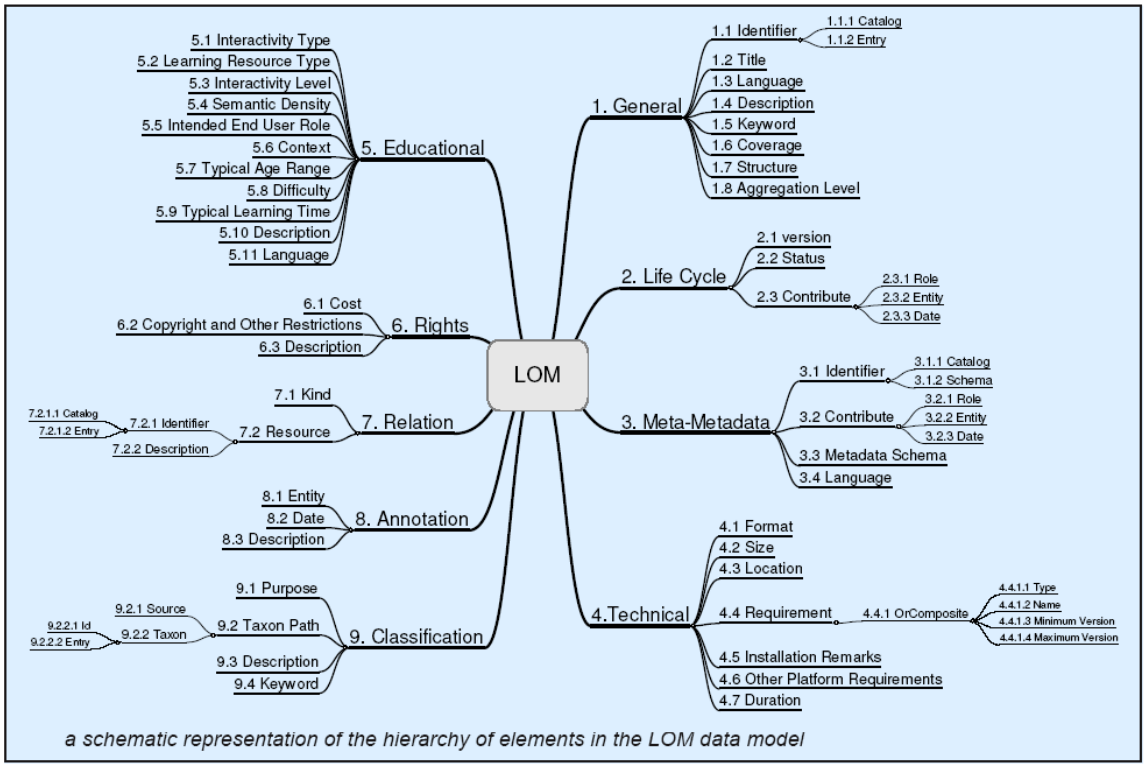


Figure 2.2 A schematic representation of the hierarchy of elements in the LOM data model [Barker, 2005]

In the framework developed in this thesis LOM is used for the description the educational templates and scenarios and their integral parts (e.g. learning activities and resources).

2.2.3. Sharable Content Object Reference Model (SCORM)

SCORM (Sharable Content Object Reference Model) [SCORM, 2001, 2004] is a set of profiles of standards and specifications for reusable learning content. It addresses interoperability between content and the platforms that deliver the content. SCORM is widely adopted by Learning Management Systems (LMSs), Learning Content Management Systems (LCMSs),

authoring environments, assessment engines and course management systems.

Simply stated, SCORM is a set of specifications for developing, packaging and delivering high quality education and training materials whenever and wherever they are needed. These specifications and standards have been bundled into a collection of “technical books.” Each can be viewed as separate books gathered together into a growing library. These technical books (Figure 2.3) are presently grouped under three main topics: the Content Aggregation Model (CAM), the Run-time Environment (RTE) and Sequencing and Navigation (SN). The use of SCORM enables reusability, accessibility and durability of the learning material in technology changes, and interoperability between different e-learning platforms.

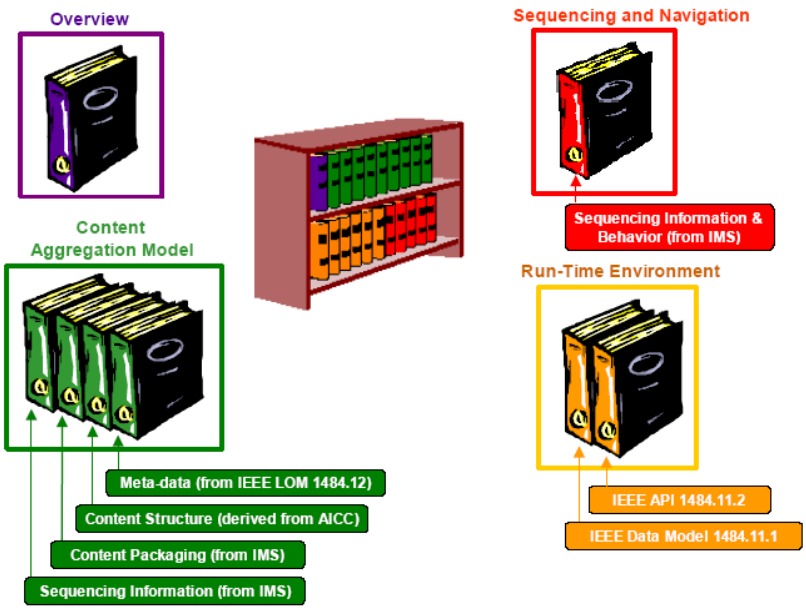


Figure 2.3 SCORM Bookshelf [SCORM, 2004]

The **SCORM Content Aggregation Model** further defines a common way by which learning content can be interoperable, interchangeable, reusable and accessible. It defines how learning content is identified, described, aggregated into a “course” and moved between systems. Specifically, the learning resources comprising a learning experience get packaged into a zip file (SCORM package of Package Interchange File (PIF)). This file contains not only the course files, but it also contains an XML file, referred to as the manifest file, describing the course contents and content sequencing.

The **SCORM Run-Time Environment** defines the means by which SCORM learning content is made interoperable between LMSs. The SCORM Run-Time Environment provides details on how LMSs should launch resources/content, communicate with the content (using a predefined language and vocabulary) and exchange predefined data elements during execution.

In SCORM 2004 version, another specification has been added to SCORM named **Sequencing and Navigation** that describes how SCORM-conformant content may be sequenced through a set of learner-initiated or system-initiated navigation events. The branching and flow of that content may be described by a predefined set of activities, typically defined at design time.

Octopus provides mechanisms for exporting the educational templates and scenarios developed within the tool to SCORM format. This way interoperability of these templates and scenarios is ensured and they can be shared, used and reused in other tools/environments.

2.3. Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH)

The Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) (7) is a low-barrier mechanism for repository interoperability. It specifies a method for digital repositories (“data providers”) to expose metadata about their objects for harvesting by aggregators (“service providers”), which may subsequently provide search and other services based on the aggregated collections of metadata. OAI-PMH is widely used to harvest (or collect) metadata descriptions of the records in a repository into a central point.

Data Providers are repositories that expose structured metadata via OAI-PMH. Service Providers then make OAI-PMH service requests to harvest that metadata. According to the OAI-PMH V2.0 (7) specification, a target service has to implement the following verbs (i.e. methods) as services that are invoked within HTTP. Each verb corresponds to an OAI-PMH request:

- Identify: The identification of the underlying repository

- ListMetadataFormats: A list of supported metadata formats
- ListIdentifiers: A list of identifiers
- ListRecords: A list of metadata records
- GetRecord: A metadata record containing the description about an item

These verbs are requested in REST (9) style. i.e., every verb is, together with parameters, encoded as a URL. Through this URL, a harvester application can retrieve metadata stored in the underlying repository, formatted in XML.

The OAI-PMH protocol has been implemented on top of the Octopus educational templates/scenarios repository providing services that allow the dissemination of educational templates/ scenarios metadata to external repositories/federations implementing all methods required by OAI-PMH V2.0 [17]

2.4. Tools related with instructional design

According to Griffith et al. [11], tools supporting the authoring of learning designs can be classified along two axes as it is presented in:

1) Close to specification (“low-level”) - distant from specification (“high-level”) and
2) General purpose tools - specific purpose tools. The first axis has to do with how close the presentation terms and structures of the tool are to the specification, while the second is related with how generic or specialized a tool is [20]. Generic tools give users access to the entire specification, whereas specialized cater for a specific pedagogy.

MOT+ LD Editor [19], LAMS [3] and ASK LDT are high level, generic tools. MOT+ LD Editor is a stand-alone graphical authoring tool, which enables users to graphically design learning designs and learning design templates based on the interconnection of user defined learning activities. However, it requires further understanding of knowledge based concepts before it can be used. LAMS is a web-based graphical authoring tool, which enables users to

graphically design LDs and LD templates based on a linear sequence of pre-defined learning activities. MOT+ LD Editor and the LAMS underlying model are not IMS LD compliant, but they can export LDs and LD templates to IMS LD compatible format. ASK-LDT is a stand-alone graphical authoring tool, which enables users to graphically design LDs and LD templates based on the interconnection of user defined learning activities. ASK-LDT can export LDs and LD templates in IMS LD Level A, B compatible format. ASK-LDT enables its users to characterize the learning activities used for developing learning design and learning design templates based on a common vocabulary of terms derived from the "DialogPlus Taxonomy of Learning Activities" [8]. ASK-LDT uses the same concepts with IMS LD in its GUI and, along with the complex graphical notation used to classify the different types of activities, makes the learning design process complicated.

"Low level" tools include RELOAD Editor [17], CopperAuthor [26] and ReCourse [9]. RELOAD Editor supports the full IMS Learning Design specifications for Levels A, B and C. However, it is not suitable for instructional designers and educators since it requires the designer to know every detail of the IMS LD elements and concepts to use it. CopperAuthor is a form-based editor supporting IMS LD Level A. As with RELOAD, it is extremely difficult to use it since it requires detailed understanding of the IMS LD specification. ReCourse is a stand-alone authoring tool supporting IMS LD, which combines form-based and graphical-based authoring of learning designs and learning design templates based on the interconnection of user defined learning activities. Although its GUIs are more intuitive than those of RELOAD and CopperAuthor editors, it is still difficult for teachers to use it, especially using its graphical-based interface. ReCourse can import and export LDs and LD templates in IMS LD compatible format.

Open Graphical Learning Modeler (OpenGLM) [14] is a tool distant from the specification (high-level) and specific-purpose, which supports IMS LD at levels A and B. The tool was conceived to facilitate non-IMS LD experts in creating, sharing and reusing units of learning. To achieve that, OpenGLM adopts a visual modeling metaphor that conceals the complex and unintuitive elements and structures of IMS LD from the graphical user interface. Although more intuitive than the other visual modeling tools, the results of the

evaluation performed in [14] show that the teachers still have problems with transferring concepts from their teaching environment to the concepts of IMS LD and difficulties to assemble a learning design using the visual modeling interface of the tool.

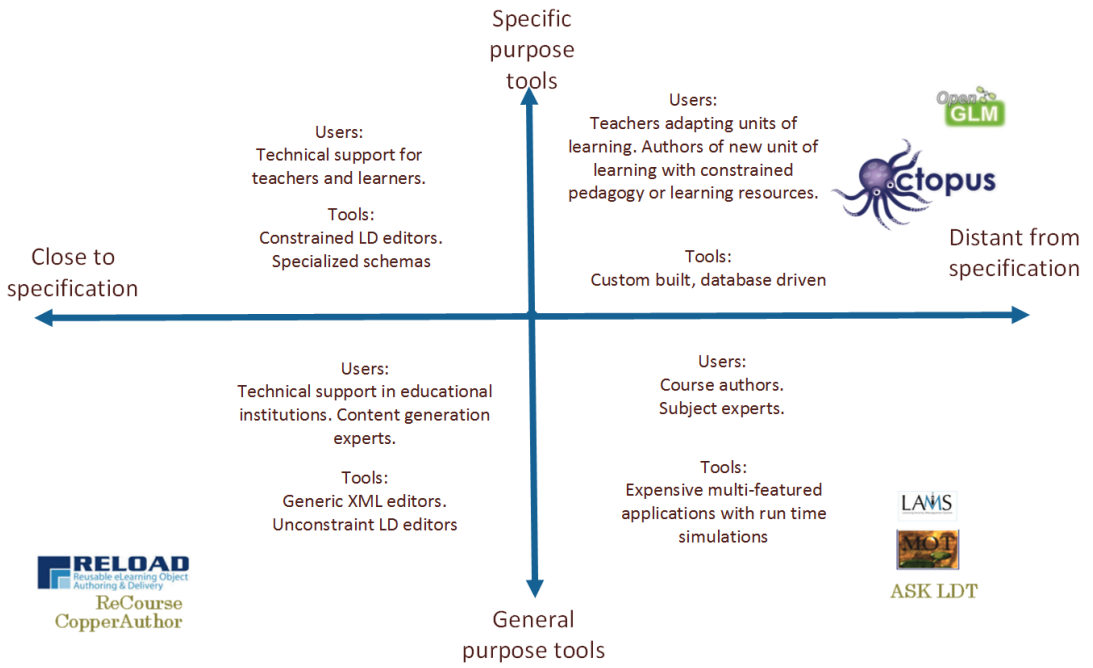


Figure 4. The figure depicts the Griffith's two axis classification. The tools supporting the authoring of learning designs along these two axis.

As noted in [7], Griffith et al. classification implies that "Typical teachers are not supposed to learn a general purpose LD tool. Useful tools for instructional designers seem to be distant from the specification, in the sense that "real" users should not understand IMS LD and that their designs are just compiled into IMS LD".

Octopus presented thesis is a high level environment distant from the specification, which supports IMS LD Level A, while hiding the complexity of IMS LD specification from its graphical user interfaces. In this sense it is closer to OpenGLM. As ASK-LDT, MOT+ and LAMS, it supports the development of educational templates. In addition to all tools mentioned here, Octopus supports

1) collaboration between instructional designers and teachers (and designers-designers and teachers-teachers as well,

2) Collaboration among teachers and students or students and students working on specific educational scenarios.
3) development and reusability of educational practices (educational templates) and educational scenarios developed by other users with a simple way (search and dragging and dropping parts of them), and
4) Connection with other environments, repositories/federations exploiting available designs but also sharing educational practices and scenarios developed within the system with the wider educational community, using their APIs and implementing protocols such as OAI-PMH.

As opposed with most of the tools mentioned here, Octopus focus is to support the real user needs, while staying compatible with standards. Thus, the user requirements were taken into account from the design phase and usability studies have been performed from the earliest development steps, as well as a number of workshops were organized with the participation of pedagogy experts and teachers. The continuous feedback of the users resulted in a number of tool releases.

2.5. Summary

In this chapter some of the most important standards and specifications in eLearning and digital libraries domain have been presented and their role in this thesis has been explained. Moreover, different systems used to support the instructional design process were presented in comparison with Octopus tools.

Next, Chapter 3, introduces to the concepts of the instructional design methodologies and the Octopus tool.

Chapter 3. Octopus and the instructional design process

3.1. Introduction

In this chapter the Octopus tool and the instructional design process will be analyzed in detail. More specifically, this chapter focuses on the conceptual model of the octopus tool and its functional design in terms of use cases.

3.2. Octopus Goals - Actions psychology - Addie instructional design process

Octopus is a collaborative environment facilitating instructional designers to develop learning strategies in the form of pedagogical patterns (or educational templates), as prescriptions for designing instructional products to optimize the learning outcome. Pedagogical Patterns capture best practice in particular educational domains, assisting teachers to outline the strategies to surpass common difficulties and problems, such as how to motivate students, how to introduce new concepts or how to sequence activities[35]. The teachers, based on these patterns, can create a number of educational scenarios for various educational contexts. There is an obvious relation with architectural design patterns, as described by Alexander [24], where “a pattern language gives each person who uses it, the power to create an infinite variety of new and unique buildings, just as his ordinary language gives him the power to create an infinite variety of sentences”. Those educational scenarios might be implemented and enriched by students. This way, the derived different scenarios can be used to evaluate its parent scenarios and as a base for the creation of revised educational scenarios.

Sharing of educational templates and scenarios is supported in workspaces, as well as reusability of educational scenarios and parts of them (e.g. activities, activities structures) in other scenarios with an easy way from within the Octopus. This adds a social dimension in the process of instructional design. Instructional designers and educators can easily find and use learning activities or structures of them residing in templates or scenarios developed by other users, with a simple copy-paste function.

Octopus pays special attention in the users’ needs, while staying compatible with standards.

3.3. Educational design model

Octopus underlying model supports the simplest profile of IMS LD, i.e. IMS LD Level A since it seems to be the most understandable and suitable for instructional designers and teachers, if they know the correspondence of its concepts with the concepts that are familiar with [12][34][22][9]. IMS LD Level A includes activities, roles and environments. Activities (learning activities or support activities) can be grouped into activities structures and executed into specific environments. An environment is formed by learning objects and services provided to users during activity execution. Users are classified into roles (learners, teachers, tutors, etc.). Octopus presentation model hides IMS LD complexity from its graphical user interfaces and where needed it uses more appropriate concepts in place of IMS LD ones. The decisions made were based on the feedback from instructional designers and teachers from the earliest development steps and later in a number of usability studies and workshops (Section V). Figure 5, shows the Octopus presentation model compared to the model of IMS LD Level A. The concepts used in the GUI are presented with bold line. The concepts of the IMS LD replaced with more appropriate ones are presented with italics. The concepts presented with dash line are hidden from the GUI.

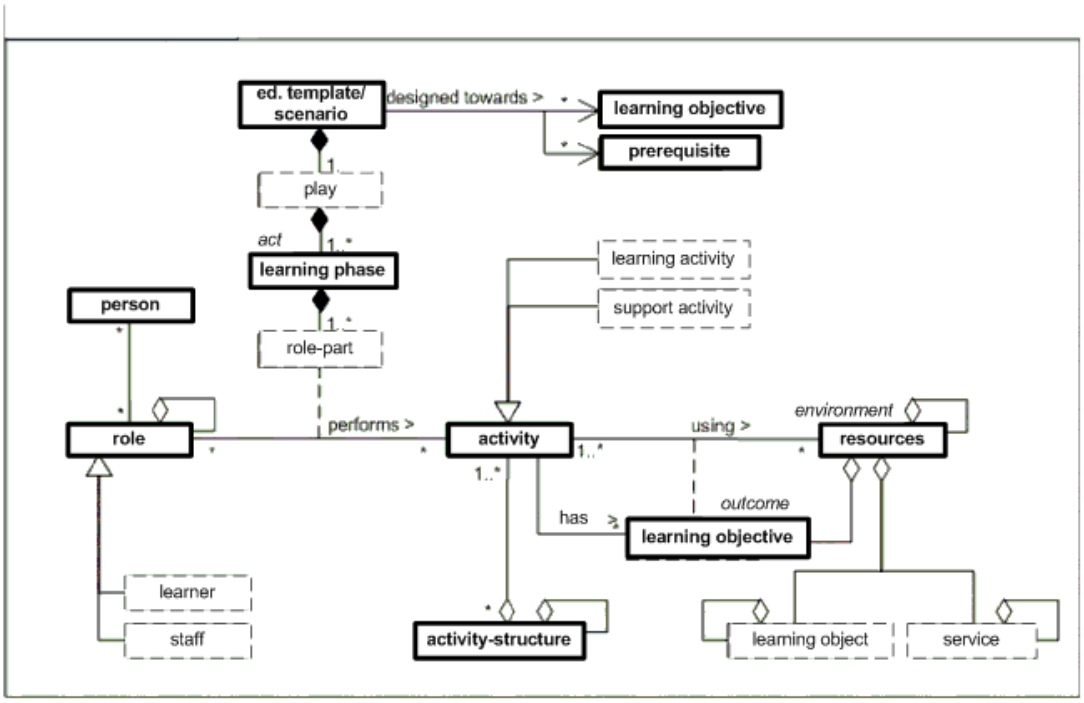


Figure 5 – Conceptual model of Learning design Level A conceptual model.

Octopus allows metadata description of educational templates/scenarios and their integral parts (e.g. activities, resources) using LOM or Application Profiles of it supporting this way the needs of different communities [21]. Connection with external environments/tools and repositories is also supported, both for finding and reusing available resources, but also exposing and sharing educational templates and scenarios developed with the tool with the wider educational community.

3.4. Conceptual model

This chapter describes the model develop to support the Octopus environment. The classes that Octopus is comprised of are identified and presented in Figure 6.

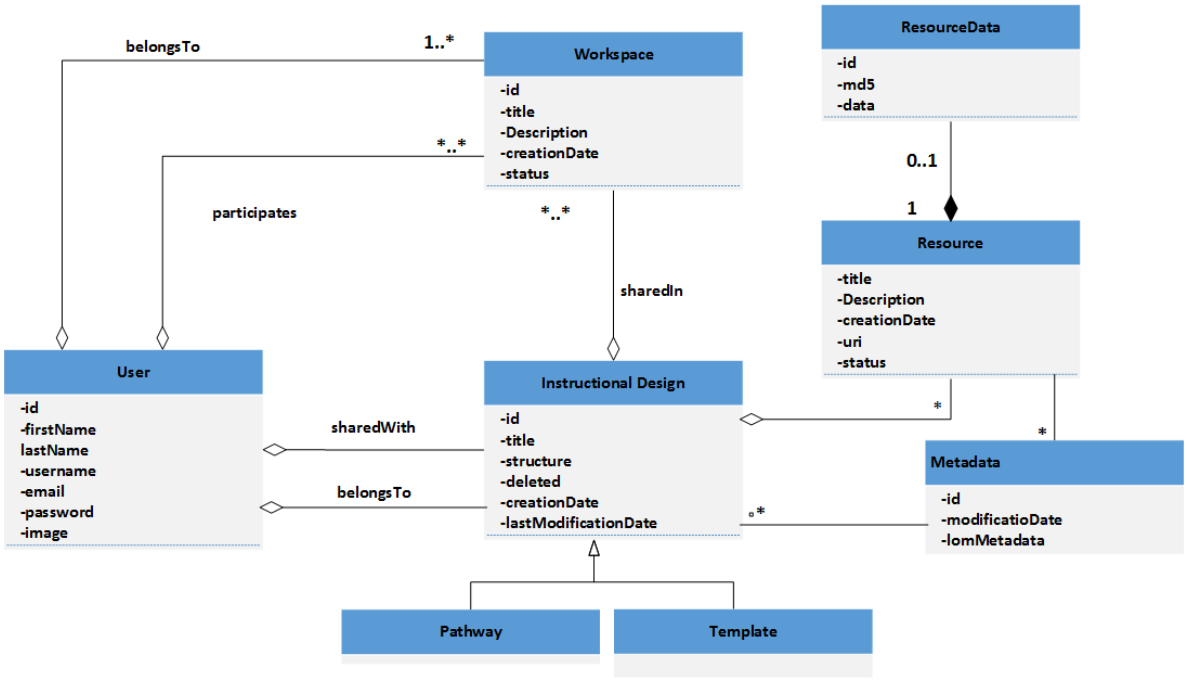


Figure 6: The above image depicts the conceptual model of Octopus tool

3.4.1. User

This class represents the users of the system. The attributes that each user has are the following:

- firstName: the given first name of the user.
- lastName: the last name of the user.
- email: the user's email address.

- password: the password used for logging in the system.
- image: a profile image of the user.

Each user is capable to create Instructional Designs, to share them with other users for collaborative editing or to create and participates in Workspaces.

3.4.2. Instructional Design

Instructional Design class represents the actual scenarios developed by users. Instructional design might be recognized as of two different types. As a Pathway that represents an educational scenario or as a Template that might be used to create Pathways. The attributes each Educational Design accommodates are:

- Title : the given title
- Description : the given description
- creationDate : the date the educational design was created
- lastModificationDate : the last modification date

Lom metadata can be used for the description of each instructional design.

3.4.3. Workspace

This class represent a place that accommodates Users, and Instructional Designs. The Workspace which is private or public, belongs to a specific user and many users participates in a Workspace.

3.4.4. Resource

Resource class represents content that is connected with an educational design. Each resource might be optionally coupled with a binary resource that is kept as a resource data. The attributes that each resource has are the following:

- Title : the resource's given title
- Description: the resource's given description
- creationDate : the creation date of the resource
- uri: the resource uri

3.4.5. ResourceData

Resource Data class represents the actual binary data uploaded by a user for a resource. The attributes of each resource data are :

- Md5: the hash value of the data, used to avoid duplications
- Data : the actual binary data

3.4.6. Metadata

Metadata class represents the LOM metadata descriptions used for the educational descriptions of the referred resources. The attributes of this class are:

- lomMetadata: lom representation of the metadata
- lastModification: the last modification

To implement these functionalities the Octopus Tool is employing technologies such as HTML, CSS, JSP, for the presentation, AJAX, for asynchronous communication, XML, JSON for the interchange of data and JavaScript to bring these technologies together.

3.5. Octopus use cases supporting the instructional design process

The Octopus Tool is the front-end web based application that is used by for the creation of the educational scenarios and templates. The main functionality of the tool allows to:

- create/update/delete/share Educational scenarios and Educational templates
- create/delete/ update users
- create/update/delete workspaces

The primary actors of the system are the Octopus Users as physical persons, who use the system in order to achieve their goals. Additionally, the secondary actors of the system are the back-end infrastructure of the system, as well as the external search services utilized.

The functionality of the Octopus Tool can be overviewed in Figure 7. The figure depicts a Use Case Diagram, illustrating the actors of the system and their goals.

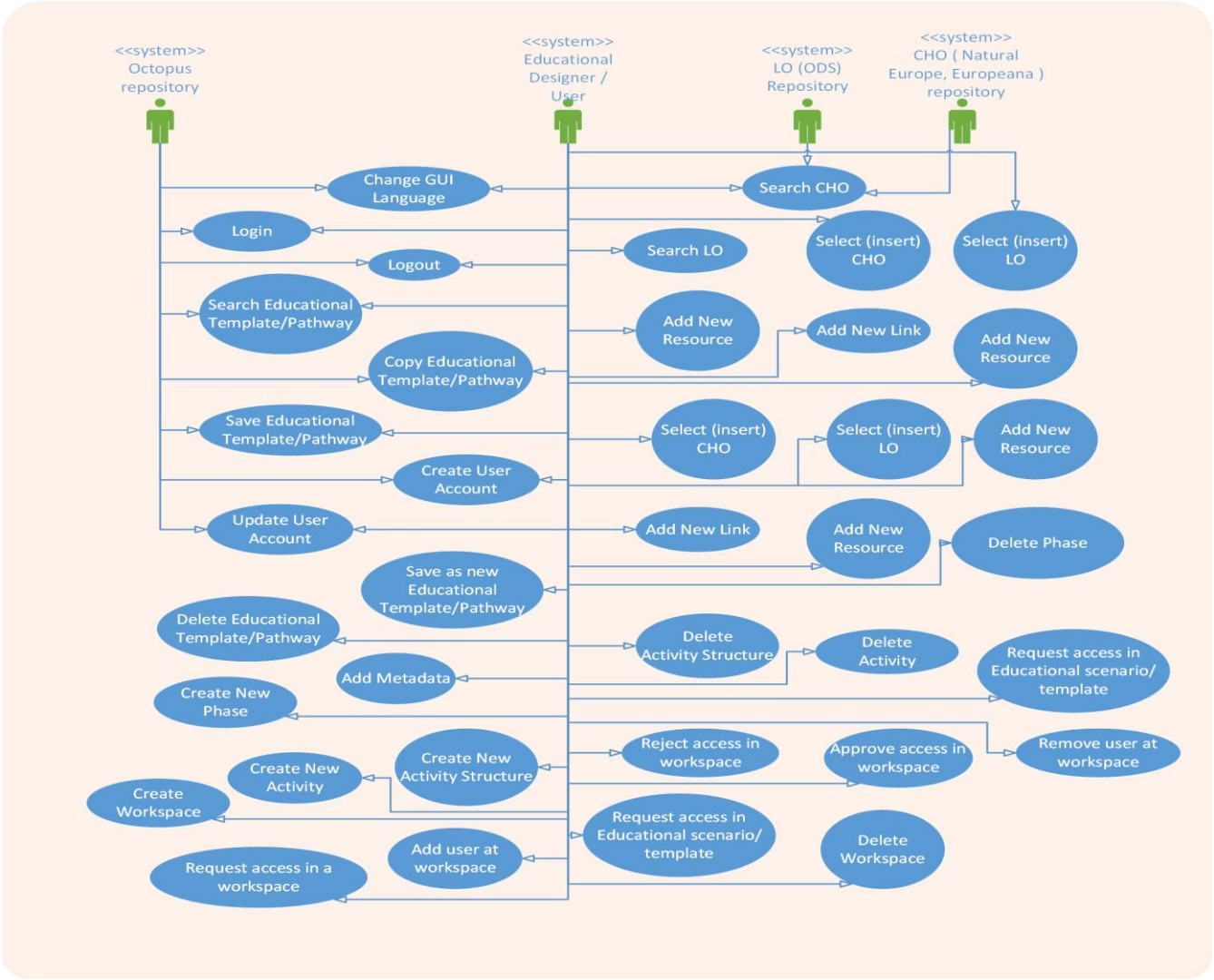


Figure 7: Use case diagram depicting the actors of the EPT Authoring Tool and their goals.

#	Summary Goal	User Goal	Overview	Affected Use Cases
1	User authentication	Login	The user wants to log in to the system.	UC2
2		Logout	The user wants to logout from the system.	UC3

3		Create User Account	The user wants to register to the system and create a user account.	UC30
4		Modify User Account	The Octopus User wants to modify his/her account.	UC31
5	Identifying an Educational Pathway Template to edit	Create New Educational Pathway Template	The user wants to create a new Educational Pathway Template.	UC8, UC7
6		Search Educational Pathway Template	The user wants to search for appropriate pathway templates.	UC4
7		Open Educational Pathway Template	The user wants to open an Educational Pathway Template.	UC4, UC5
9	Editing an Educational Pathway Template	Create New Phase (Act)	The user wants to create a new Phase (Act) in the Educational Pathway Template.	UC9
10		Create New Activity Structure	The user wants to create a new Activity Structure under a Phase or an Activity Structure of the Educational Pathway Template.	UC10
11		Create New Activity	The user wants to create a new Activity under a Phase or Activity Structure of the Educational Pathway Template.	UC11
12		Delete Phase (Act)/Activity Structure/Activity	The user wants to delete a Phase (Act), an Activity Structure or an Activity.	UC22, UC23, UC24

14		Insert Metadata	The user wants to add metadata for an Educational Pathway Template, Phase (Act), Activity Structure, Activity or Resource.	UC29
15		Add New Resource	The user wants to add a new resource to an activity (supporting material).	UC15, UC16, UC17, UC18, UC19
16		Delete Resource	The user wants to delete a resource (supporting material) from an Activity.	UC28
17	Saving/Deleting a Pathway Template	Save Educational Pathway Template	The wants to save the current pathway template.	UC7
18		Copy Educational Pathway Template (Save as)	The user wants to create a copy of a selected Educational Pathway Template.	UC4, UC6
19		Delete Educational Pathway Template	The user wants to delete an Educational Pathway Template.	UC21
		Export Educational Pathway Template		New

Table 1: Brief descriptions of Octopus Functionality supporting the instructional design process.

Next,Table 2, describes the internal action script of use case shown on Figure 7.

#	Actors	Goal	Overview
1	Octopus User, Octopus Repository	Login	The Octopus User fills in his/her username and password to log in to the system. The system checks if the user exists, and if the given credentials are correct. In case of success, the main page appears; otherwise the system informs the user for the failure, presenting an appropriate message.
2	Octopus User, Octopus Repository	Logout	The Octopus User selects to logout from the system. The system logs out the user and displays the login screen.
3	Octopus User, Octopus Repository	Search Educational Pathway Template	The Octopus User gives his/her search criteria (keywords) and submits his/her request to the system. The system searches for appropriate templates based on their metadata. In case of success, it returns the results and presents them to the Octopus User. Otherwise, the system returns null.
4	Octopus User, Octopus Repository	Open Educational Pathway Template	The Octopus User selects an Educational Pathway Template from the list (search results) in order to view or update it. By pressing on the title of the template presented in the list, the Octopus User sends a request to the system. The system processes the request and prepares the template in order to present it to the GUI.
5	Octopus User, Octopus Repository	Copy Educational Pathway Template	The Octopus User selects an Educational Pathway Template from the list (search results), in order to create a copy of it. By pressing on the title of the template presented in the list, a field appears to complete the title of the new template. The

#	Actors	Goal	Overview
			Octopus User sends a request to the system a request to the system. The system processes the request and prepares the template in order to be copied and present thereafter the copy to the GUI.
6	Octopus User, Octopus Repository	Save Educational Pathway Template	The Octopus User selects to save the changes of the template (by clicking the “Save” button). The system checks if the submitted information is correct in order to be saved. In case of success, the system saves the template and informs the user. Otherwise, the template is not saved. An appropriate message is sent back to user in both cases.
7	Octopus User, Octopus Repository	Create New Educational Pathway Template	The Octopus User selects to create a new Educational Pathway Template by pressing the “New Template” button. The system checks if there is an open template. If yes, the system Saves the Educational Pathway Template (use case #7). Otherwise, the system asks for the title of the new template, then cleans up the structure and the design area of the system in order for the user to be able to design the new template.
8	Octopus User	Create New Phase (Act)	The Octopus User selects to create a new Phase (Act) in the structure of the Educational Pathway Template by pressing the button “New Act”. Afterwards, (s)he gives the requested information and confirms the creation of the new Act. The new Act appears now in the structure of the template.
9	Octopus User	Create New Activity Structure	The Octopus User selects to create a new Activity Structure in a Phase or in an Activity Structure of the Educational Pathway Template by clicking on the “New Activity Structure” on the toolbar. The

#	Actors	Goal	Overview
			system asks him/her to complete some basic information about the new Activity Structure. The Octopus User completes the requested information and confirms the creation of the new Activity Structure. The system creates the new Activity Structure and it is now apparent in the template structure.
10	Octopus User	Create New Activity	The Octopus User selects to create a new Activity in a Phase or in an Activity Structure of the Educational Pathway Template by clicking on the “New Activity” on the toolbar. The system asks him/her to complete some basic information about the new Activity. The Octopus User gives the requested information and confirms the creation of the new Activity. The system creates the new Activity and it is now apparent in the template structure.
11	Octopus User, CHO Repository	Search CHO	The Octopus User selects to search for a CHO. (S)he gives the search criteria (keywords) and submits his/her request. The system searches for appropriate CHO based on their metadata. In case of success, it returns the results to the user. Otherwise, the system returns null.
12	Octopus User, LO Repository	Search LO	The Octopus User selects to search for a LO, by pressing the “Search LO” button. (S)he gives the search criteria (keywords) and submits his/her request. The system searches for appropriate LO based on their metadata. In case of success, it prepares and returns the results to the user. Otherwise, the system returns null.
13	Octopus User	Select (insert)	The Octopus User selects a CHO to be added to

#	Actors	Goal	Overview
		CHO	the current Activity and submits his/her request. The system stores the association of the Activity with the CHO.
14	Octopus User	Select (insert) LO	The Octopus User selects a LO to be added to the current Activity and submits his/her request by pressing the button “Add Resource”. The system stores the association of the Activity with the LO.
15	Octopus User, Octopus Repository	Add New Resource	The Octopus User selects to add a new resource that will be uploaded to the Octopus Repository. To do so, (s)he selects the preferred file from the disk and selects “Upload” to be uploaded to the Octopus Repository.
17	Octopus User	Delete Educational Pathway Template	The Octopus User selects an Educational Pathway Template to be deleted. The system asks him/her to confirm the deletion of the template. If the user selects “Yes”, the template gets deleted. Otherwise, the system returns.
18	Octopus User	Delete Phase (Act)	The user selects to delete an Act. The system asks him/her to confirm the deletion of the Act. If the user selects “Yes”, the Act gets deleted. Otherwise, the system returns.
19	Octopus User	Delete Activity Structure	The Octopus User selects an Educational Pathway Template to be deleted, by clicking on the “Delete” button next to “Activity Structure”. The system asks the Octopus User to confirm the deletion of the template. If the user selects “Yes”, the template gets deleted. Otherwise, the system returns.
20	Octopus User	Delete Activity	The Octopus User selects an Activity to be deleted. The system asks him/her to confirm the

#	Actors	Goal	Overview
			deletion of the Activity. If the user selects “Yes”, the Activity gets deleted. Otherwise, the system returns.
21	Octopus User	Delete Start point	The Octopus User selects a Start Point for deletion and submits his/her request. The system asks him/her to confirm the deletion. If the user selects “Yes”, the Start Point gets deleted. Otherwise, the system returns.
22	Octopus User	Delete End point	The Octopus User selects a Start Point for deletion and submits his/her request. The system asks him/her to confirm the deletion. If the user selects “Yes”, the Start Point gets deleted. Otherwise, the system returns.
23	Octopus User	Delete connection	The Octopus User selects a Start Point for deletion and submits his/her request. The system asks him/her to confirm the deletion. If the user selects “Yes”, the Start Point gets deleted. Otherwise, the system returns.
	Octopus User	Delete Resource	The user selects to delete a resource from the structure by clicking on the corresponding button next to the resource, in the resource list. The system asks him/her to confirm the deletion. If the user selects “Yes”, the resource gets deleted. Otherwise, the system returns.
25	Octopus User, Octopus Repository	Insert Metadata	The user selects to insert metadata by clicking on the “General Information” button and the

#	Actors	Goal	Overview
			corresponding form appears. The user fills in the fields and then clicks on the save button. The system checks if the mandatory elements are filled in presenting a message in case of error. Otherwise, the system sends the information to the server in order to save it to the repository.
26	Octopus User, Octopus Repository	Create User Account	The Octopus User selects to create a user account by clicking on the “New Account” button and a form related to the user’s personal information appears. The user fills in the requested fields and selects the “Save” button. The system checks the user’s input, creates the new user, inserts him in the users list and displays a message indicating that the operation has been successfully completed.
27	Octopus User, Octopus Repository	Modify User Account	The Octopus User selects to modify his/her account by clicking on the “Edit my Account” button and a form related to the user’s personal information appears. The user fills in the requested fields and selects the “Save” button. The system checks the user’s input, updates the user’s account and displays a message indicating that the operation has been successfully completed.
28	Octopus User, Octopus Repository	Finalize EP Template	The user selects to finalize the EP Template by clicking on the “General Information” button and the related metadata appears. (S)he selects the “final” choice of the status field and then clicks on the “Save” button. The system checks if the mandatory elements are filled in and presents a message in case of error. Otherwise, the system sends the information to the server in order to

#	Actors	Goal	Overview
			save it to the repository.

Table 2: Octopus Use Cases supporting the instructional design process

3.6. Summary

In this chapter we presented the conceptual model of the Octopus system and it's functional specifications through use cases that support the instructional design process.

Chapter 4, focuses on the implementation of the Octopus system

Chapter 4. Octopus Architecture and Implementation

4.1. Introduction

This chapter presents the architecture of Octopus along with a detailed walkthrough that illustrates how it supports the work of instructional designers. This support refers to the development and sharing of educational templates and scenarios. Furthermore it support collaboration between instructional designers through the notion of workspaces.

4.2. Architecture

Octopus follows a service oriented architecture. Service-oriented architecture (SOA) is a design pattern based on distinct pieces of software providing application functionality as services to other applications via a protocol. This is known as service-orientation. It is independent of any vendor, product or technology.[1] A service is a self-contained unit of functionality, such as retrieving an online bank statement.[2] Services can be combined by other software applications to provide the complete functionality of a large software application.[3] SOA makes it easy for computers connected over a network to cooperate. Every computer can run an arbitrary number of services, and each service is built in a way that ensures that the service can exchange information with any other service in the network without human interaction and without the need to make changes to the underlying program itself.

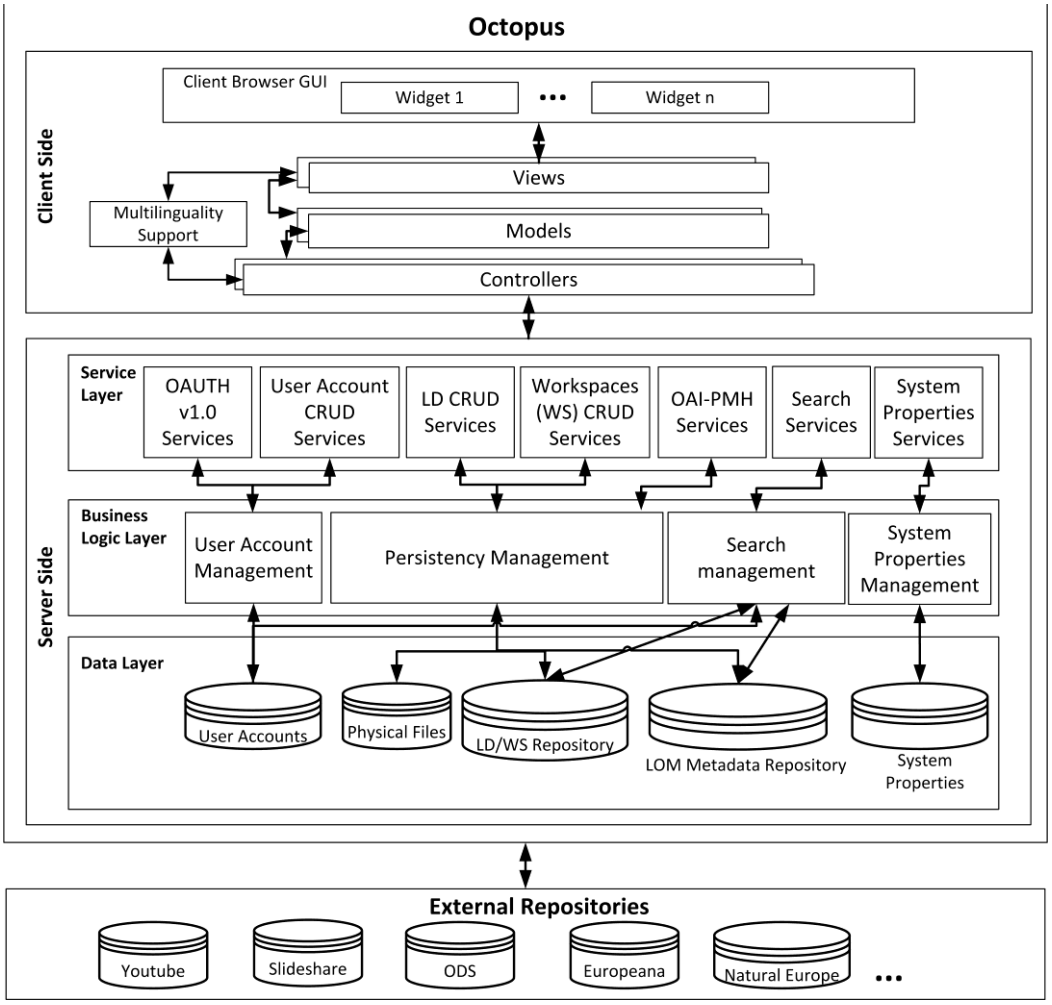


Figure 8: Octopus Architecture

The components of this architecture are described in the following sections.

4.2.1. Client Side

The client side component follows a MVC-like pattern with models, views and controllers, undertaking the communication between the client side as well as the server side component. *Models* are collections of data that are used and presented by the views which could be panels, trees, grids, forms, buttons and windows etc. The *View* is made with HTML, CSS, JavaScript and templates. Combinations of different views are used to produce different *Widgets* to be delivered to the end user through the browser. The *Controller* is the decision maker and the glue between the model and view as well as server side component. The controller updates the views when the model changes. It also adds event listeners to the views and updates the models when the user manipulates the view. If the data in the model needs to be persisted, the controller makes asynchronous calls to the server. The data

interchange between the client and the server side component is made through asynchronous AJAX calls and JSON messages. The *Multilinguality Support module* handles the translation of the user interface elements. While the tool loads on the client's browser, the translation corresponding to the user language preferences is transferred along with the user interface components.

The different components - widgets of the client side utilize a common web browser in order to present their functionality. Based on the above architecture, six different components expose their functionality through the web browser:

The User Accounts Management widget, which is responsible for the management of the user accounts.

The Educational Templates/Scenarios Finder widget, which is responsible for the search of existence educational templates, scenarios and workspaces in the Octopus.

The Metadata Management widget, is responsible for the management of educational templates and scenarios metadata. It allows description of templates/scenarios with LOM metadata, as well as Application Profiles of it, supporting this way the needs of different communities.

The Educational Template/Scenarios Authoring widget, allowing the authoring of educational templates and scenarios.

The Workspaces Management widget, allowing the administration of users' workspaces, educational scenarios and templates.

4.2.2. Server side

The server side consists of three different layers: the service layer, the business logic layer and the data layer.

4.2.2.1. Service Layer

The Service Layer controls the communication between the client and server logic by exposing a set of services to the client side widgets. These services comprise the middleware concealing the application's business logic. The service layer provides the following services:

OAuth Services to authorize a foreign web application's requests for access to a user's data [17].

User account CRUD services providing the appropriate services for the management of user accounts. Specifically, these services are responsible for the creation, retrieval, update, deletion (CRUD) and authentication of a user accounts based on the corresponding business logic.

LD (Educational Templates/Scenarios) CRUD services for the management of educational templates and scenarios. Specifically, these services are responsible for the creation, deletion, retrieval and update of the templates/scenarios, , as well as their metadata following the corresponding business logic.

Workspaces (WS) CRUD services for the manipulation of the workspaces. In detail, these services provide the functionality needed for the creation, deletion, retrieval and update of the workspaces as well as the manipulation of their content.

OAI-PMH services allowing the dissemination of educational templates/scenarios metadata to external repositories/federations. These metadata conform to LOM or LOM application profiles. The target service implements all verbs (i.e. methods) required by OAI-PMH V2.0 [42], each one corresponding to an OAI-PMH request (Identify, ListMetadataFormats, ListIdentifiers, ListRecords, GetRecord).

Search services allowing search in data layer for users, workspaces or educational templates and scenarios based on the submitted information through the corresponding client-server module and matching with the corresponding metadata. **OpenSearch services** are also provided to be able for external tools and environments to search for templates/scenarios.

System Properties services responsible for the system properties management based on the submitted information through the corresponding client side component along with the related business logic.

4.2.2.2. Business Logic Layer

This layer is responsible for enforcing the business rules on the data. It implements the necessary functionality in order to support the services in the service layer, making possible the use of the data, in the data layer. It consists of the following components:

The **User Account Management** component implements the rules for the creation, the deletion, the modification the authentication and authorization of the users' accounts.

The **Educational Templates/Scenarios Authoring and Persistency Management** component is responsible for the CRUD services related to the educational templates and scenarios supporting the authoring process described above, as well as workspaces and the manipulation of their content. Moreover, it is also responsible for the implementation of the rules supporting the OAI-PMH services in order to disseminate the educational templates and scenarios metadata.

The **Search Management** component applies rules for the manipulation of the templates/scenarios, workspaces and users, and implements the necessary functions in order to serve the search services utilizing the related information in the data layer.

The **System Properties Management** component is responsible for the creation, deletion, the modification of system properties as well as with the multilinguality support properties.

4.2.2.3. Data Layer

The data layer is responsible for the storage of the different information: information associated with the user accounts, workspaces, educational templates and scenarios representations, LOM metadata that is kept for the description of the educational templates and scenarios, system configurations and physical files.

The system underlying repository provides all the required support to complete actions related to creating/retrieving/updating/deleting educational templates, scenarios and corresponding metadata, as well as workspaces

and users, and making available educational templates and scenarios to external digital libraries/repositories/tools.

4.3. The process of instructional design in Octopus - Educational templates and scenarios authoring process

The process of the creation and editing of educational templates and scenarios is presented in the activity diagram illustrated in Figure 9. This can be divided into the following three phases:

- Identifying an educational template/scenario to edit
- Editing an educational template/scenario
- Saving/Deleting/Exporting (to IMS LD or SCORM) a Pathway Template

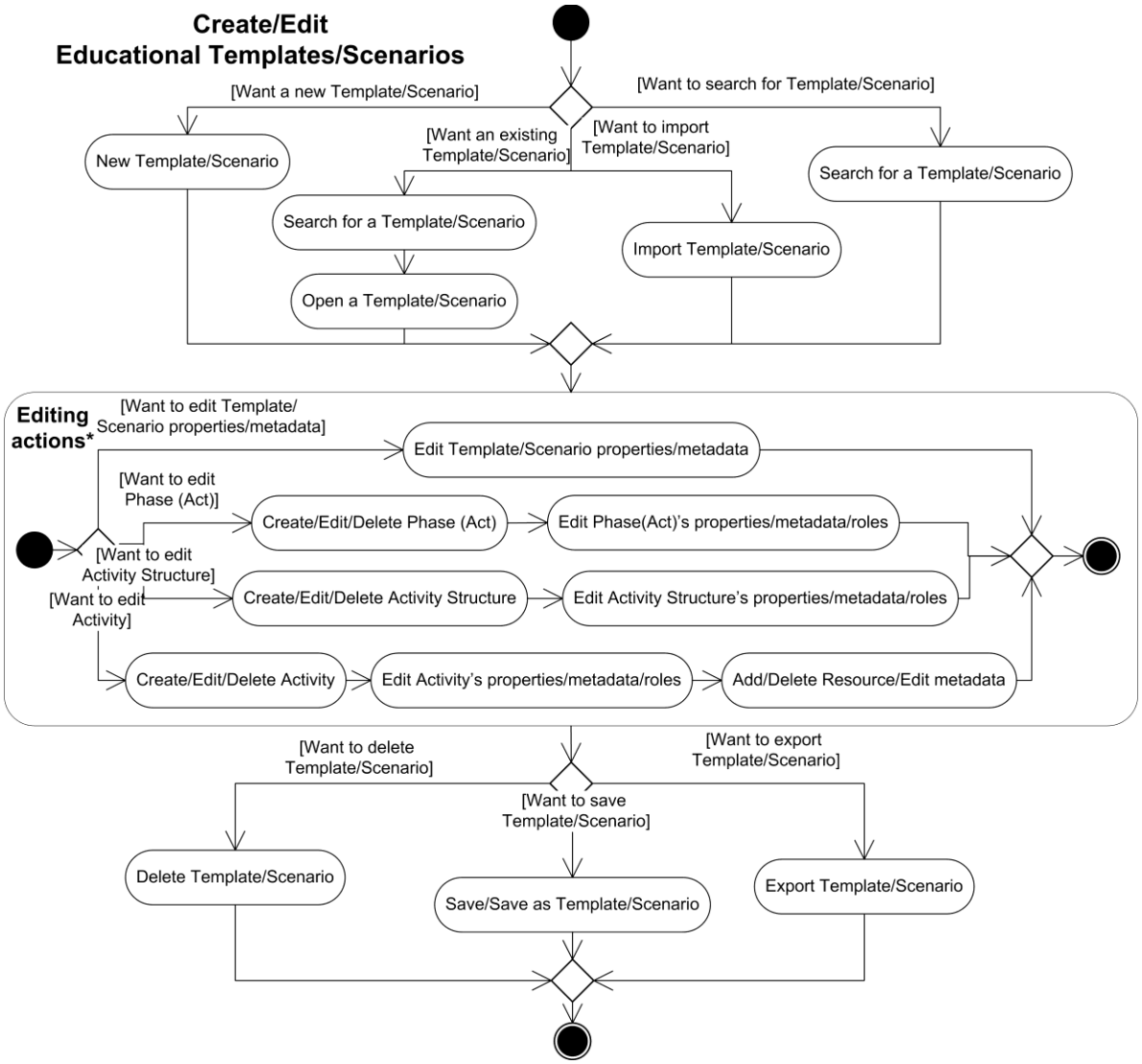


Figure 9 : The process of the creation and editing of educational templates and scenarios

Phase 1 - Identifying an educational template/scenario to edit

This phase may include the creation of a new educational template/scenario or search/open/import an available one. In the case of a new educational scenario it may also include search and use of an educational template for the development of the educational scenario.

Phase 2 - Editing an educational template/scenario

The educational template/scenario development phase includes the following steps:

Define the scope and learning objectives of the educational template/scenario according to the current educational context. Define any prerequisites. Edit the properties/metadata of the educational template/scenario including those values (3.3).

Divide the upper learning objective into sub-objectives and define a number of learning phases and activities needed to achieve these objectives. Structure and describe those activities (e.g. insert new nodes, delete nodes or change their position, edit description). Search and reuse of learning activities or structures of them from other templates/scenarios developed and shared by other users is supported with a simple drag and drop function (0). Edit the properties/metadata of learning phases, activities. Assign roles to phases, activities.

Associate resources (e.g. learning objects, services) to activities and edit their metadata. Search and retrieval of resources residing in external repositories, such as Europeana, Natural Europe, SlideShare, Youtube etc. is supported). Reusing activities and activity structures from other scenarios / templates with a simple drag and drop function.

Phase 3 - Saving/Deleting/Exporting (to IMS LD or SCORM) an educational template/scenario

This phase may include saving, deleting or exporting an educational template or scenario for transfer and use in other environments. The system supports exporting of educational templates/scenarios to IMS LD Level A or SCORM format.

4.4. Octopus in action

This chapter presents the Octopus tool following a detailed walkthrough that illustrates how the use cases presented in section…. Are actually supported by Octopus.

4.4.3. Sign-in, login and account settings

Octopus is a web-based tool for authoring pedagogical scenarios. You may access the tool through the address: http://learn.ced.tuc.gr/octopus. The following screenshot depicts the initial page of the tool:

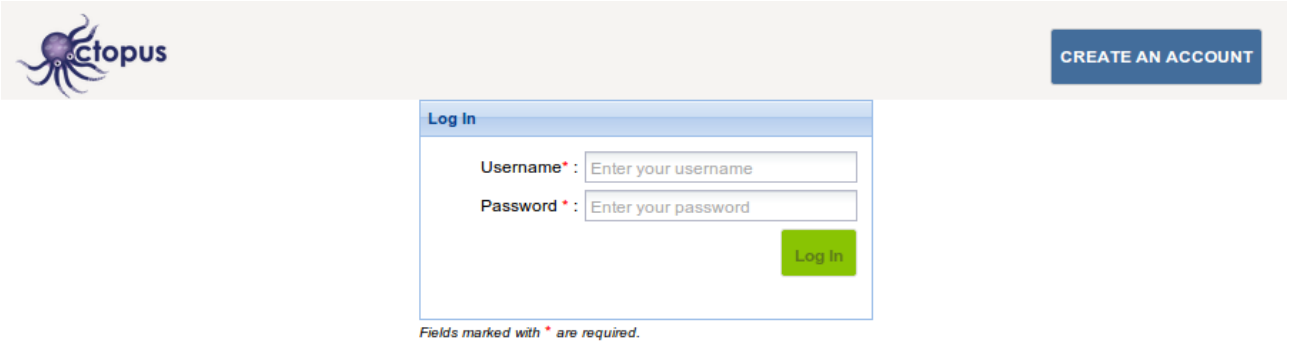


Figure 10 The initial page of the Octopus Tool. From this point a new visitor may create an account in the system. In case of an existing user she/he may access their personal account after a successful login.

Assuming you have no account in the tool yet, the first thing to do is to click the ‘CREATE ACCOUNT’ button on the top right of the page. A pop-up form shows up so that you could provide the necessary information for the creation of the account. Type all necessary information and click the ‘Create Account !’ button when you finish. The following screenshot depicts the appearance of this pop-up form after the necessary information has been provided (all required fields are marked with a red asterisk) for a new user account.

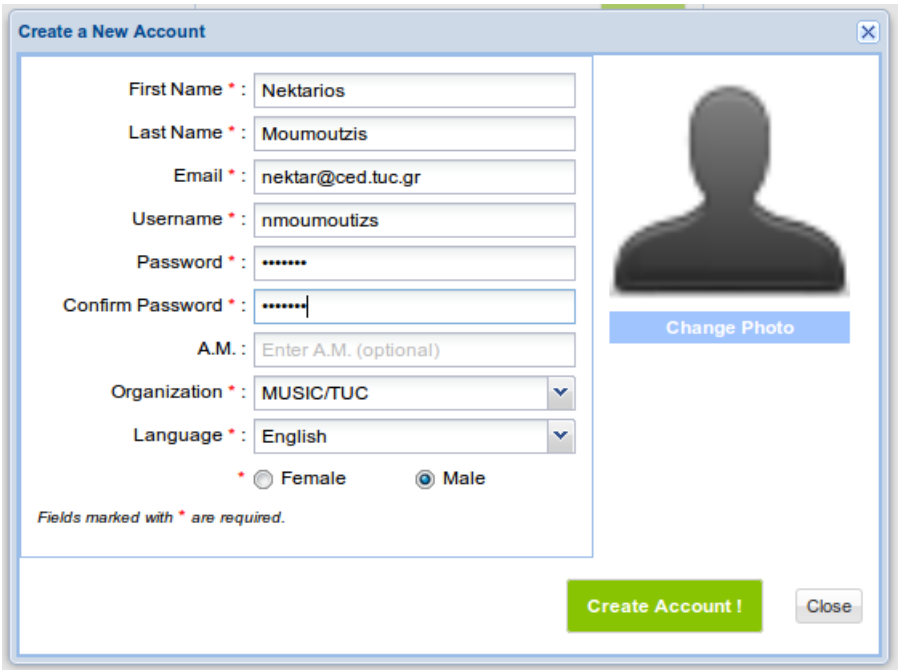


Figure 11 : The screenshot depicts the form is used for the creations of a new account. After the necessary information has been provided (all required fields are marked with a red asterisk) for a new user account

After clicking the 'Create Account !' button your account is created and in Figure 12 your inventory of pathways is presented, which is empty at this point as shown in the following screenshot. Templates and Workspaces are empty as well.

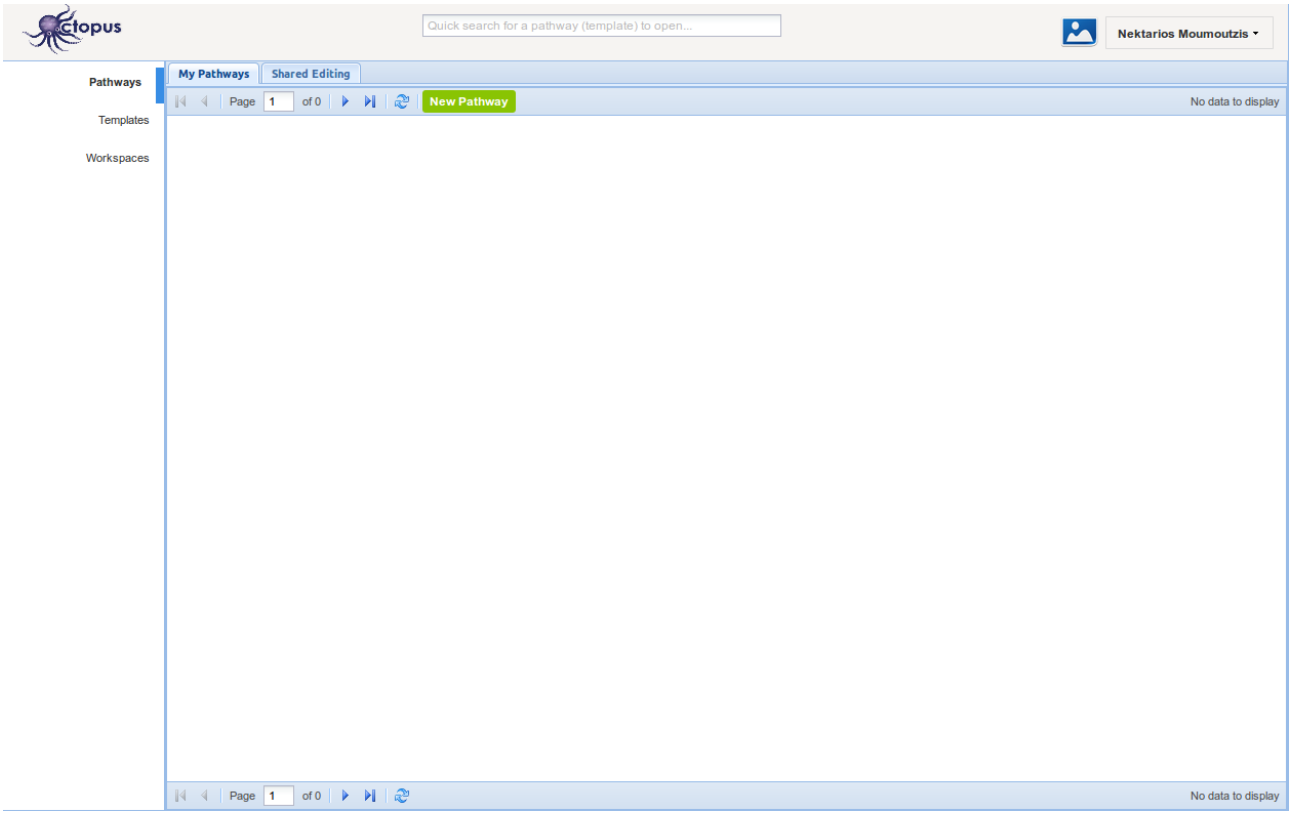


Figure 12 A new account has the inventory of pathways empty. Templates and Workspaces are empty as well.

Before exploring how you could start creating your own content in the tool, let us see how you could inspect and change your account details Figure 13. Click on your name at the top-right of the Octopus page. A pop-up menu shows up. Click on the 'Account Options' item as shown in the next screenshot.

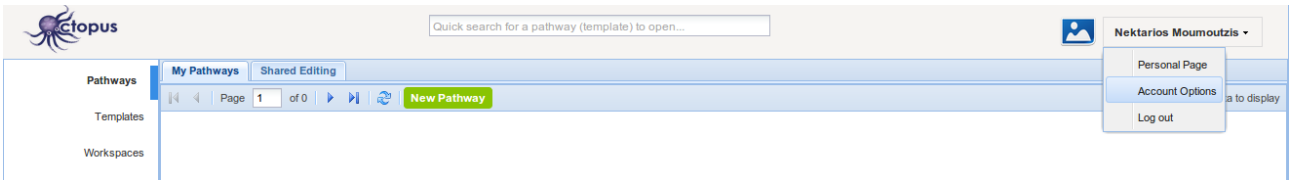


Figure 13: Manage your account details. Click on your name at the top-right of the Octopus page. A pop-up menu shows up. Click on the 'Account Options'

After you click on 'Account Options', a pop-up form shows up Figure 14, similar to the 'Create a New Account' form already presented. You may modify the information of your account.

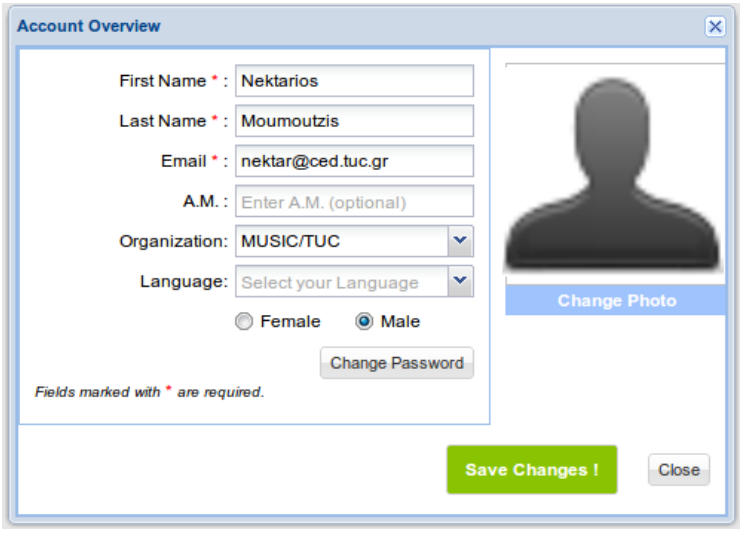


Figure 14: The form that allows for the user details update

Let us see how you could upload your photo: Click on the 'Change Photo' button. A file chooser shows up as in Figure 15. Browse your local disk to locate the photo you want to upload to your account and click 'Open'.

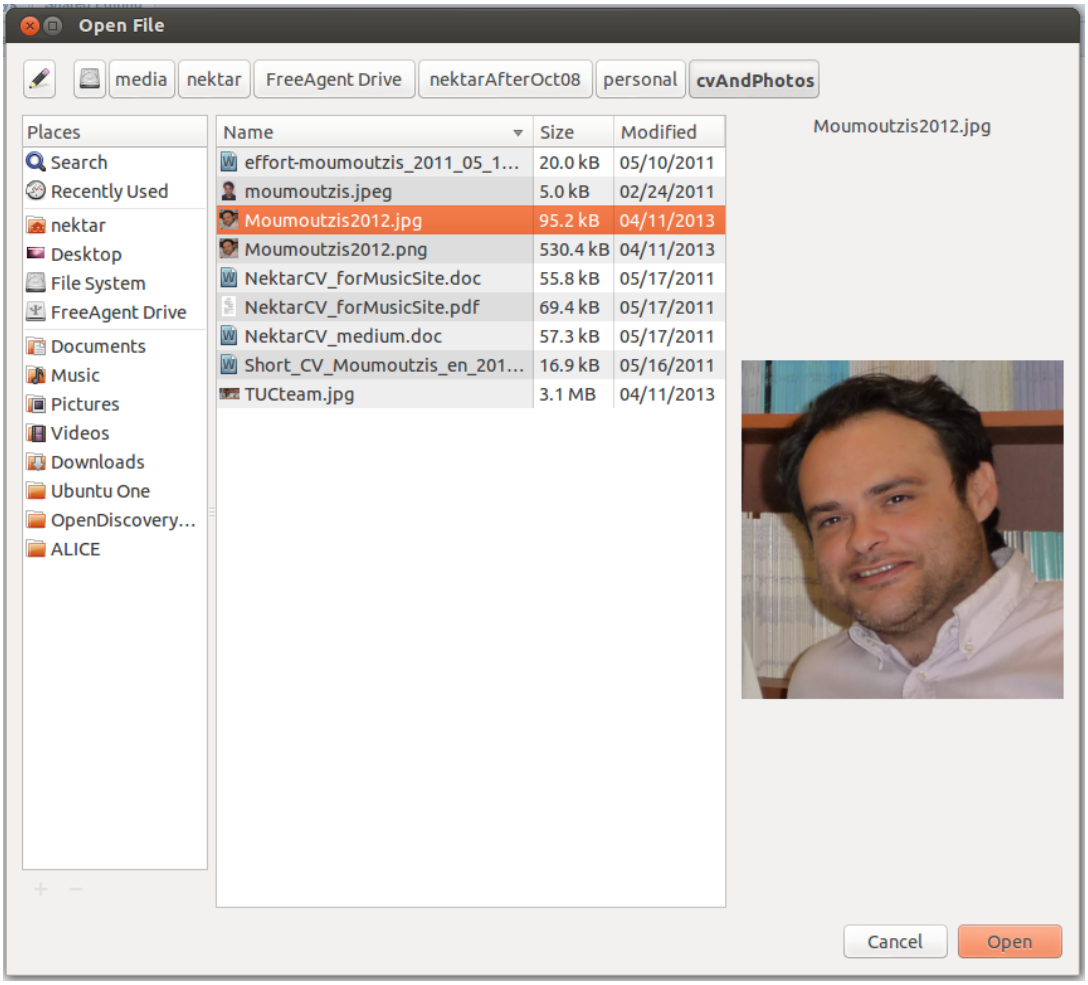


Figure 15: Select a photo from your disk in order to update your account details.

Your photo is uploaded in Octopus and the ‘Account Overview’ form is refreshed. Click on ‘Save Changes !’ button Figure 16 to finish.

Figure 16 : Press save changes button in order to update your info.

In case you want to change your password, click the 'Change Password' button just above the "Save Changes !" button. A new form pops-up Figure 17:

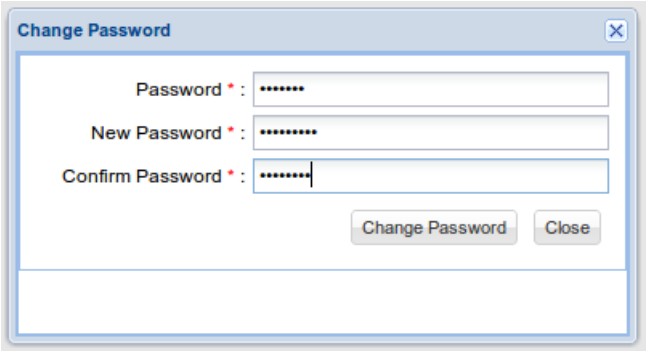


Figure 17: Form that is used for password update.

Type your old password and then your new one. Retype the new password for confirmation and click the 'Change Password' button. Press 'Save Changes !' and then 'Close' on the 'Account Overview' form.

4.4.4. Creating a pathway using a template

You are now ready to create your first pathway. In Octopus terminology, a pathway stands for a pedagogical scenario or a lesson plan that prescribes how to teach a certain topic. We will see that a pathway consists of a number of learning activities that are supported by resources. Resources refer to digital content that is to be used by students during the implementation of the pathway.

4.4.4.4. Join a workspace

As you have already seen in the previous section, when your account is created, your inventory of pathways is empty. One way to start creating your pathways is to join a workspace where you could find some ready-made pathways that you may modify to suit your needs. You could also find *templates* to use as a starting point for the creation of your pathways. Templates are essentially generic structures that contain guidance to develop your own pathway in a way that it conforms to some pedagogical approach or best practice.

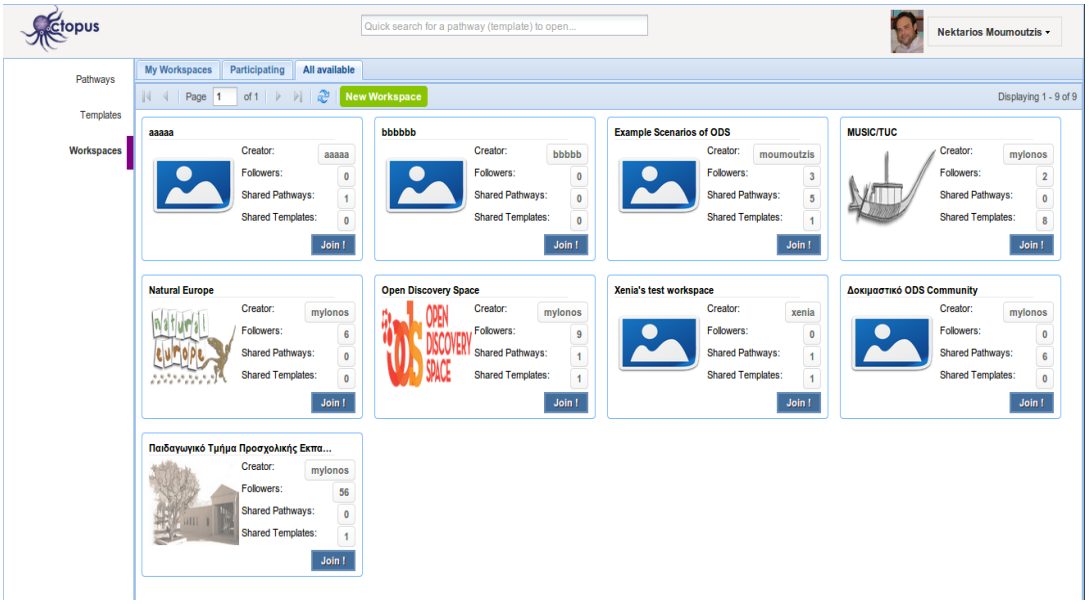


Figure 18: The list of the available workspaces. By pressing the "Join" button a request to the workspace administrator is sent, so she/he can accept or reject your request.

So, let us see how you could join a workspace and use one of its templates to create your first scenario. Select the 'Workspaces' option on the vertical menu on the left of the Octopus main page. Then, select the tab 'All available' Figure 18. You will see all the workspaces in which you could send a join

request, as shown in the screenshot above. Now click the ‘Join !’ button inside the ‘Example Scenarios of ODS’ to join that workspace.

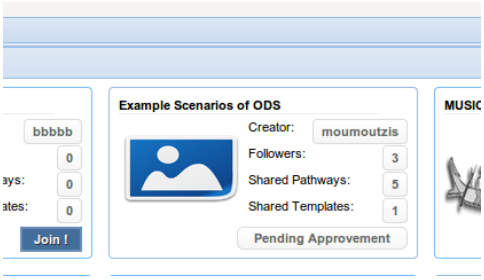


Figure 19: The “Join” button is pressed and the ‘Pending Approvement’ message appears.

As soon as you click the ‘Join !’ button, its label changes to ‘Pending Approvement’ and the button cannot be clicked any more as shown in the screenshot on the right Figure 19.

What has happened is that Octopus has sent a notification to the owner of the workspace, i.e. the user that has created it, that a new user, you, is requesting to join the workspace. The owner of the workspace can approve or reject your request.

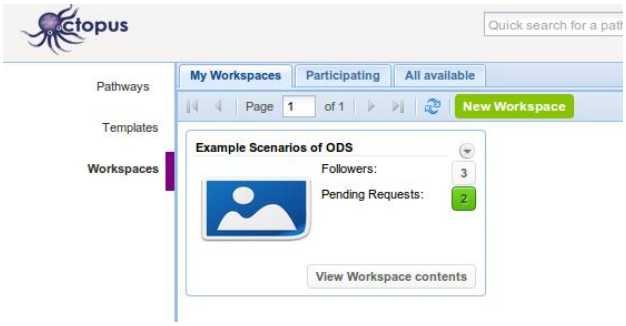


Figure 20: The owner of a workspace is informed about the pending requests.

In the screenshot on the left you can see what is happening on the owner’s side. When he/she browses his/her workspaces, he/she can see that there are pending requests in the ‘Example Scenarios of ODS’ workspace Figure 20. The number of pending requests is marked with green color.

The owner can click on this number and see a list of the pending requests from which he/she could approve or reject each one of the requests. You

could see how the list of pending requests is presented in the screenshot on the right. The pending requests are shown in tabular form. Each row corresponds to one request and the owner of the workspace can accept or reject it by clicking on the corresponding button.

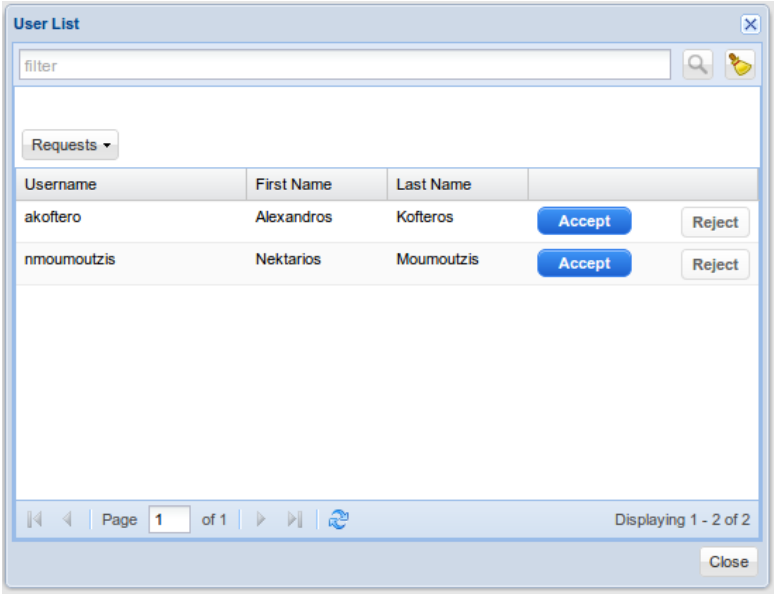


Figure 21: The list of the users that have requested access to the workspace

You will find out more about workspaces in sections 5-8 of this User Guide where you will also see how you could create your own workspace and manage its participants and content. For now let us assume that you have sent your request to join the ‘Example Scenarios of ODS’ workspace and that your request has been accepted so you could reuse all templates and pathways in there.

Let us now go back to your own account. After the owner of the workspace has approved your request, you will see that the appearance of the ‘Example Scenarios of ODS’ rectangle changes and you are now offered with the option to ‘View Workspace contents’ as shown below in Figure 22. Click that button.

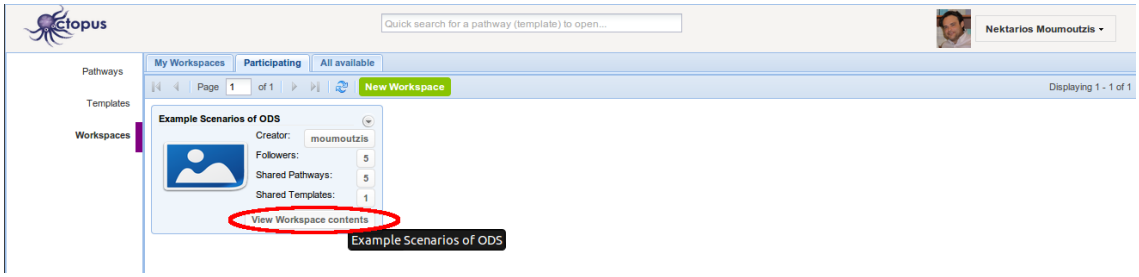


Figure 22: After the owner of the workspace has approved your request, you will see that the appearance of the 'Example Scenarios of ODS' rectangle changes and you are now offered with the option to 'View Workspace contents'

You are now able to see the Pathways shared through the workspace as shown below in Figure 23. Click on the tab 'Templates'.

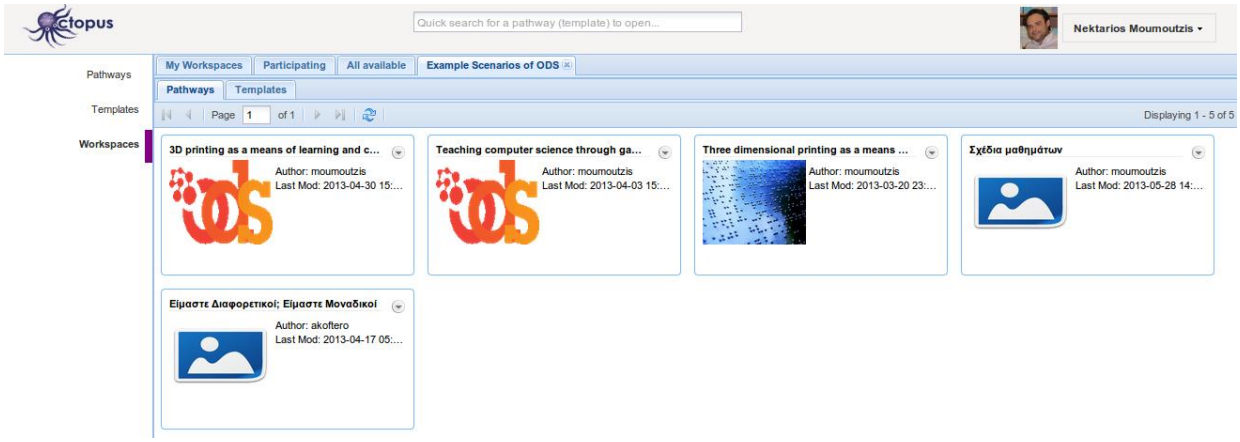


Figure 23: The pathways and the templates shared in a workspace

4.4.4.5. Creating a new pathway from an existing template

You are now able to see the available templates in the 'Example Scenarios of ODS' workspace. There is only one template available Figure 24, which is essentially based on the actual template that the ODS project has elaborated to enable the creation of scenarios in a general way that could accommodate any pedagogical approach. Let us use this template to develop a new scenario. We will use the material for the scenario presented in Annex B entitled 'The Design Challenge'. Of course, you are free to work out your own scenario when following this guide.

Figure 24 The available templates shared in a specific workspace.

To start creating the new pathway using the ODS template, click on the small button marked with a small arrowhead pointing downwards, on the right of the template title, to show the pop-up menu depicted in the screenshot below in Figure 25. Select the ‘Use this Template’ item on the pop-up menu.

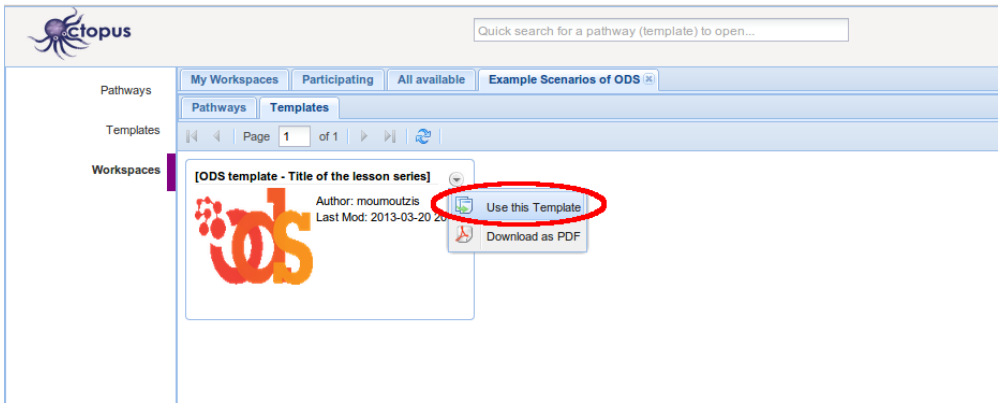


Figure 25: Create a new pathway using a specific template. Click on the small button marked with a small arrowhead pointing downwards, on the right of the template title, to show the pop-up menu. Press “Use this Template” button to create a new pathway based on the corresponding template.

A new pathway is created and the page for editing this new pathway is presented as shown in the screenshot below in Figure 26. On the left side of the page you can see a graphical representation of the hierarchical structure of the pathway (its phases, depicted as red-bulleted items, its composite activities depicted as green-bulleted items and its learning activities depicted as yellow-bulleted items. On the ‘info’ pane on the middle of the page you can see the title and the description of the selected item in the hierarchy on the left. You are now able to edit this information presented on the ‘info’ pane.

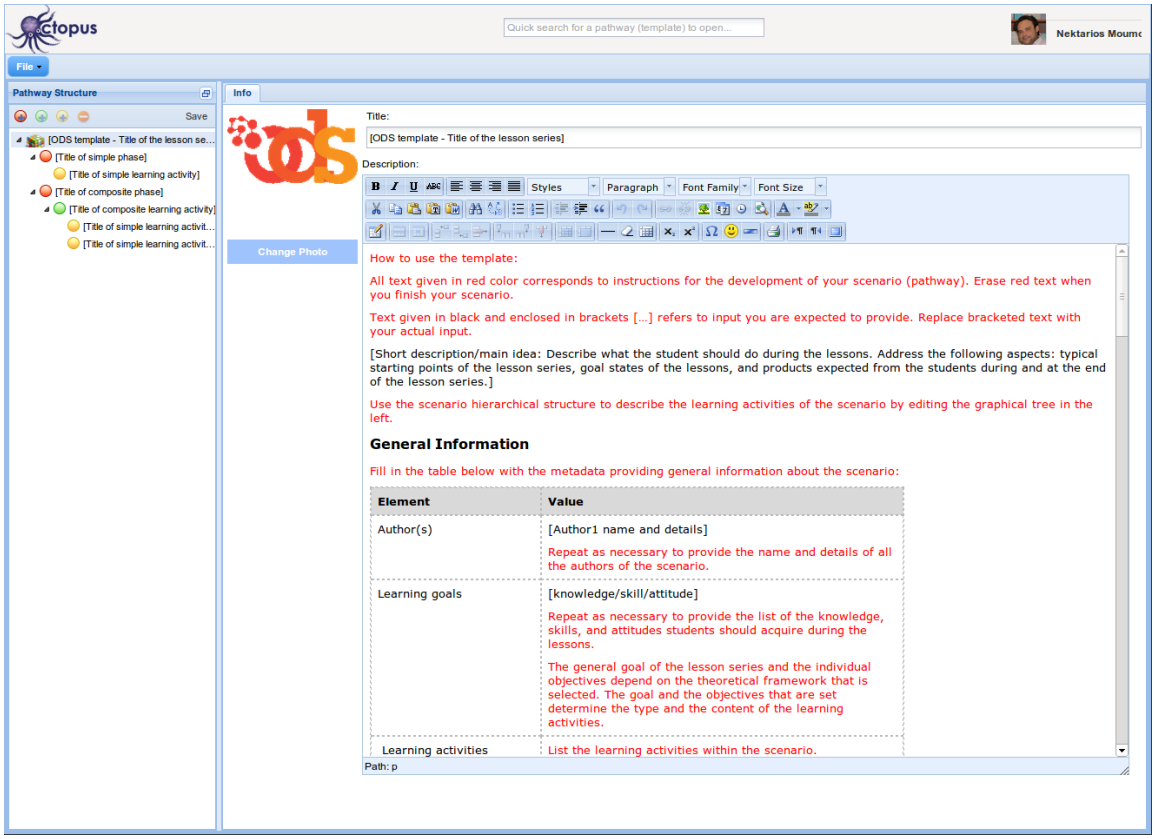


Figure 26: A new pathway is created and the page for editing this new pathway is presented as shown. On the left side of the page you can see a graphical representation of the hierarchical structure of the pathway (its phases, depicted as red-bulleted items, its composite activities depicted as green-bulleted items and its learning activities depicted as yellow-bulleted items. On the 'info' pane on the middle of the page you can see the title and the description of the selected item in the hierarchy on the left. You are now able to edit this information presented on the 'info' pane.

4.4.4.6. Editing the new pathway

To start with, let us change the title of the new pathway. Be sure that the item representing the whole pathway is selected on the tree view on the left. Then, click on the Title field and change the title to "THE DESIGN CHALLENGE". Notice that the tree view on the left changes to show the new pathway title in Figure 27.

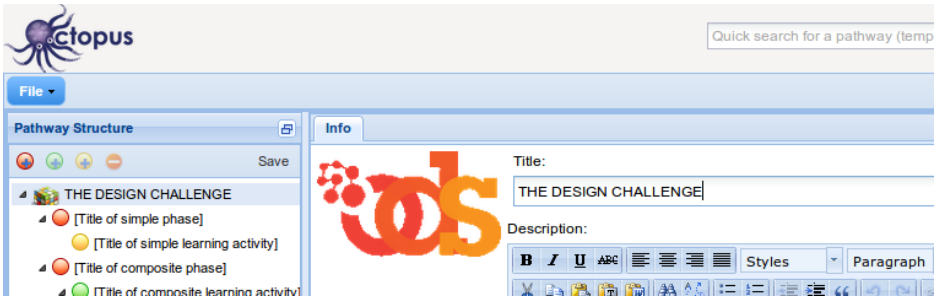


Figure 27: Change the title of the new pathway. Be sure that the item representing the whole pathway is selected on the tree view on the left. Then, click on the Title field and change the title to "THE DESIGN CHALLENGE". Notice that the tree view on the left changes to show the new pathway title.

Now, go no to change the description under the title field. The description field supports a simple WYSIWYG editor that allows you to create tables, format the text you enter, change the paragraph justification, and create bulleted or numbered lists and many more. In the following screenshot Figure 28, you can see how the description has been changed to present general information and the learning context within which THE DESIGN CHALLENG SCENARIO is to be implemented.

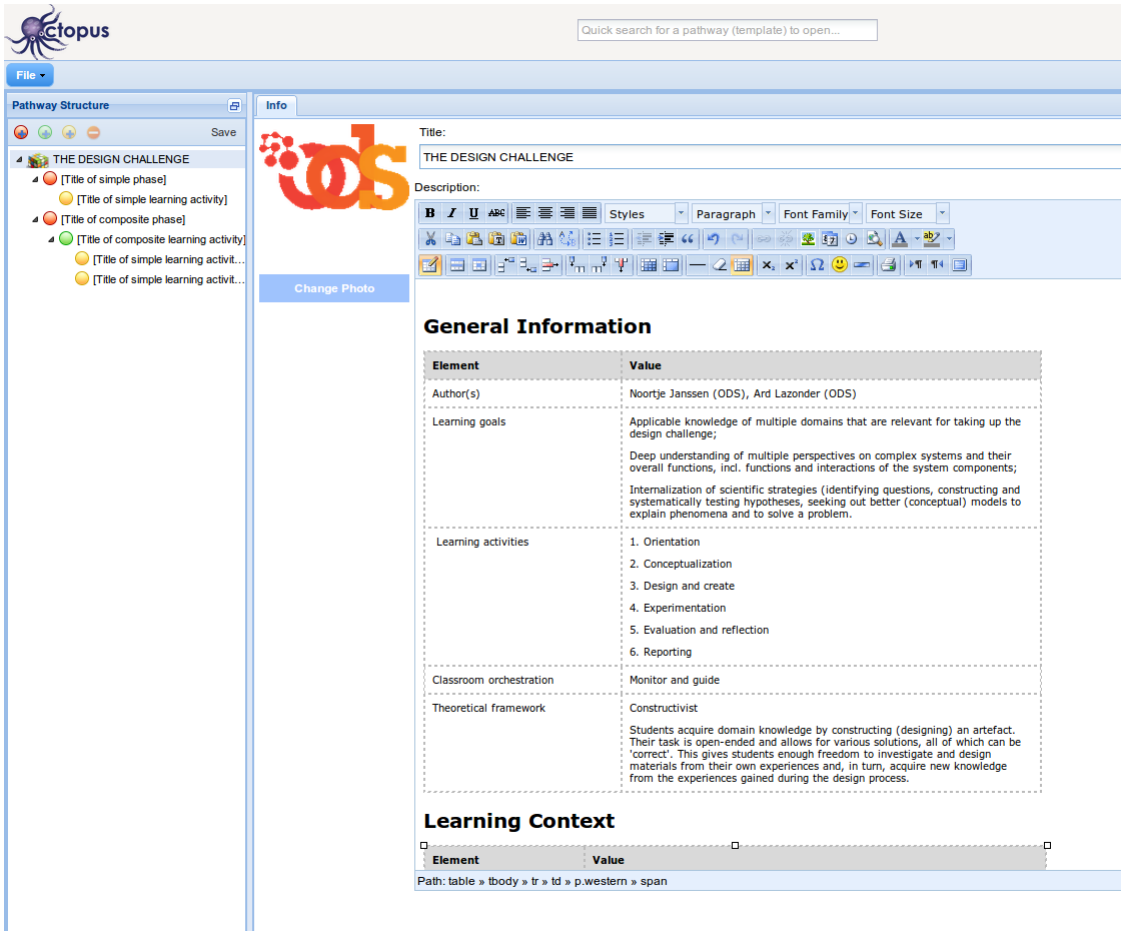


Figure 28 : Change the description of an item. As you can see, the description can been changed to present general information and the learning context within which THE DESIGN CHALLENG SCENARIO is to be implemented.

Let us see now how you could change the icon of the pathway. To do this, you first have to click on the ‘Change Photo’ button as shown in the Figure 29:

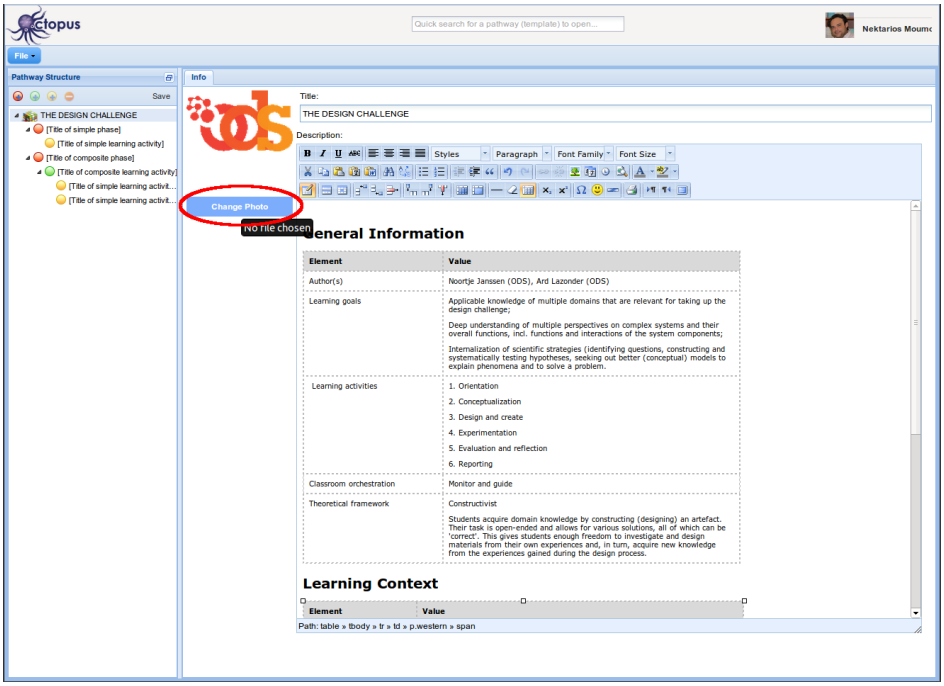


Figure 29 : Change the the icon of the pathway. To do this, you first have to click on the 'Change Photo' button as shown.

Then, a file dialogue opens (see Figure 30) so that you could browse on your local drive and locate an image to be used as your pathway's icon. Select the desired image and click 'Open'.

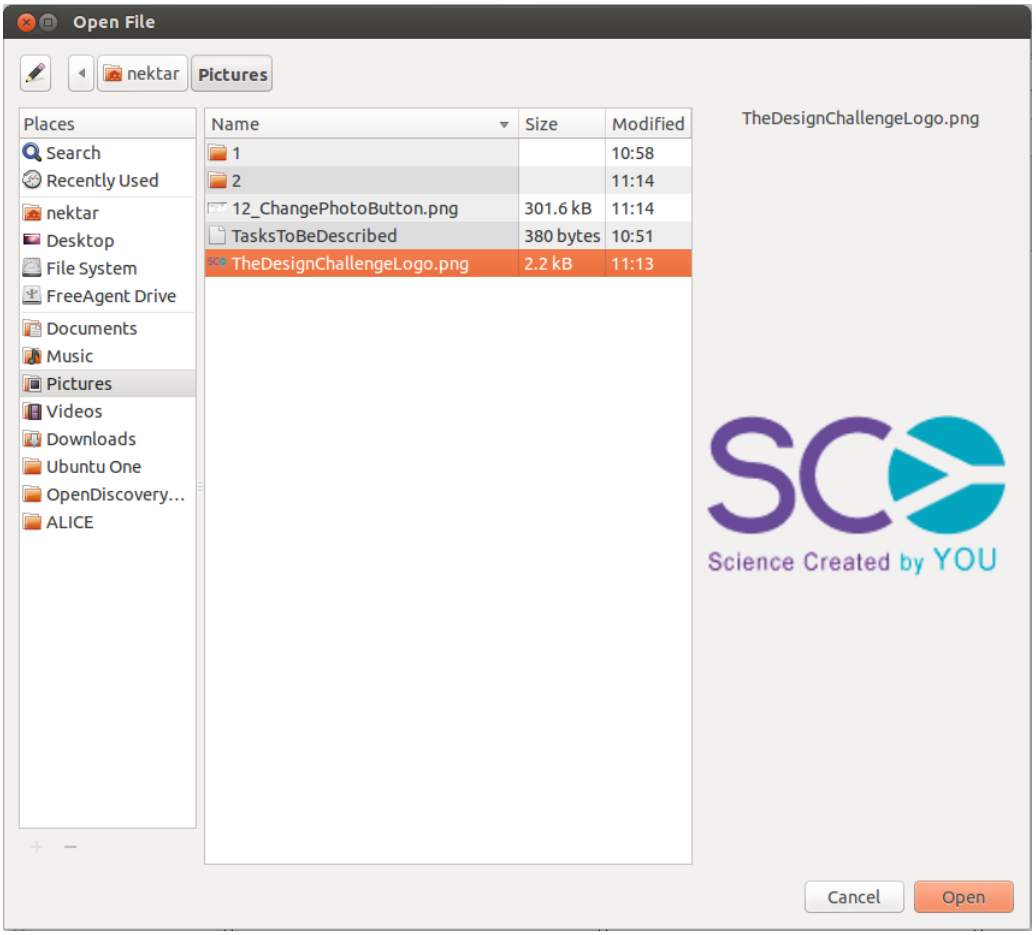


Figure 30: A file dialogue opens so that you could browse on your local drive and locate an image to be used as your pathway's icon. Select the desired image and click 'Open'

After selecting the image you want, you can see it in your pathway as shown in Figure 31. You can change it again whenever you want.

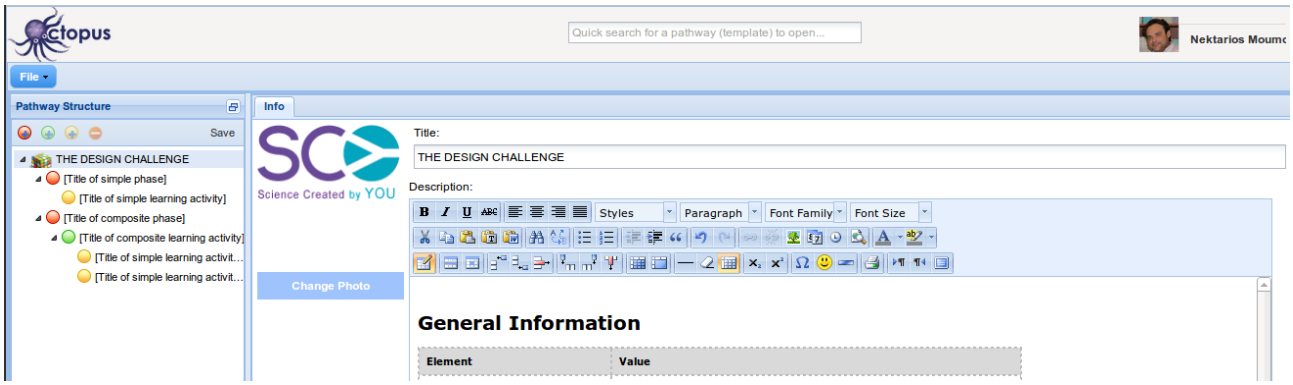


Figure 31: After selecting the image you want, you can see it in your pathway as shown below. You can change it again whenever you want.

4.4.4.7. Editing the learning activities of a pathway

Having finished with the information that refer to the new pathway as a whole, we are now ready to describe how the pathway is to be implemented in terms of the specific learning activities to be done by students. Our example scenario consists of six learning activities as described in Annex B of this document:

1. Orientation
2. Conceptualization
3. Design and create
4. Experimentation
5. Evaluation and reflection
6. Reporting

All these activities are simple activities without further structure underneath. Consequently, we would first delete the structures offered by the ODS template that are intended for the description of composite activities. This is shown in the Figure 32: First right-click on the phase that contains the composite activity (green-bulleted item) and then select ‘Delete’ in the pop-up menu.

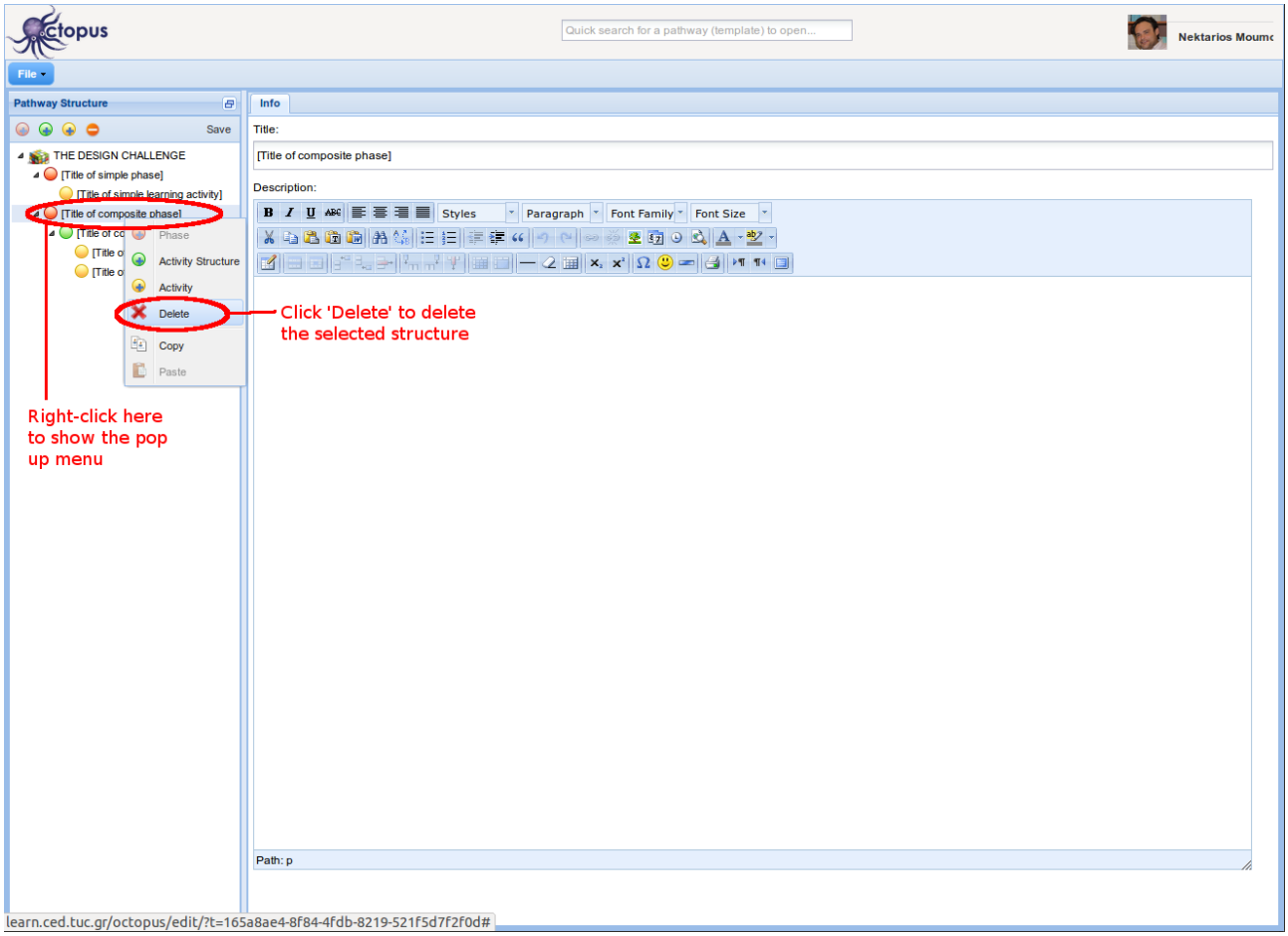


Figure 32 example scenario consists of six learning activities as described in Annex B of this document: 1. Orientation 2. Conceptualization 3. Design and create 4. Experimentation 5. Evaluation and reflection 6. Reporting All these activities are simple activities without further structure underneath. Consequently, we would first delete the structures offered by the ODS template that are intended for the description of composite activities. This is shown in the screenshot below: First right-click on the phase that contains the composite activity (green-bulleted item) and then select 'Delete' in the pop-up menu

Click yes in the confirmation dialog box that appears in Figure 33:

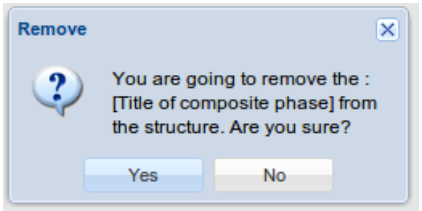


Figure 33: Delete confirmation Message.

You should see a structure like the one depicted in the following Figure 34:

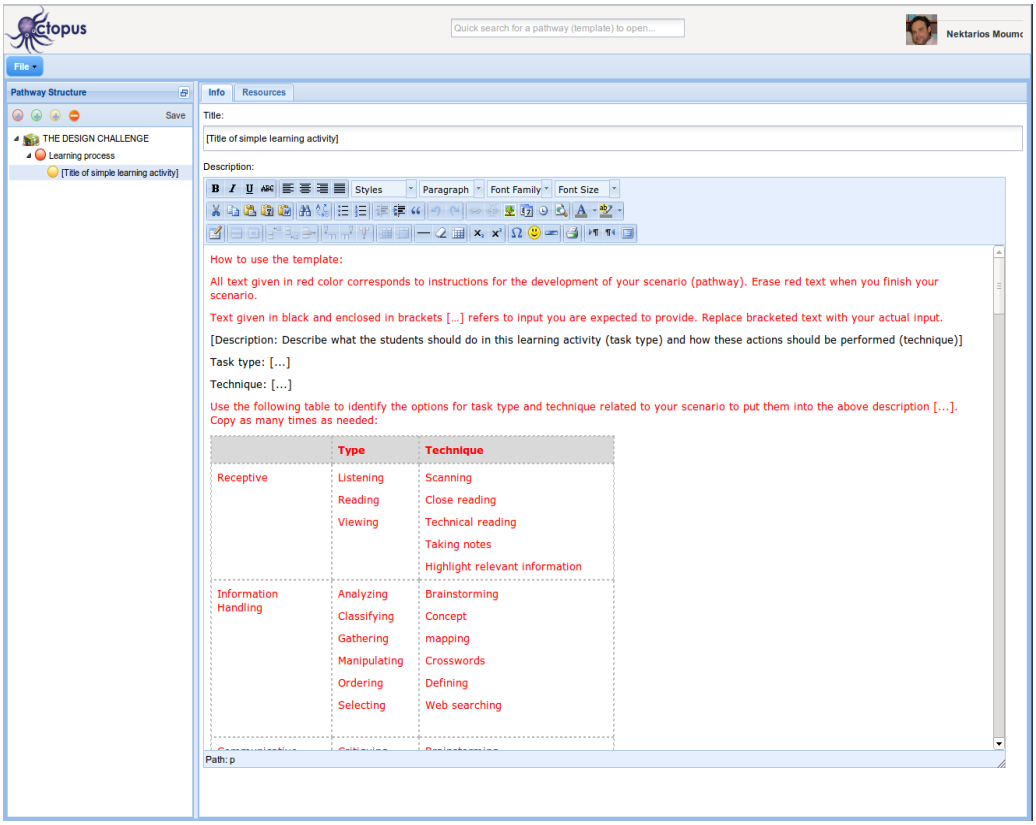


Figure 34 after a successful deletion

Now we are ready to create the six learning activities in our scenario. To facilitate our work we would first copy the one learning activity of the scenario so that we have six learning activities and then start editing each one of them.

To copy a learning activity, you right-click on it in the tree view on the left and you select ‘Copy’ in the pop-up menu as shown in Figure 35.

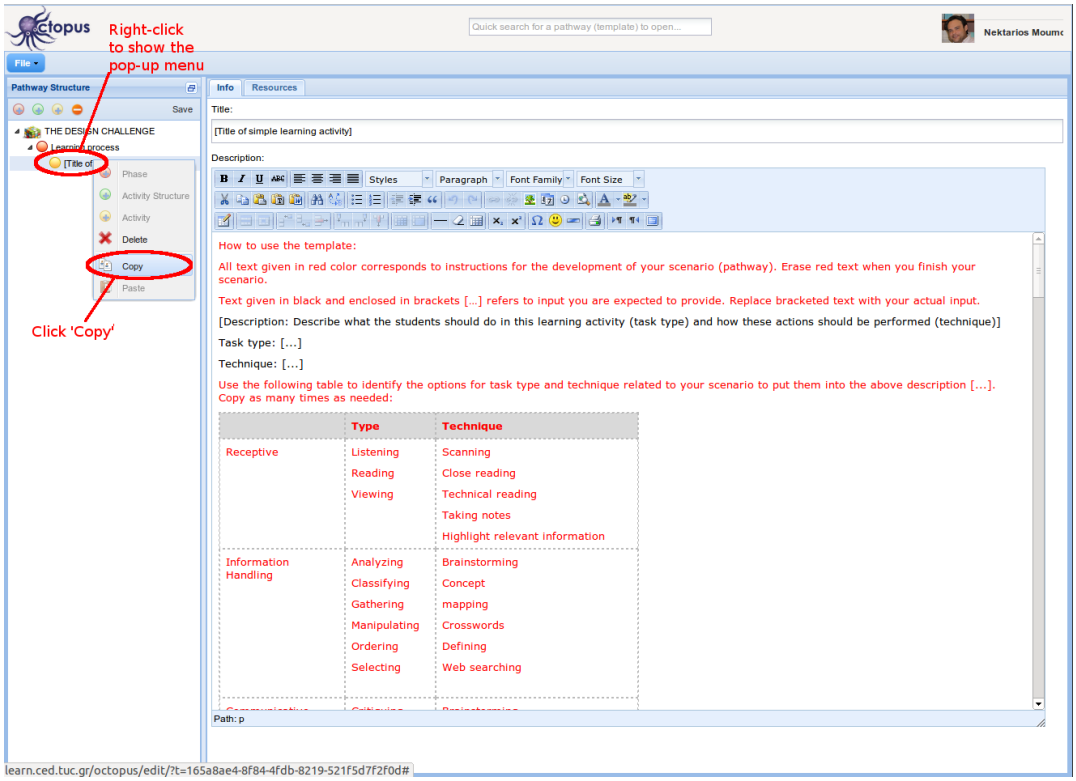


Figure 35: To copy a learning activity, you right-click on it in the tree view on the left and you select 'Copy' in the pop-up menu.

Then you could right-click wherever you want to paste it and select the 'Paste' option on the pop-up menu as shown in the Figure 36.

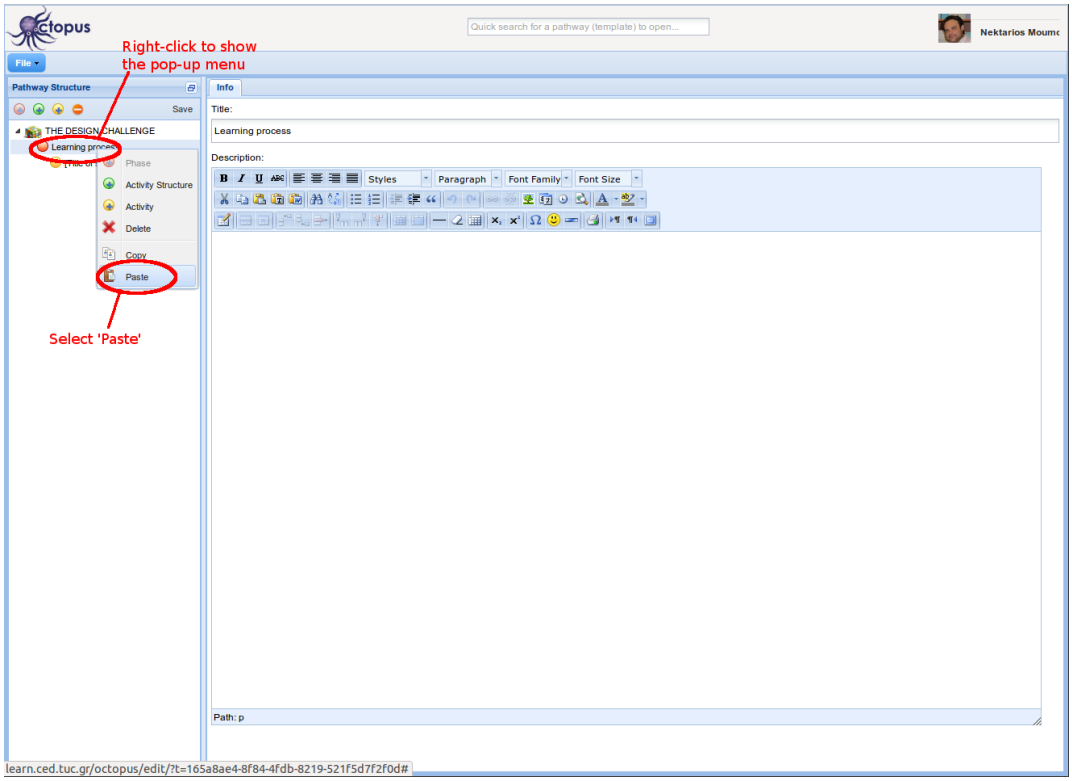


Figure 36: You could right-click wherever you want to paste it and select the 'Paste' option on the pop-up menu as shown in the next screenshot

After repeating five times the above copy-paste process, you will have a structure like the one depicted in the following Figure 37:

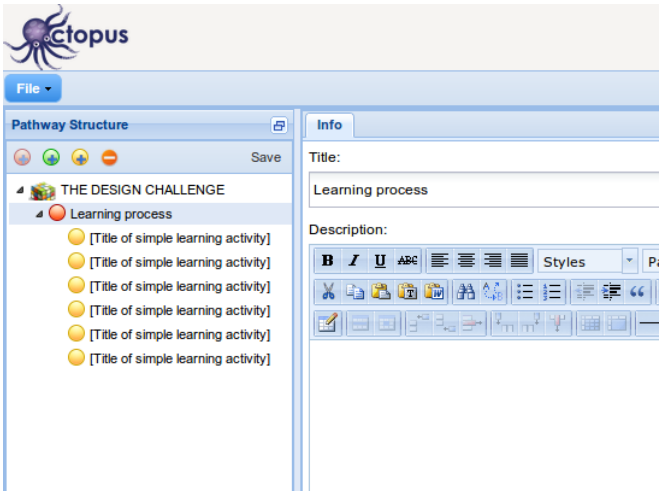


Figure 37 : Repeating five times the above copy-paste process, you will have a structure like the one depicted in the following

Now, you could start editing one-by-one the learning activities. First, you enter the title of the first learning activity (Orientation) as shown in Figure 38:

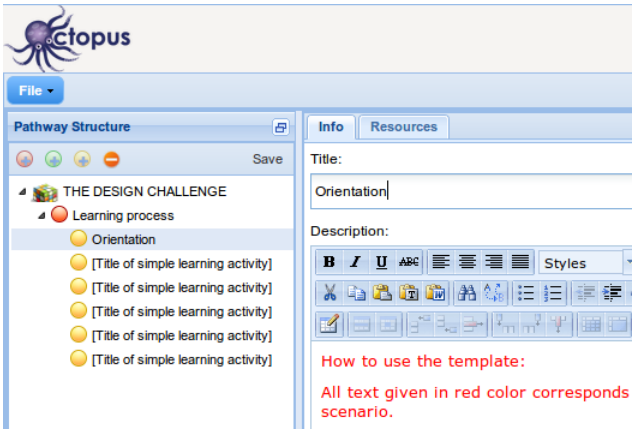


Figure 38 editing the new activities

Then, you provide a description for this learning activity as shown in the Figure 39:

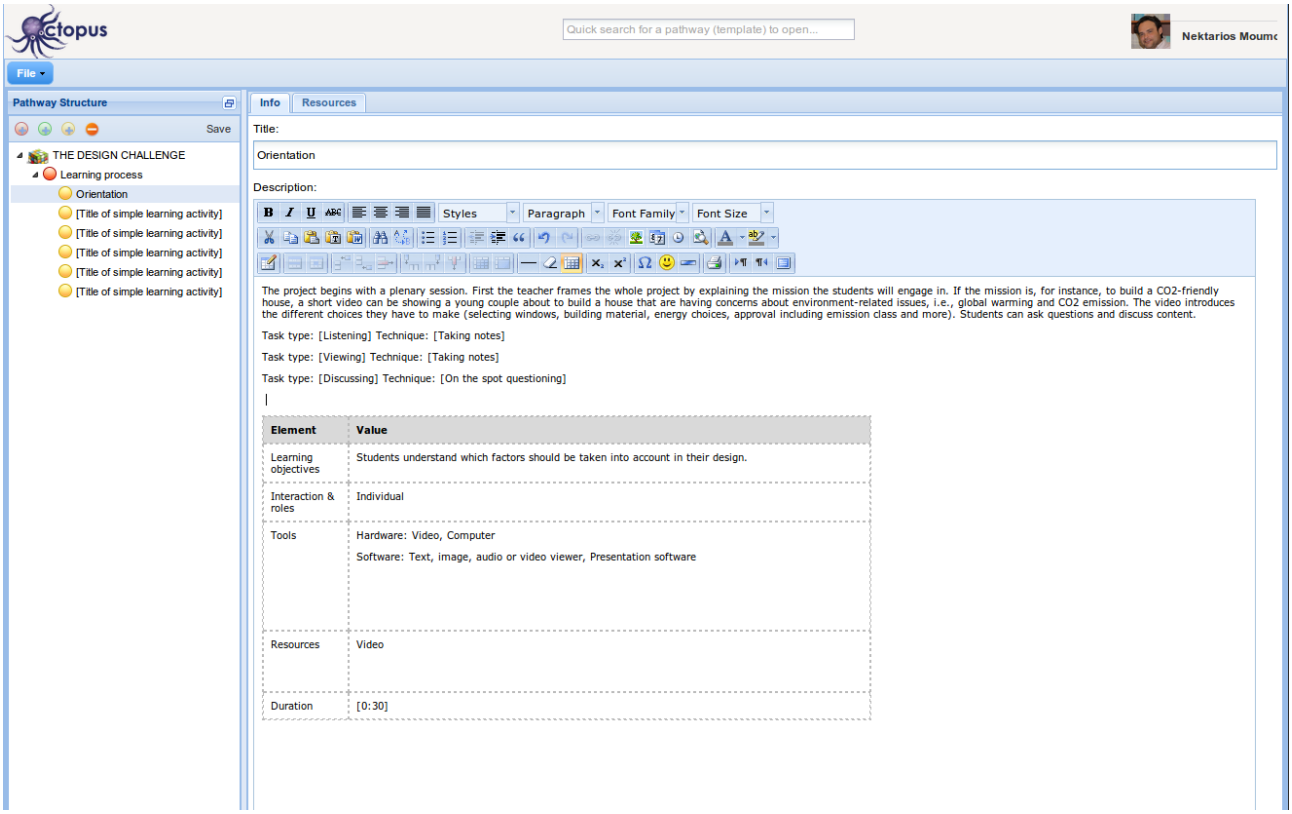


Figure 39 : Provide a new description for the activity

You continue with the second learning activity (Conceptualization) in Figure 40:

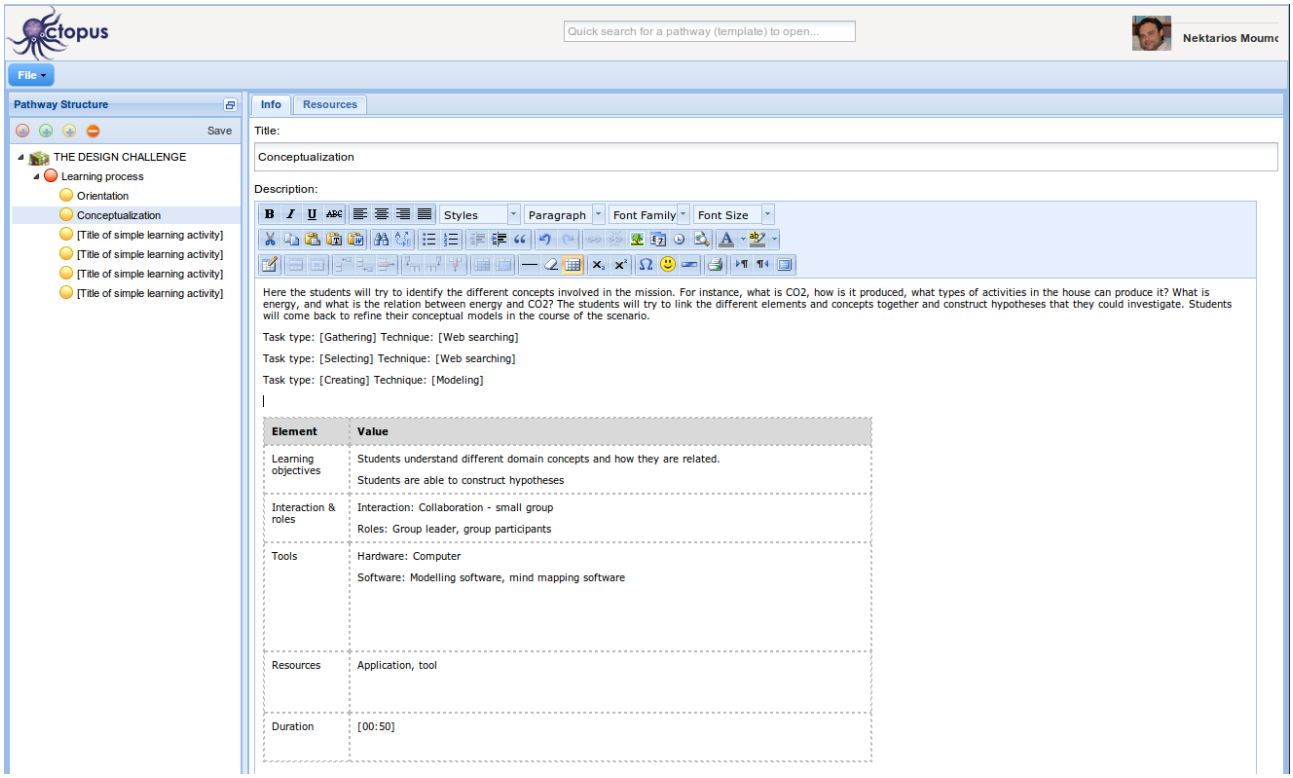


Figure 40: Change the description of the second activity

You continue with the rest of the learning activities and finally you have all six learning activities as shown in Figure 41:

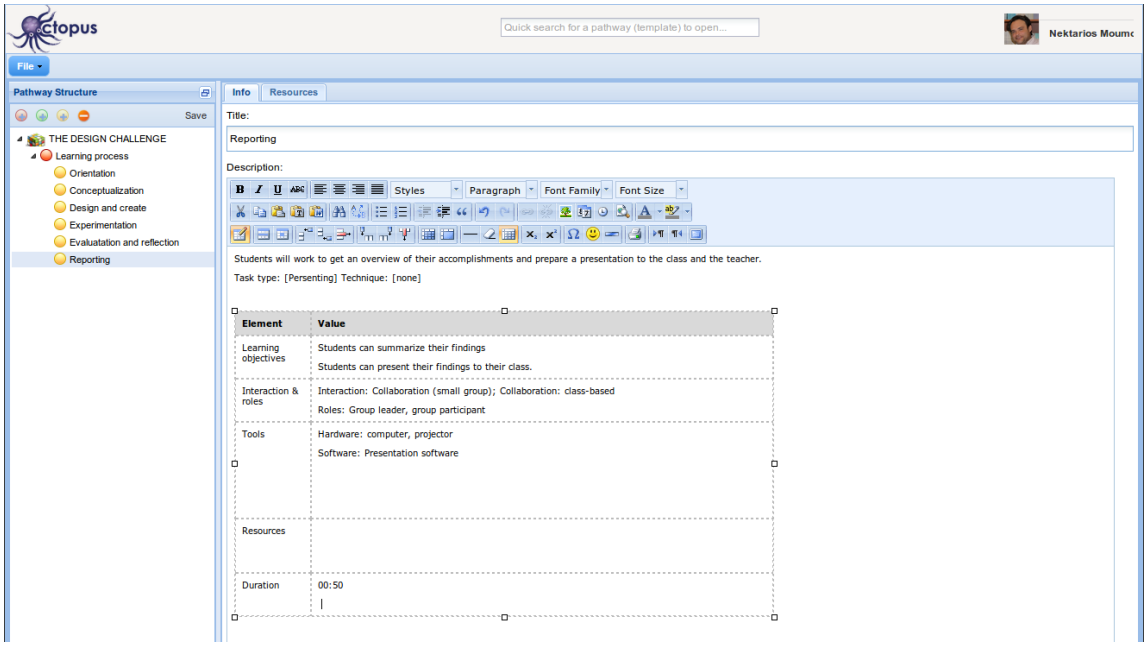


Figure 41 : Continue to the last activity and change its description

4.4.4.8. Enriching learning activities with resources

Now, it's time to see how you could enrich the learning activities of your scenario with resources, i.e. Digital content that could be used during their implementation by the students. Let us assume that you want to enrich the second learning activity with a new resource. Select the learning activity by clicking on its node in the tree view on the left. Then select the 'Resources' tab on the main page pane. Initially you could see a list of resources that have been defined in the template, as examples. Delete them one-by-one by clicking on the red X's as shown in Figure 42.

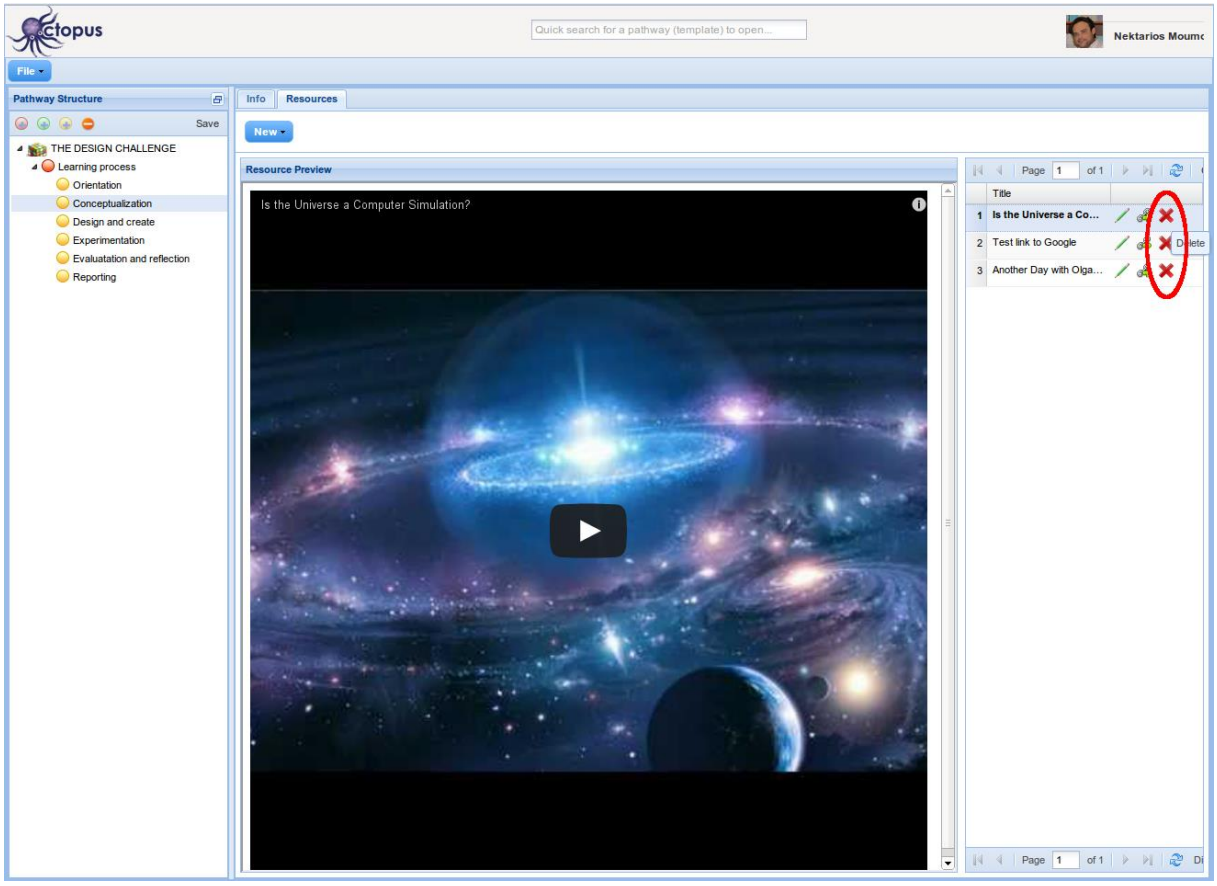


Figure 42 : Enrich the learning activities of your scenario with resources, i.e. Digital content that could be used during their implementation by the students. Select the learning activity by clicking on its node in the tree view on the left. Then select the 'Resources' tab on the main page pane. Initially you could see a list of resources that have been defined in the template, as examples. Delete them one-by-one by clicking on the red X's

Each time, you have to confirm your delete action by clicking 'Yes' on the corresponding dialogue box Figure 43:

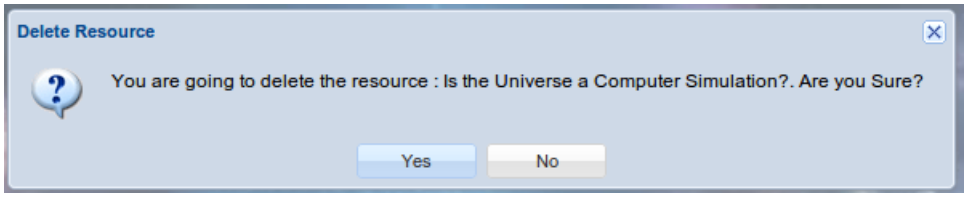


Figure 43: Confirmation message of a delete action.

After deleting all the irrelevant resources, press the 'New' blue button and select the 'Add Link' option in the menu that shows up. We assume here that the resource that we will attach to the "Conceptualization" learning activity, is a web page. In case you want to upload a file from your local drive or find digital content from external sources (Europeana, YouTube), you just have to select the corresponding options in the menu shown in Figure 44.

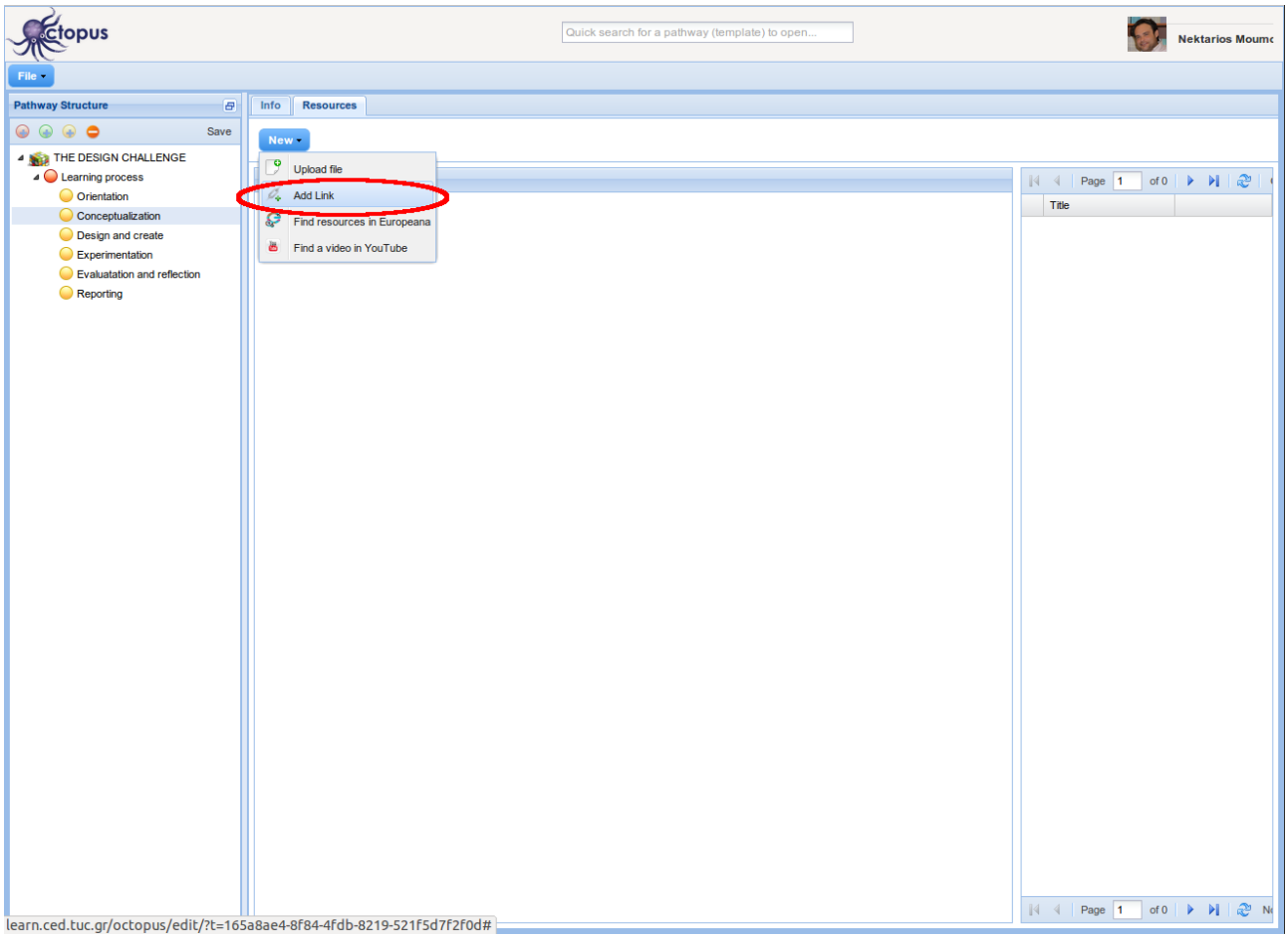


Figure 44: Add new resource to the activity

Assuming that you selected to add a link, the next dialogue box prompts you to provide the link that points to the resource you want to add in the learning activity as depicts the Figure 45:

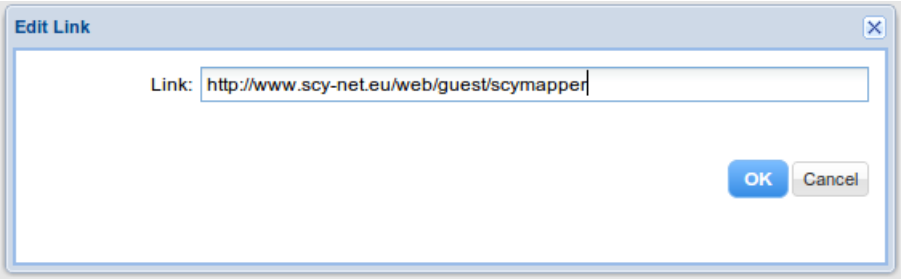


Figure 45 : Add a link as a resource in the activity

Give the link and click 'OK. A new dialogue box shows up so that you could provide more information about the resource like its title, the time needed for students to consume the resource and a textual description:

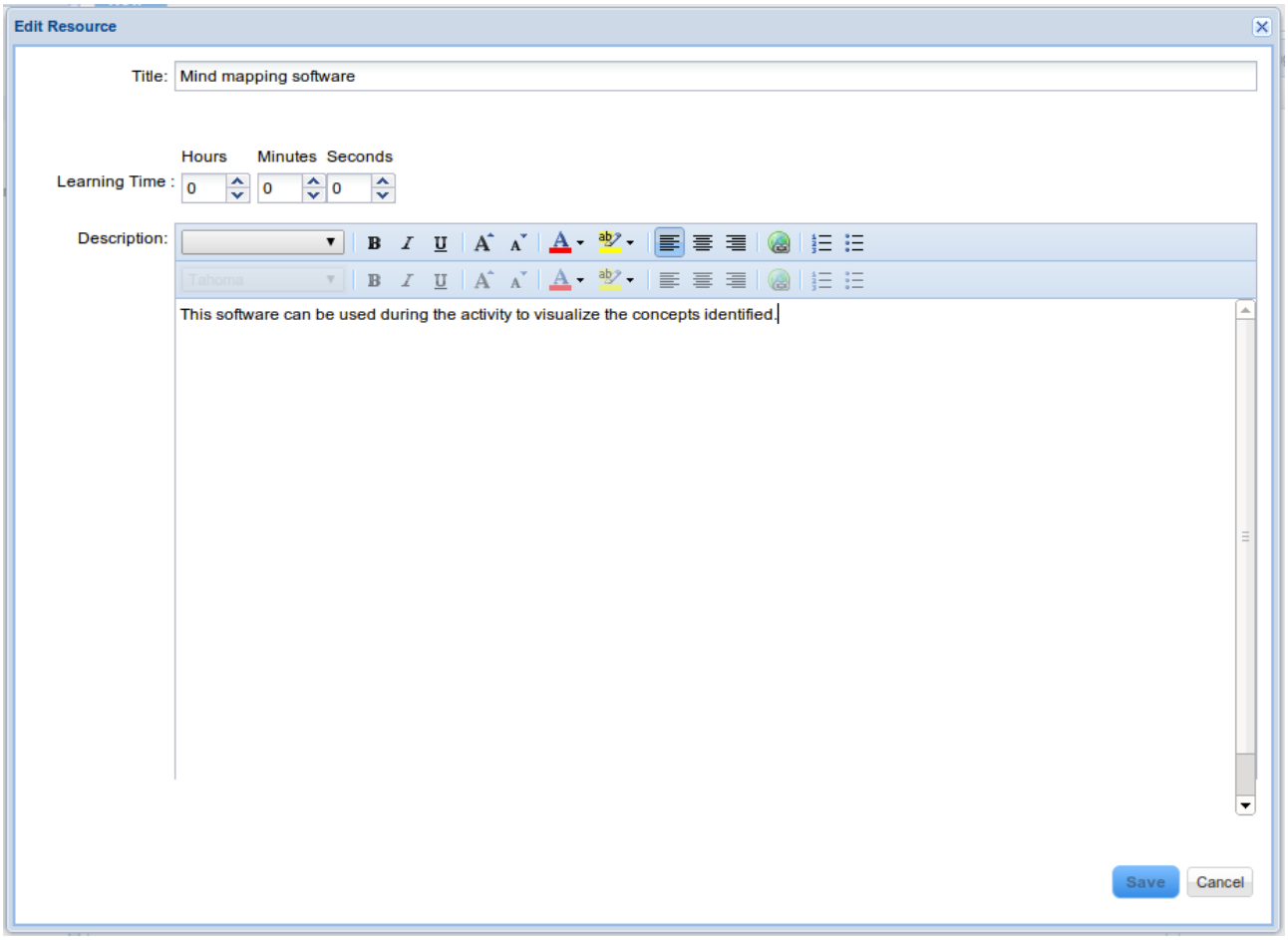


Figure 46: Provide detailed description for a resource

After you finish editing this information, click 'Save'. You are able now to see that the new resource has been added in the list of the resources for the selected learning activity. Furthermore, a preview of the resource is shown in the main pane of the page.

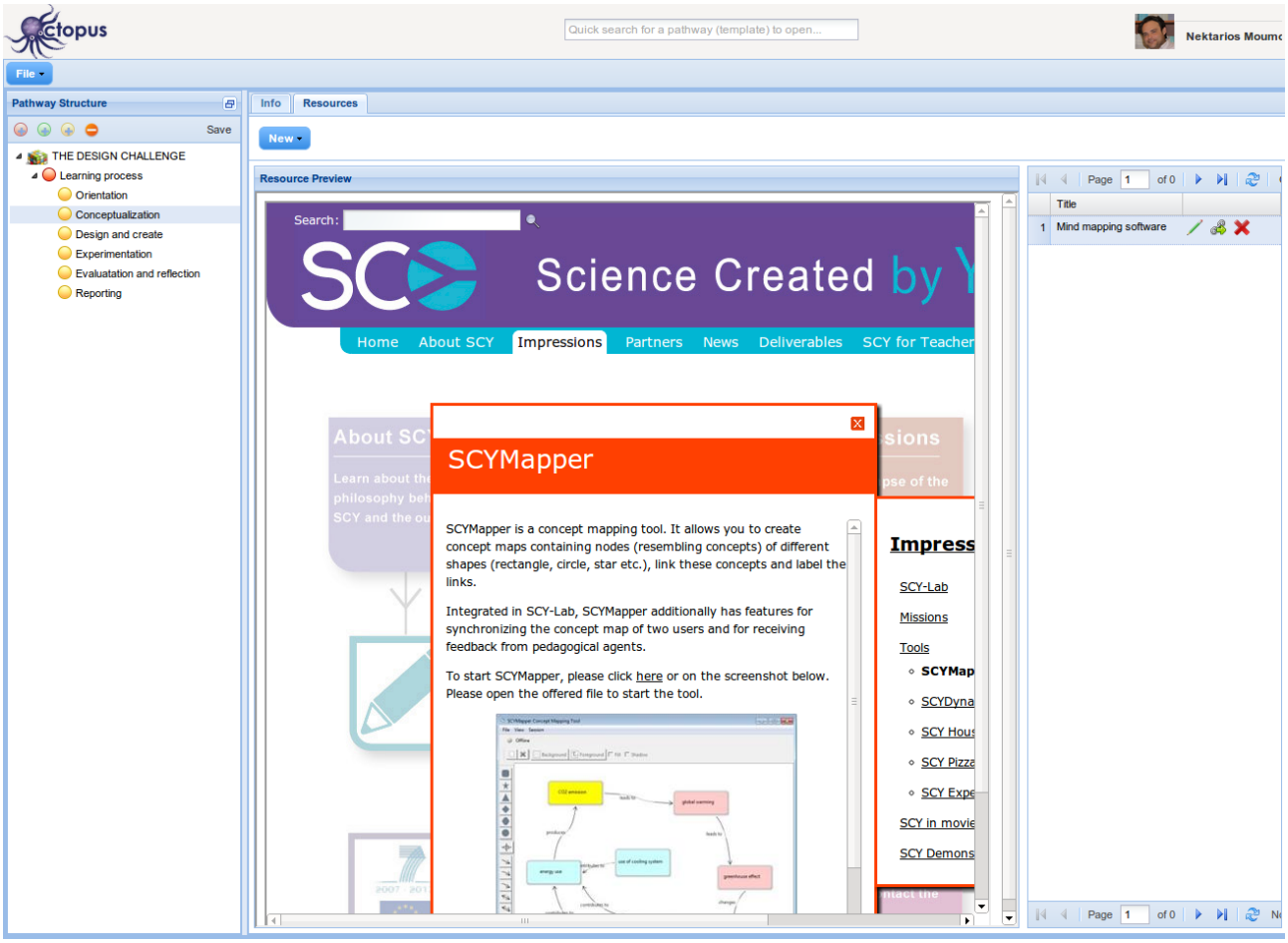


Figure 47 The preview of resource

Following the same process, you could enrich your pathway with all the resources that are necessary for the implementation of each one of its learning activities. In the following sections we will see that it is also possible to enrich with resources pathways that are created by other Octopus users. Finally, you may share your own pathways within a Workspace and enable other users to enrich them with resources.

4.4.5. Reusing parts of a pathway

Octopus supports drag-and-drop reorganization and reuse of activities and activity structures. Within a pathway you could drag the node to be moved and drop it at the point you want to paste it. You could also copy/paste nodes within a pathway. This can be done with the pop-up menu shown when right-clicking on a node.

To reuse nodes from other pathways (or templates) you have to open the "Copy structure" pane, find the scenario containing the structure to be copied and then drag-and-drop it to the desired location or copy/paste it. This process is demonstrated in the following screenshots:

4.4.5.1. Copy/paste within the same scenario

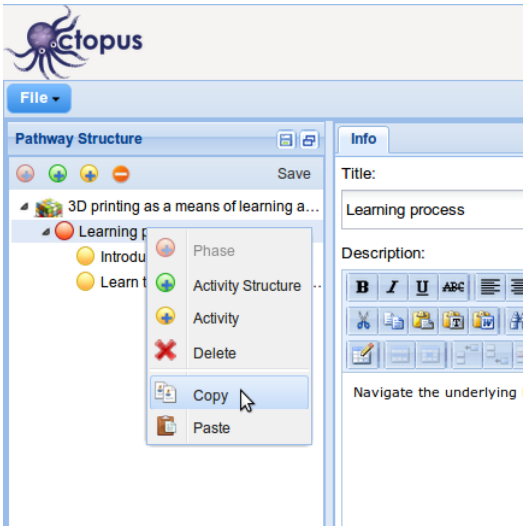


Figure 48 : Copy a specific item of the structure by pressing the "Copy" button in the pop-up menu.

To copy an activity, you first right-click on it and the pop-up menu shows up. Then select the menu item "Copy".

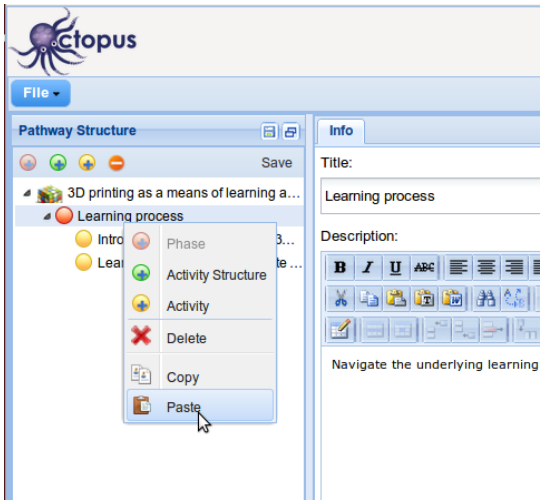


Figure 49 : Paste an Activity : right-click on the node where we want to paste the copied activity and select "Paste" in the pop up menu

Then we right-click on the node where we want to paste the copied activity and select “Paste” in the pop up menu.

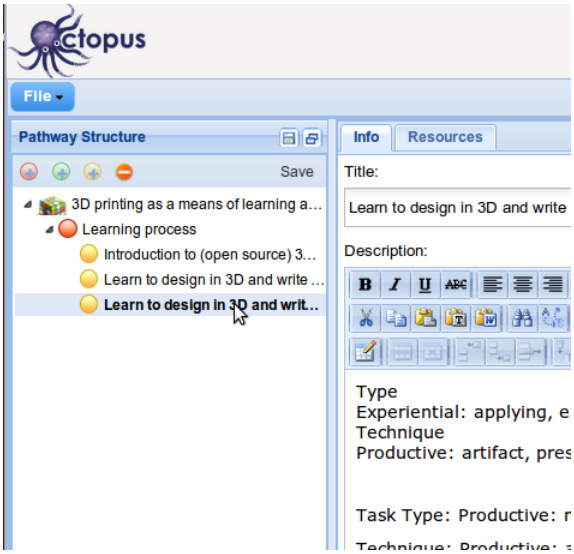


Figure 50: The result of the "Paste" action

The structure is copied in the new position:

4.4.5.2. Drag & drop within the same scenario

First, wewe select a learning activity within a pathway and start dragging it.

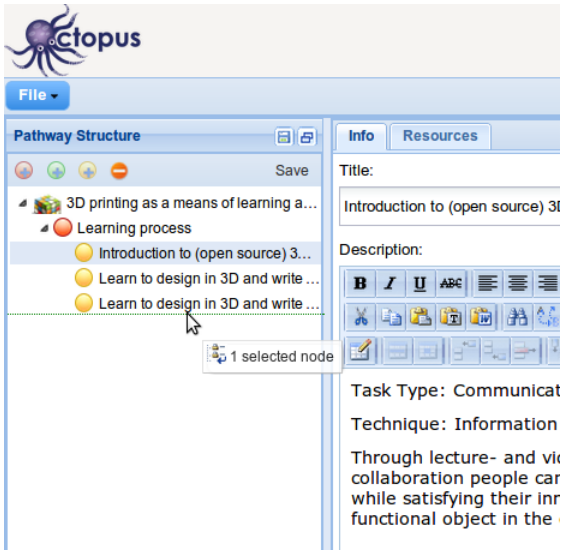


Figure 51 : Drag n Drop functionality. Click on a node, keep mouse button pressed and drag the node to the new position.

Then we drop it to the desired location:

The new structure of the pathway contains the activity moved to the new position:

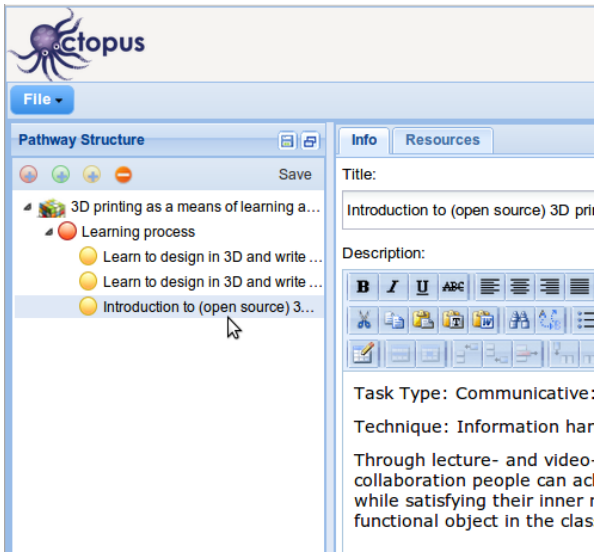


Figure 52 : Drop the node in a new position

4.4.5.3. Reusing activities and activity structures from other scenarios / templates

Finally, let us see how structures from other pathways/templates could be reused in the scenario that we are editing: First open the “Copy Structure” pane, find a scenario/template to copy from and then select the structure to drag to the initial pathway:

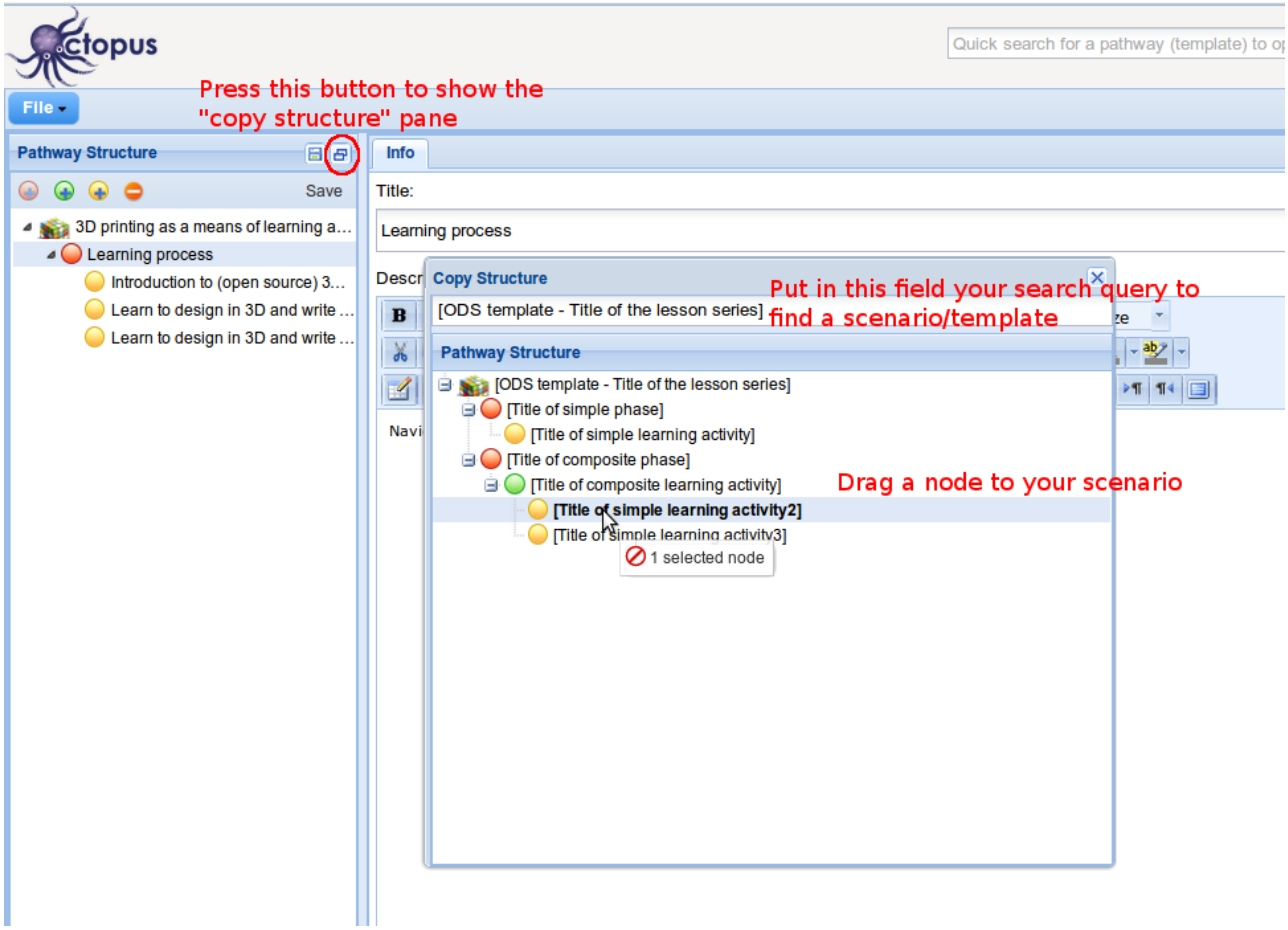


Figure 53 : let us see how structures from other pathways/templates could be reused in the scenario that we are editing: First open the “Copy Structure” pane, find a scenario/template to copy from and then select the structure to drag to the initial pathway

Drop at the node of your scenario where the structure should be placed.

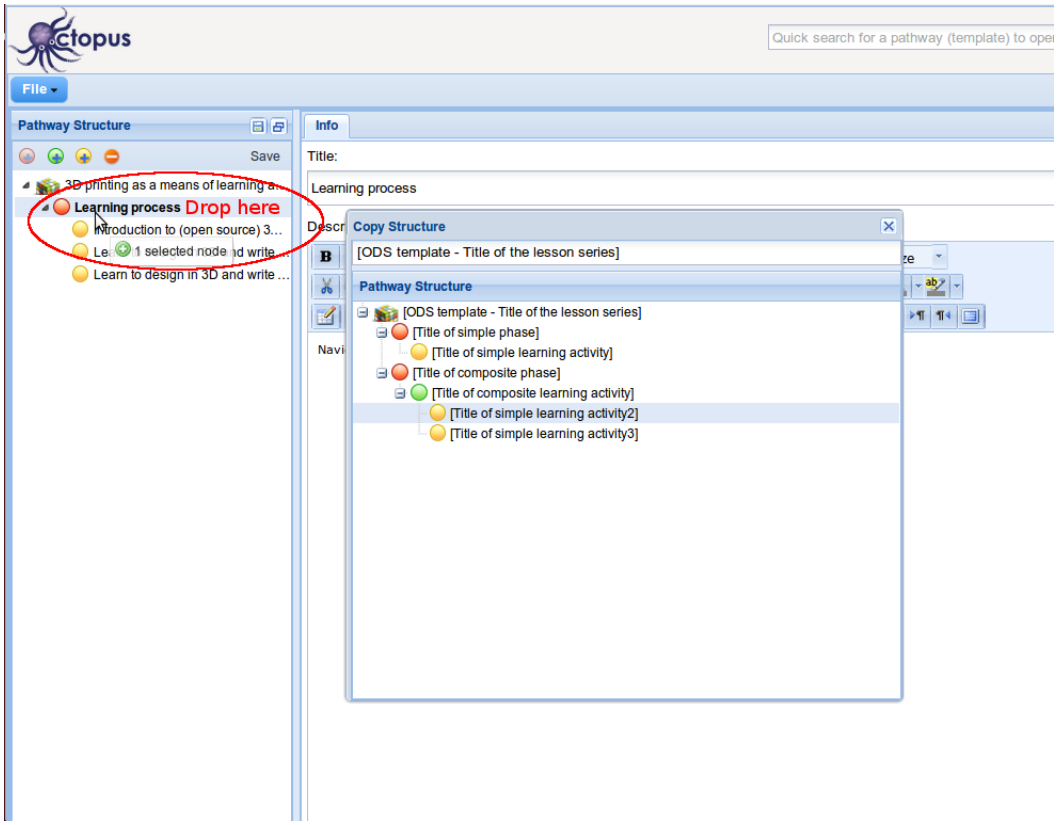


Figure 54 : Drop at the node of your scenario where the structure should be placed

Finally, the new node is shown in your pathway:

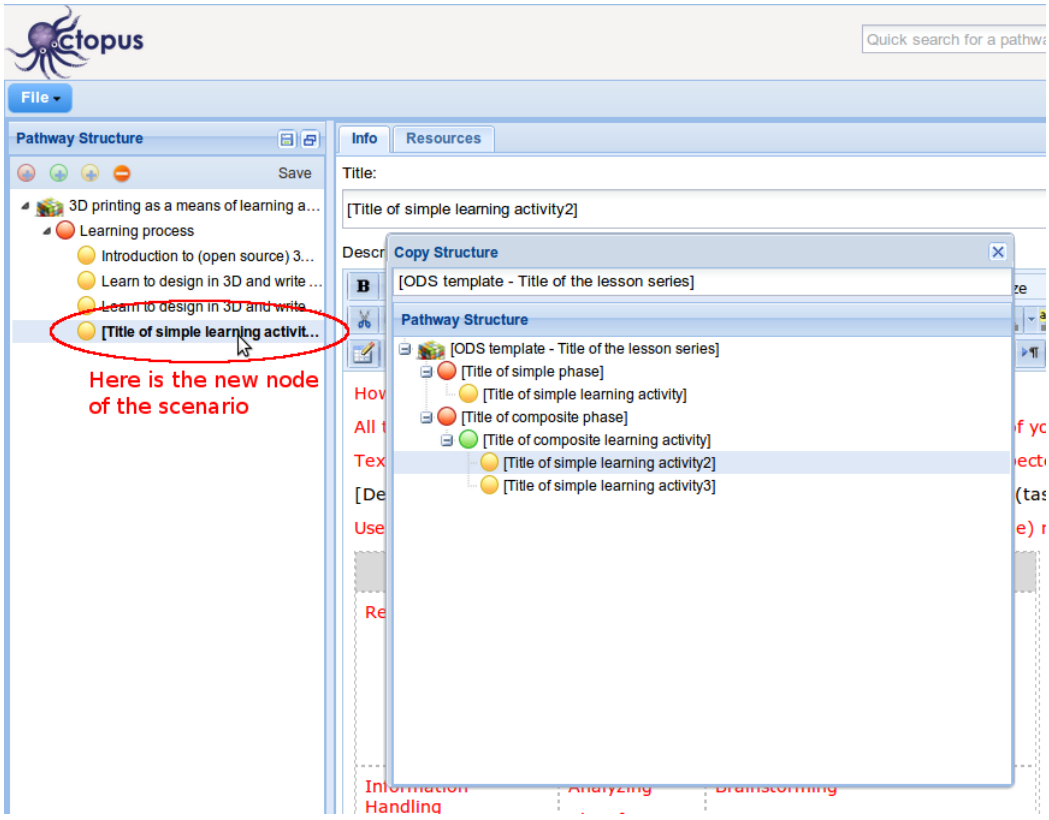


Figure 55 : the result of the Drop action

4.4.5.4. Copy/paste parts of another pathway

Use the “Copy structure” pane to copy a node and paste it in the pathway you are editing just like you paste structure from the same pathway (see description of copy 4. Access rights to scenarios/paste within the same pathway).

4.4.6. Creation and management of workspaces

As already presented, a workspace in Octopus offers a way of sharing pathways and templates among a group of users, the members of the workspace. All Octopus users are able to join other workspaces or even create and manage their own workspaces. Workspaces are distinguished into public and private ones. Public workspaces are visible to all Octopus users so that they can send a join request. Private workspace are visible only to their members. The only way to join a private workspace is through the workspace owner which is able to add and remove members to the workspace. As soon as the owner of the workspace adds a user to it, the user is able to see the workspace and its contents through the Workspace view of his/her personal page.

Let us see now in more detail how you could create a workspace and how you could manage its members and contents.

4.4.6.1. Creation of a workspace

Let us assume that you have created a number of pathways that you want to share with other users through a workspace. The following screenshot depicts your Pathway view with four pathways already created (note that the pathways shown correspond to pedagogical scenarios and lesson plans specified by ODS pilot schools within the context of deliverable D4.3 Open Discovery Space Scenarios).

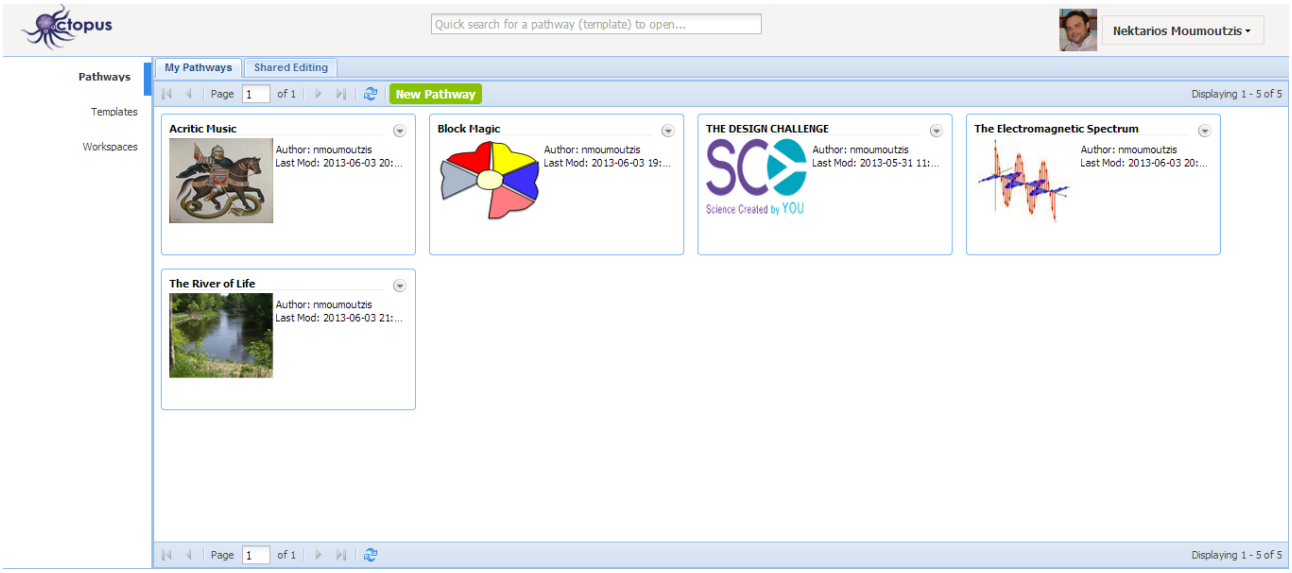


Figure 56 : Pathway view with four pathways already created (note that the pathways shown correspond to pedagogical scenarios and lesson plans specified by ODS pilot schools within the context of deliverable D4.3 Open Discovery Space Scenarios)

The first thing you have to do to create the new workspace is go to the Workspaces view by clicking on the corresponding item in the views' list on the left of your personal page. Then, click the 'New Workspace' button as shown in the screenshot below.

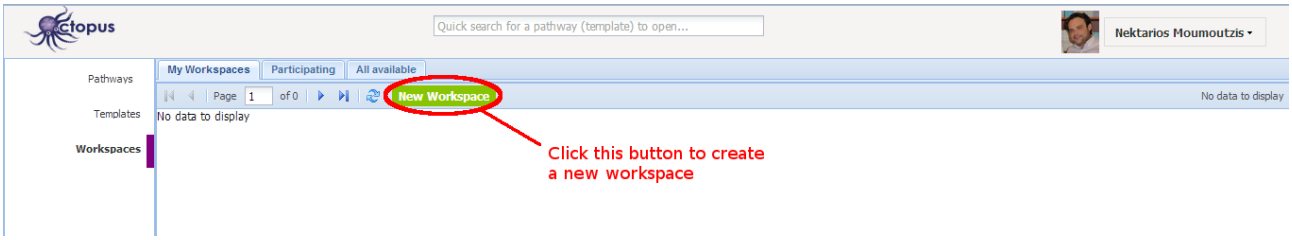


Figure 57 : the Workspaces view by clicking on the corresponding item in the views' list on the left of your personal page. Then, click the 'New Workspace' button

After clicking the 'New Workspace' button, a dialogue box shows up and prompts you to provide the necessary information in order to create the new workspace. In the screenshot below you may see this dialogue box filled with information including the new workspace name, its description and icon. Let us assume that in this workspace you want to share pedagogical scenarios and lesson plans that refer to Open Discovery Space pilot activities in Greece. A workspace could be 'Open' to any user to view its contents and request to join, or 'Private', i.e. accessible only by its creator. The default option is 'Open' which is the option we want in our example so that every user is able to join.

Figure 58 : provide the necessary information in order to create the new workspace. In the screenshot below you may see this dialogue box filled with information including the new workspace name, its description and icon. Let us assume that in this workspace you want to share pedagogical scenarios and lesson plans that refer to Open Discovery Space pilot activities in Greece. A workspace could be 'Open' to any user to view its contents and request to join, or 'Private', i.e. accessible only by its creator. The default option is 'Open' which is the option we want in our example so that every user is able to join

After you provide all the necessary information, click 'Save changes' to store the information for the new workspace and then 'Close' to close the dialogue box. The workspace has been created and you can see it represented as a box within your workspace under the 'My Workspaces' tab of the Workspaces view of your personal page as depicted below.

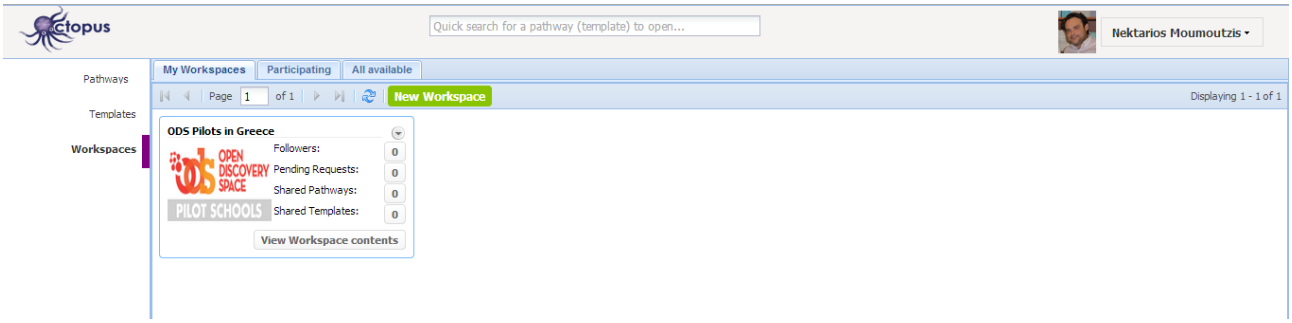


Figure 59 : The workspace has been created and you can see it represented as a box within your workspace under the 'My Workspaces' tab of the Workspaces

4.4.6.2. Approve requests of users to join your workspace

Being an 'Open' your newly created workspace is visible to all users so that they can request to join it. After sending a request to join, you are, as the creator of the workspace, able to review the pending requests and approve or reject them. For a description of this process please refer to section 2.1 of this user guide. In that section we have guided you through the process of requesting to join a workspace in order to be able to use a template for creating your first pathway. We have seen how the creator of that workspace was able to review and approve your request. Now, having created your own workspace, you are the one who manages the join requests of other users.

4.4.6.3. Adding/Browsing templates and pathways to a workspace

Let us see now how you could share your pathways within the new workspace you have created. Switch to the Pathways view in your personal page as shown below. Using the drop down menu of a pathway you may select to share it with a workspace (see below).

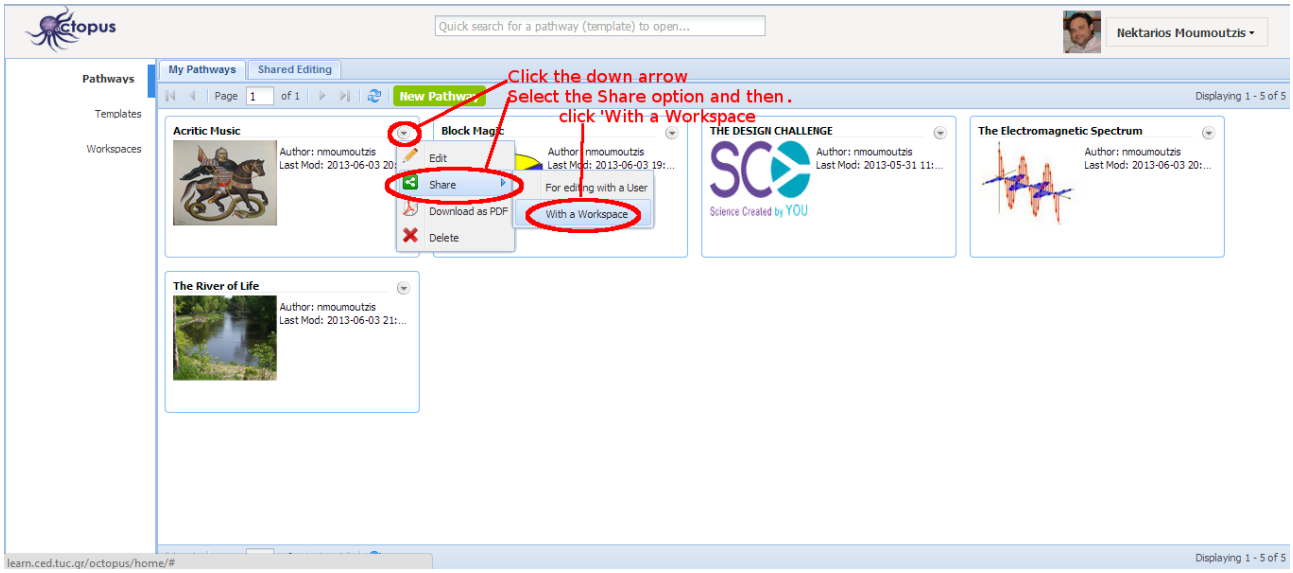


Figure 60 : you could share your pathways within the new workspace you have created. Switch to the Pathways view in your personal page as shown below. Using the drop down menu of a pathway you may select to share it with a workspace

You may select one or more workspaces with which to share your pathway as shown below. In the dialog box you can see a list of the workspaces. Click on the 'Share with' button to share the selected pathway with a specific workspace.

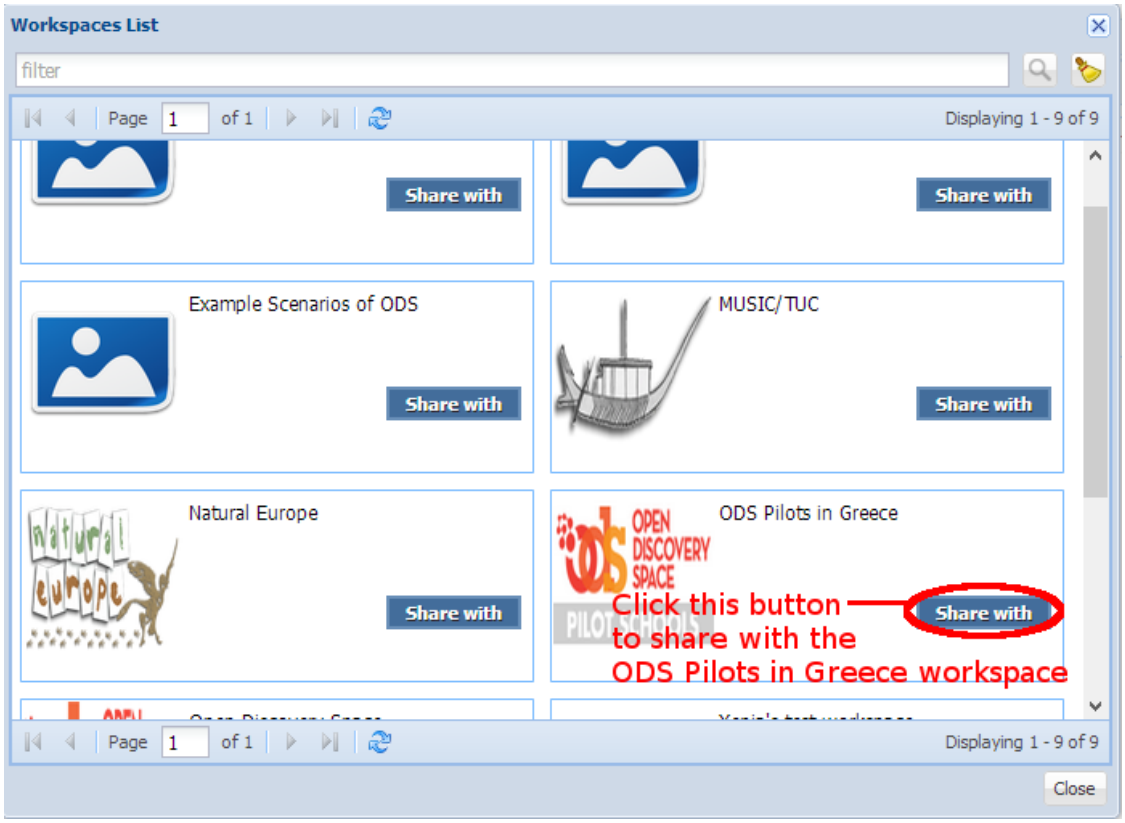


Figure 61 : Select one or more workspaces with which to share your pathway as shown below. In the dialog box you can see a list of the workspaces. Click on the 'Share with' button to share the selected pathway with a specific workspace.

As soon as you select a workspace to share your pathway the corresponding 'Share with' button changes to 'Stop sharing' to offer to you the capability to stop sharing the pathway in that workspace, if you want:

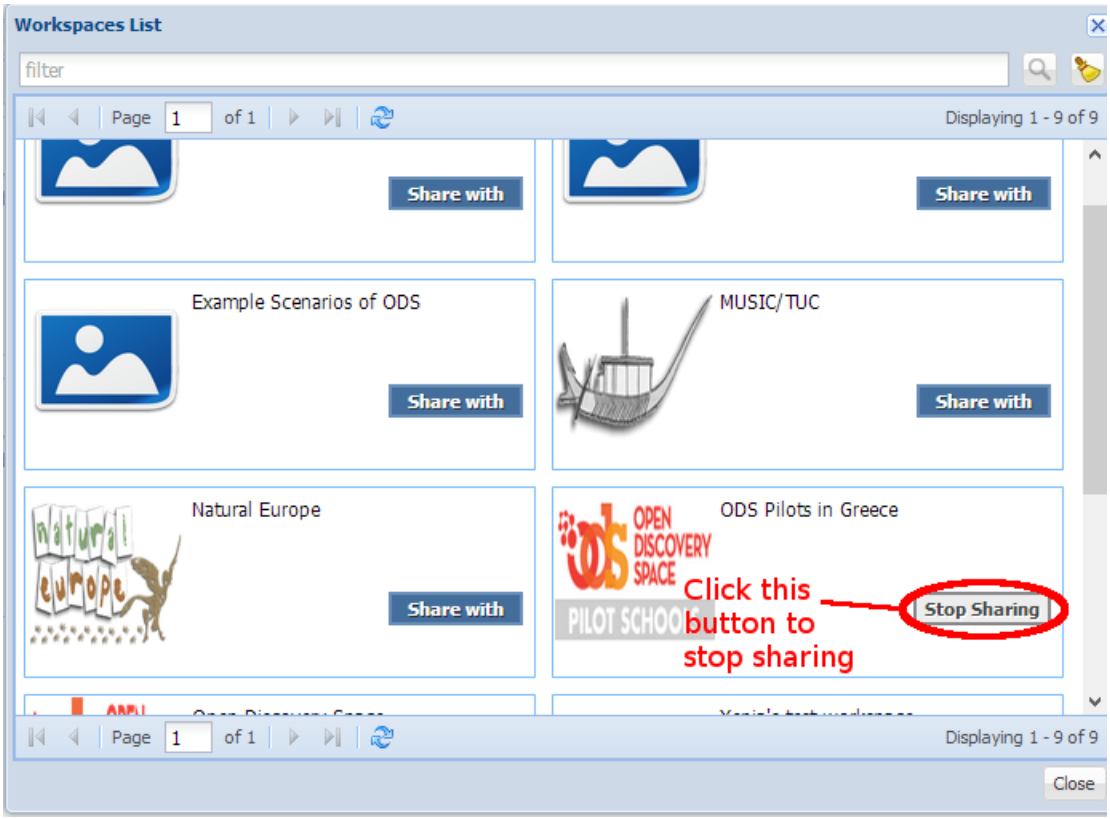


Figure 62 : The corresponding 'Share with' button changes to 'Stop sharing' to offer to you the capability to stop sharing the pathway in that workspace

Follow the previous steps for all the pathways that you want to share through the new workspace. After you finish, go back to the Workspaces view of your personal page and click on the 'View Workspace contents' button that corresponds to the new workspace as shown below:

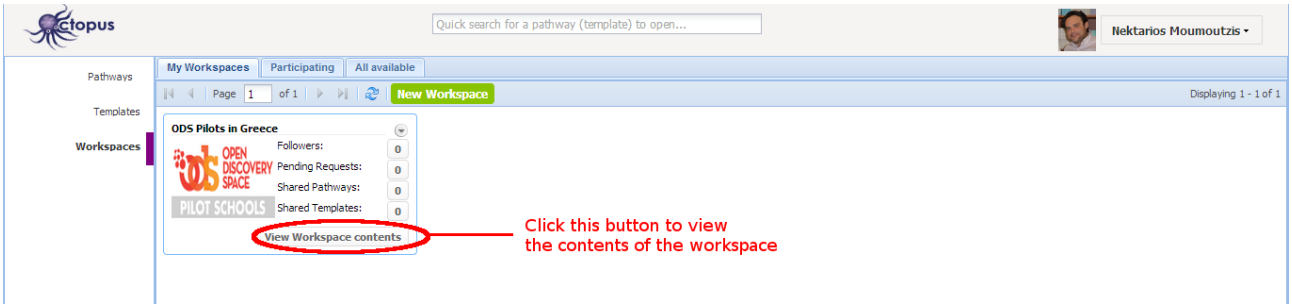


Figure 63 : click on the 'View Workspace contents' button that corresponds to the new workspace

As soon as you click that button, a new tab is created within the Workspace view that represents the new workspace and the pathways shared through

this workspace is shown. If you share templates as well, you may see them at the ‘Templates’ tab. The process is exactly the same as it is for Pathways, the only difference is that you have to go the Templates view of your personal page to find the templates that you want to share.

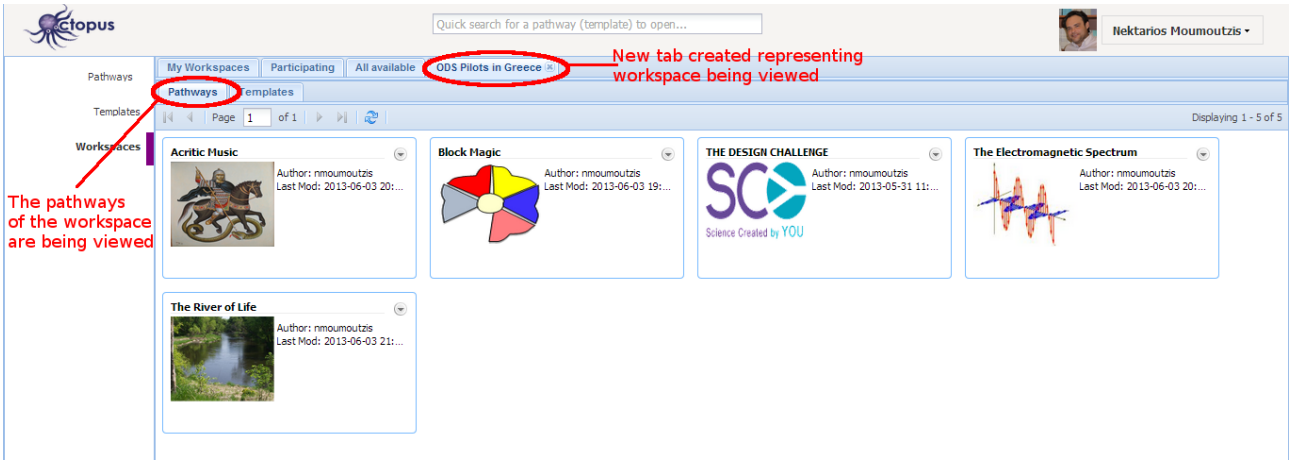


Figure 64 : Workspace view that represents the new workspace and the pathways shared through this workspace is shown. If you share templates as well, you may see them at the ‘Templates’ tab. The process is exactly the same as it is for Pathways, the only difference is that you have to go the Templates view of your personal page to find the templates that you want to share

4.4.7. Exploiting workspaces to share pathways and enable other users to enrich them with resources

Through workspaces, it is possible to share pathways with other users so that non-owners of pathways are able to view them and enrich them with resources attached to their learning activities. When accessing a workspace, a user is able to select a pathway to view as shown in the screenshot below:

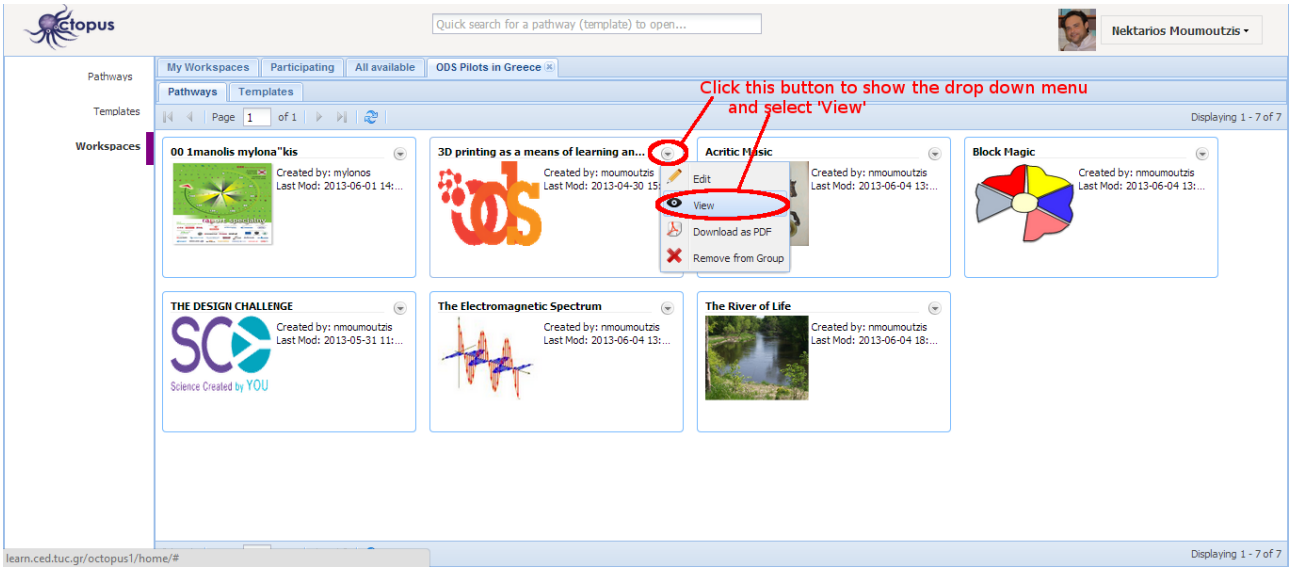


Figure 65: Through workspaces, it is possible to share pathways with other users so that non-owners of pathways are able to view them and enrich them with resources attached to their learning activities. When accessing a workspace, a user is able to select a pathway to view

By selecting to view a shared pathway, you are able to see its contents without changing them. You may, however, enrich the learning activities of the viewed pathway with additional resources. Let us see how. The screenshot below shows how the previously selected pathway is presented in view mode.

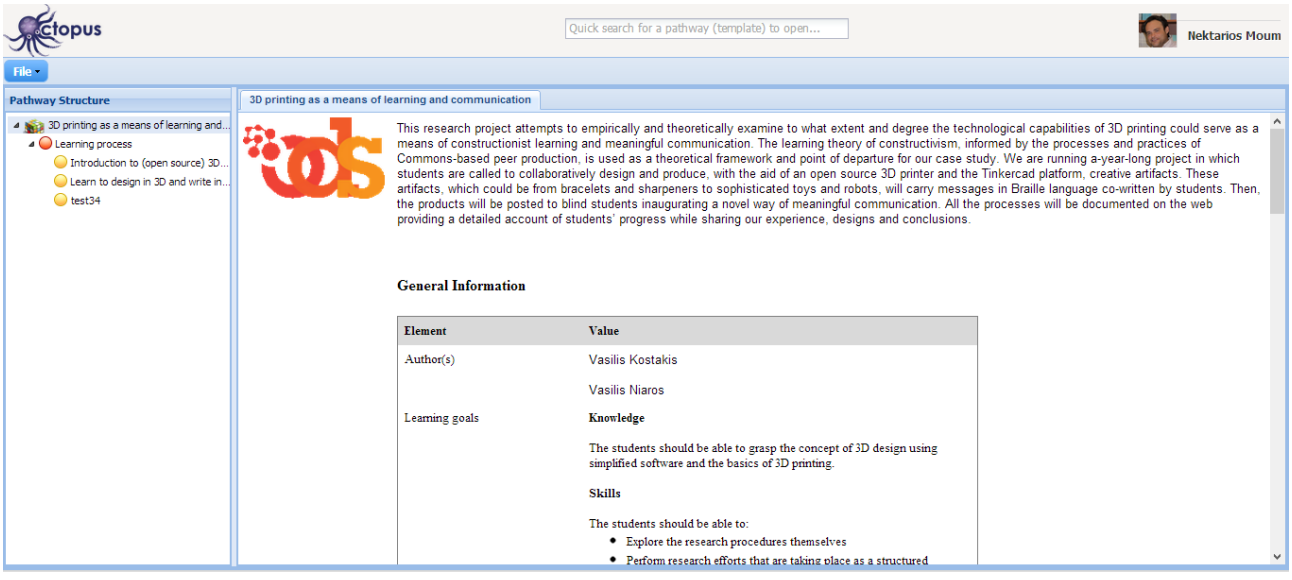


Figure 66 : The view perspective of a Pathway

To start enriching its learning activities with additional resources, first select the activity you want to enrich and then go to the 'Resources' tab of this

activity and press the ‘Add Resource’ button as shown in the screenshot below.

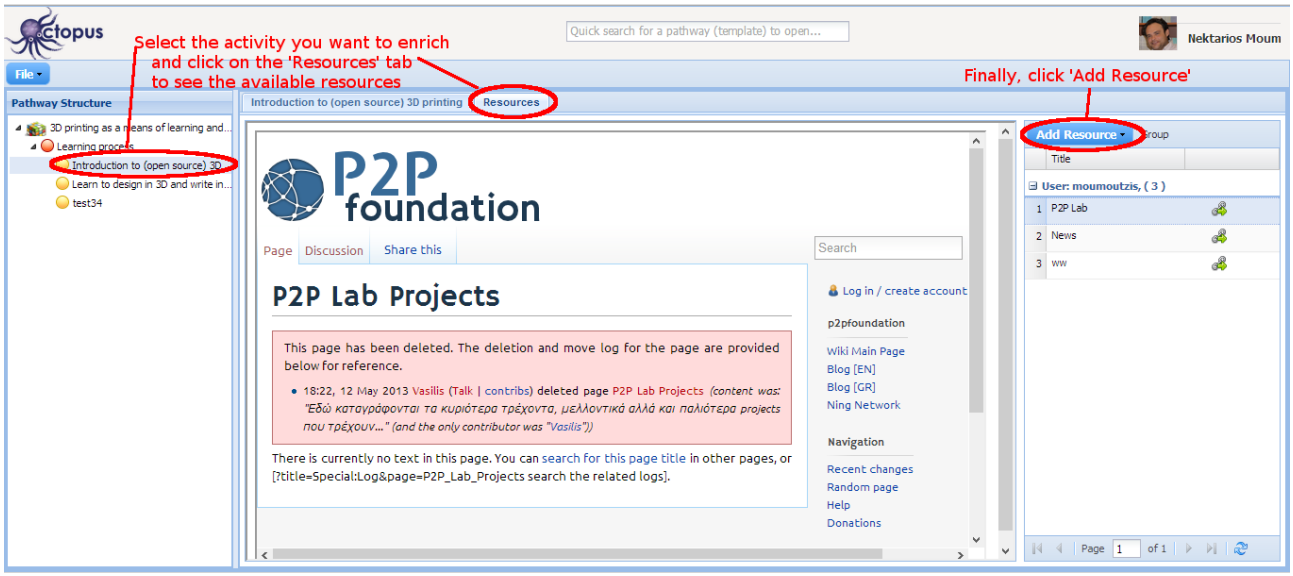


Figure 67 : Add a resource to activity as a view not as an owner. Press the Add resource button, up right corner.

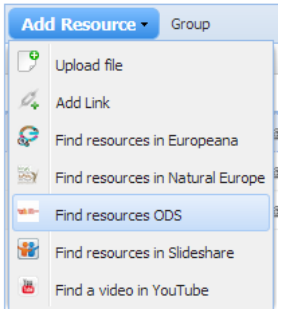


Figure 68 : The different alternative options in order to add a resource. You may upload a file from your local storage, add a link in the web of find a resource in various repositories and external content sites such as Europeana, Natural Europe repository, ODS repository, SlideShare or YouTube. Let us assume that you want to find a resource from the ODS repository. Click on ‘Find resources ODS’.

As soon as you click this button a drop down menu shows up with a list of the various options you have: You may upload a file from your local storage, add a link in the web of find a resource in various repositories and external content sites such as Europeana, Natural Europe repository, ODS repository, SlideShare or YouTube. Let us assume that you want to find a resource from the ODS repository. Click on ‘Find resources ODS’.

A pop up dialogue box shows up where you can give your search keywords and the results that satisfy them are presented. Browse on the list of the resources shown and click the ‘Add resource’ button to add the desired resource(s) in the learning activity you are working on. When you finish, click the ‘Close’ button.

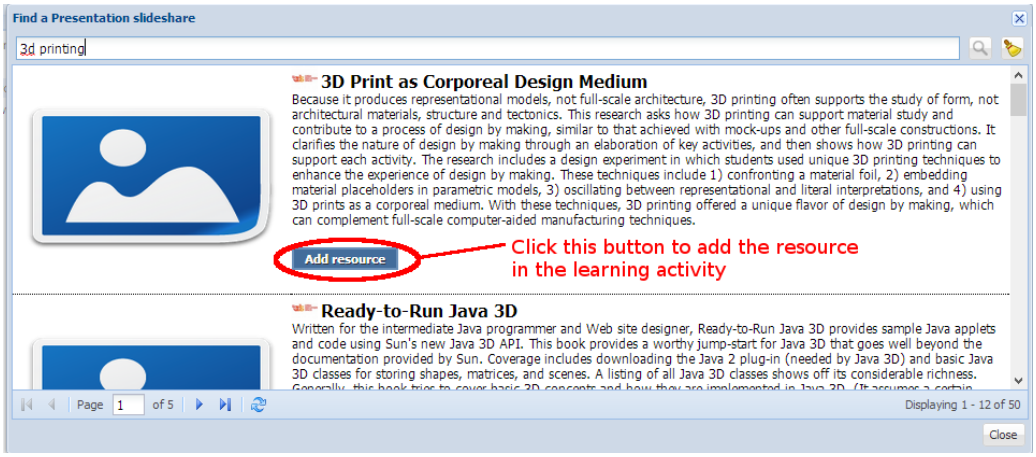


Figure 69 : Enter search keywords and press the search button . The results that satisfy them are presented. Browse on the list of the resources shown and click the 'Add resource' button to add the desired resource(s) in the learning activity you are working on

Now you should be able to see the new resource listed within the selected learning activity. To view the resource in the central view pane, click on its title.

Figure 70 : The resource from the ODS repository has been added to the activity. Then, you can act to it as a normal activity resource.

You may proceed this way to add more resources or select another learning activity to enrich.

4.4.8. Shared editing of pathways

Sharing pathways through workspaces enables other users to view and enrich them with resources. There are cases, however, when you want to collaborate with other users to edit a specific pathway. In such a case, you are able to select the users that you want to have editing access to your pathways. Let us see how.

First you go to your Personal Page using the drop down menu available through the button at the upper right part of Octopus labeled with your name. In your personal page you could browse your pathways, your templates and your workspaces. The pathways view is selected when you go to your personal page. Identify the pathway you want to share and click on the small circular button showing a downward arrowhead. A drop down menu is shown as depicted in the following screenshot.

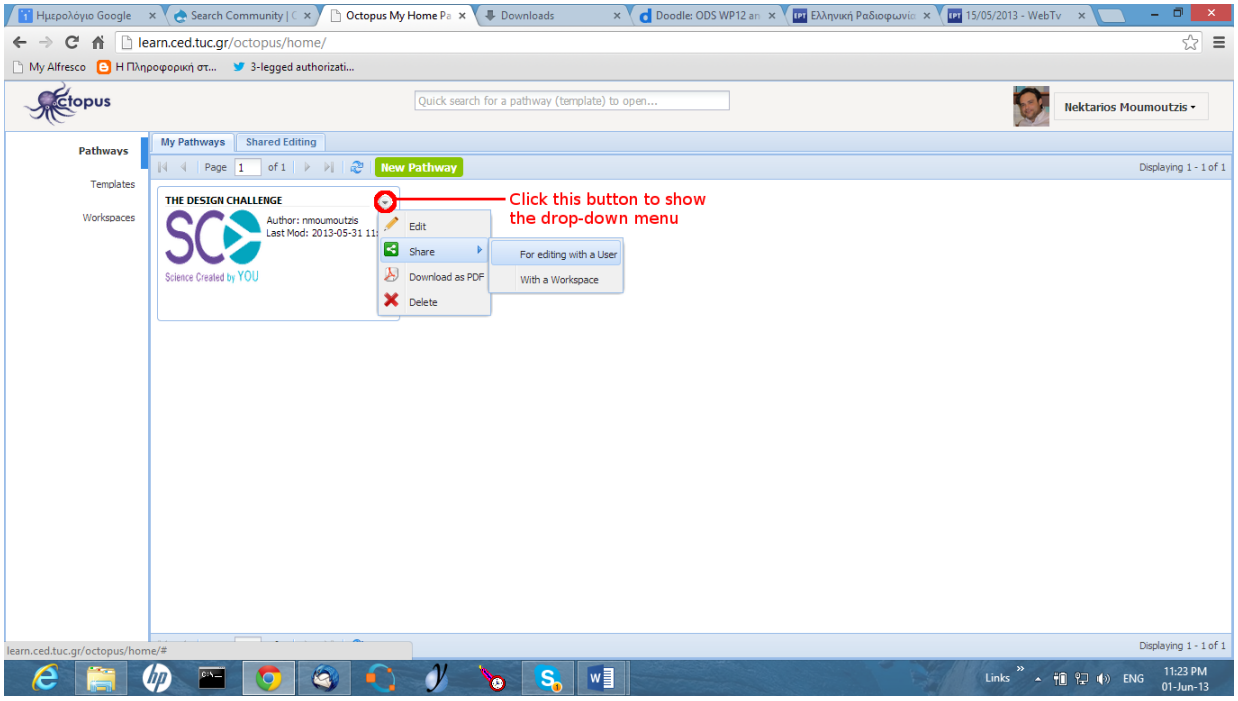


Figure 71 : Collaboration among users to modify a Pathway. First you go to your Personal Page using the drop down menu available through the button at the upper right part of Octopus labeled with your name. In your personal page you could browse your pathways, your templates and your workspaces. The pathways view is selected when you go to your personal page. Identify the pathway you want to share and click on the small circular button showing a downward arrowhead. A drop down menu is shown as depicted in the following screenshot.

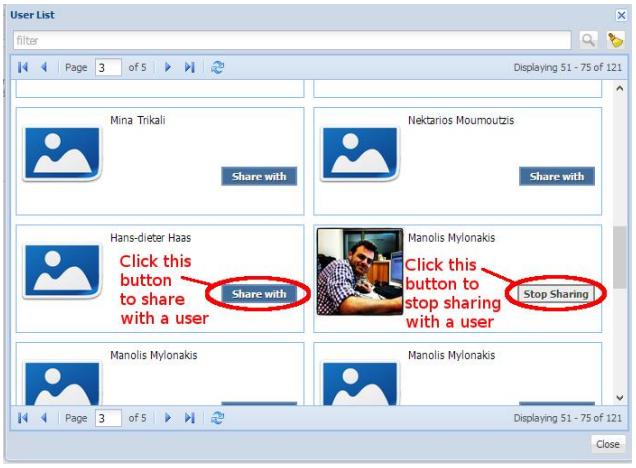


Figure 72 : A pop-up window shows up (see above screenshot) where you may browse through the set of users (see screenshot below). To share the pathway with a specific user, just click on 'Share with' button inside the box representing the user. As soon you click on this button, the user is able to edit your pathway. The button changes to 'Stop sharing'. In case you want to terminate sharing of your pathway with another user, you just click on the 'Stop sharing' button inside the box representing that user.

A pop-up window shows up (see above screenshot) where you may browse through the set of users (see screenshot below). To share the pathway with a specific user, just click on 'Share with' button inside the box representing the user. As soon you click on this button, the user is able to edit your pathway. The button changes to 'Stop sharing'. In case you want to terminate sharing of your pathway with another user, you just click on the 'Stop sharing' button inside the box representing that user.

The list of pathways that have been shared for editing with you are shown in your Personal Page, at the Pathways view under the table 'Shared Editing' next to the 'My Pathways' tab.

4.5. Summary

In this chapter we focused on the implementation of the Octopus tool in detail. We presented Octopus architecture, and a detailed walkthrough, presenting the use of the system based on its Graphical User Interfaces (GUIs).

Chapter 5 provides information about the actual use of the system and its evaluation.

Chapter 5. Use of Octopus and evaluation

5.1. Introduction

This chapter presents the activities related with the deployment and use of Octopus Tool as well as the different methods followed in the evaluation of the system. Octopus has been used in the ODS, TRANSIT, Natural Europe and ALICE EU projects during teacher training workshops for the design of learning scenarios as well as to enable documentation, sharing and reuse of learning scenarios among members of teachers' communities of practice. More than 1,200 educational scenarios have been developed by pedagogy experts and educators in the context of these projects.

As soon as the first prototypes of the system were available, four pluralistic usability walkthrough sessions with 15 participants each were organized, comprised of pedagogy experts, educators, system designers, and usability experts. The users were asked:

(a) to create an educational template and

(b) use it to develop an educational scenario.

These two high level goals were analyzed in a number of sub-goals associated with particular screens. After the analysis of these sessions, 13 user interface issues were detected and fixed. Moreover, some interesting ideas and recommendations came up from the users and were implemented in the system. Furthermore, a heuristic evaluation was performed in the context of the graduate HCI course of the Electronic and Computer Engineering Dept. of the Technical University of Crete. In this course, the students had to perform usability evaluation on several products including Octopus. The evaluation was based on Jakob Nielsen's heuristics [1] 72 errors (10 major) were detected and fixed. Finally, a think-aloud evaluation was performed with 8 educators/teachers. 8 problems were detected and fixed.

Apart from the above activities directly focusing on identifying usability issues, several sessions were organized with actual users to measure the perceived

usefulness and ease of use of Octopus. Three workshops/pilot schools were organized in the context of ODS, TRANSIT projects. In the ODS Opening Day Conference organized in Greece/Athens, 60 secondary education teachers used Octopus to develop learning scenarios from specific educational templates and share them through the ODS portal. 25 persons participated in the TRANSIT Pilot School organized in Greece/Panormo and 22 scenarios were developed with Octopus and published in ODS portal. Moreover, Octopus has been used in the context of the “Pre-school education – teaching practices” course of the Department of Preschool Education of the University of Crete. The teacher of the course used Octopus to develop a template that was given to the students (50 in total) to develop their teaching scenarios. The scenarios were enriched with resources including power point presentations, sound recordings and photos taken during the implementation of the scenarios in kindergarten. After their experience with the tool, the participants completed a Perceived Usefulness and Perceived Ease of Use Questionnaire [65].

5.2. Octopus Evaluation

Improvements of the user-interface of Octopus have been made after continuous feedback from users (e.g. pedagogy experts, teachers etc.) in a number of tool releases. Usability evaluation with the method of pluralistic walkthrough was performed, as well as heuristic evaluation and think-aloud evaluation in more mature versions of the tool. Moreover, extensible usability studies have been performed in a number of pedagogy expert/educator workshops.

5.2.1. Heuristic evaluation

Heuristic evaluation [1] (Nielsen and Molich, 1990; Nielsen 1994) is a usability engineering method for finding the usability problems in a user interface design so that they can be attended to as part of an iterative design process. Heuristic evaluation involves having a small set of evaluators examine the interface and judge its compliance with recognized usability principles (the "heuristics").

Heuristic evaluation is performed by having each individual evaluator inspect the interface alone. Only after all evaluations have been completed are the

evaluators allowed to communicate and have their findings aggregated. This procedure is important in order to ensure independent and unbiased evaluations from each evaluator. The results of the evaluation can be recorded either as written reports from each evaluator or by having the evaluators verbalize their comments to an observer as they go through the interface. Written reports have the advantage of presenting a formal record of the evaluation, but require an additional effort by the evaluators and the need to be read and aggregated by an evaluation manager. Using an observer adds to the overhead of each evaluation session, but reduces the workload on the evaluators. Also, the results of the evaluation are available fairly soon after the last evaluation session since the observer only needs to understand and organize one set of personal notes, not a set of reports written by others. Furthermore, the observer can assist the evaluators in operating the interface in case of problems, such as an unstable prototype, and help if the evaluators have limited domain expertise and need to have certain aspects of the interface explained.

In a user test situation, the observer (normally called the "experimenter") has the responsibility of interpreting the user's actions in order to infer how these actions are related to the usability issues in the design of the interface. This makes it possible to conduct user testing even if the users do not know anything about user interface design. In contrast, the responsibility for analyzing the user interface is placed with the evaluator in a heuristic evaluation session, so a possible observer only needs to record the evaluator's comments about the interface, but does not need to interpret the evaluator's actions.

Heuristic evaluation was performed in the context of the graduate HCI course of the Electronic and Computer Engineering Dept. of the Technical University of Crete. In this course, the students had to perform usability evaluation on several products including Octopus. The evaluation was based on Jakob Nielsen’s heuristics (Nielsen, 1994); 72 errors (8 major) were detected and fixed.

5.2.2. Pluralistic walkthrough with university teachers and students at a Pedagogical Department

The Pluralistic Walkthrough (also called a Participatory Design Review, User-Centered Walkthrough, Storyboarding, Table-Topping, or Group Walkthrough) is a usability inspection method used to identify usability issues in a piece of software or website in an effort to create a maximally usable human-computer interface. The method centers around using a group of users, developers and usability professionals to step through a task scenario, discussing usability issues associated with dialog elements involved in the scenario steps. The group of experts used is asked to assume the role of typical users in the testing. The method is prized for its ability to be utilized at the earliest design stages, enabling the resolution of usability issues quickly and early in the design process. The method also allows for the detection of a greater number of usability problems to be found at one time due to the interaction of multiple types of participants (users, developers and usability professionals). This type of usability inspection method has the additional objective of increasing developers' sensitivity to users' concerns about the product design.

Two pluralistic usability walkthrough sessions were organized:

a) In Natural Europe 6th coordination meeting held in March 2013 in Helsinki with the participation of 14 users (e.g. pedagogy experts, educators, system designers, and usability experts), and
b) in the context of the "Pre-school education – teaching practices" course of the Department of Preschool Education of the University of Crete were 54 users participated divided in 3 groups of 18 users each. In both cases the users were asked (a) to create an educational template and (b) use it to develop an educational scenario. These two high level goals were analyzed in a number of sub-goals associated with particular screens. After the analysis of these sessions, 13 user interface issues were detected and fixed. Moreover, some interesting ideas and recommendations came up from the users and were implemented in the system.

The results of the Pluralistic Walkthrough Evaluation are presented in Annex 1.

5.2.3. Engaging museum educators by means of the think aloud method

The think aloud method formally belongs to the verbal report methods and stems from the field of cognitive psychology. It was specifically developed to gather information on the cognitive behavior of humans performing tasks. The think aloud method is viewed upon as particularly useful in understanding the processes of cognition, because it assesses humans' cognitions concurrently with their occurrence. It is therefore a unique source of information on these cognitive processes and a very direct method to gain insight in the way humans solve problems. Overall, the method consists of two stages:

1. collecting think aloud protocols in a systematic way,
2. Analyzing these protocols to obtain a model of the cognitive processes that take place while a person tackles a problem [38].

These protocols are collected by instructing subjects to solve a problem while 'thinking aloud'; that is, stating directly what they think. As the think aloud method does not require a subject to retrieve long-term memory constructs or to retrospectively report on his thought processes, censoring and distortion of these processes is minimized. Constraints on the verbal data are imposed later through strategies for analyzing these protocols' content, according to the researcher's interest. The think aloud method can be of high value in evaluating a system's design on usability flaws and is therefore frequently used to gather information about a system's usability in testing computer systems with potential end users. During recorded usability sessions, users 'interact' with a (prototype) system or interface according to a predetermined set of scenarios while verbalizing their thoughts. Analyses of these verbal reports provide detailed insight into usability problems actually encountered by end users but also in the causes underlying these problems. However, an often expressed concern with the think aloud method is that information provided by the users is subjective. The identification and selection of a representative sample of (potential) end users is therefore crucial for generating valid usability data with a think aloud test. The subject sample should consist of persons representing those end users who will actually use the system in future. This requires a clearly defined user profile which describes the range of relevant skills of the future system users. Computer expertise, roles of subjects in the workplace, and a person's expertise in the

domain of work the computer system will support are useful dimensions in this respect. A questionnaire may be given to test subjects either before or after the session to obtain this information. As the think aloud method provides a rich source of data, a small sample of subjects (approx. 8 subjects) suffices to gain a thorough understanding of task behavior [38] or to identify the main usability problems with a computer system [39]. However, in situations where there are considerable numbers of different types of users there needs to be sufficient number of each type in the think aloud test sessions.

Think-aloud evaluation was performed with 8 museum educators/teachers in the Natural History Museum of Crete in May 2013. The users were asked

(a) to create an educational template and

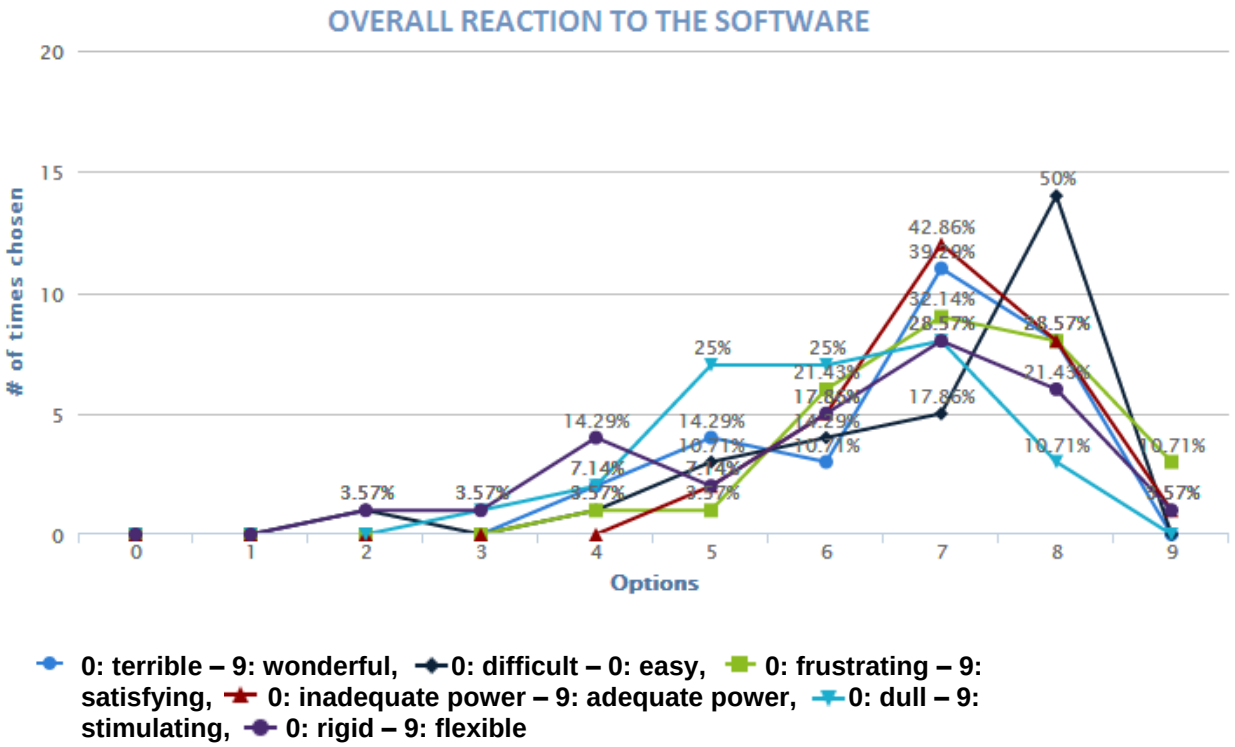
(b) (b) use it to develop an educational scenario.

These two high level goals were analyzed in a number of sub-goals. Each user had to find the way in the system to accomplish those goals without the help of the administrator and thinking aloud during this process. All sessions were recorded and the videos were analyzed thereafter by the developers. During this process 6 problems were detected and fixed.

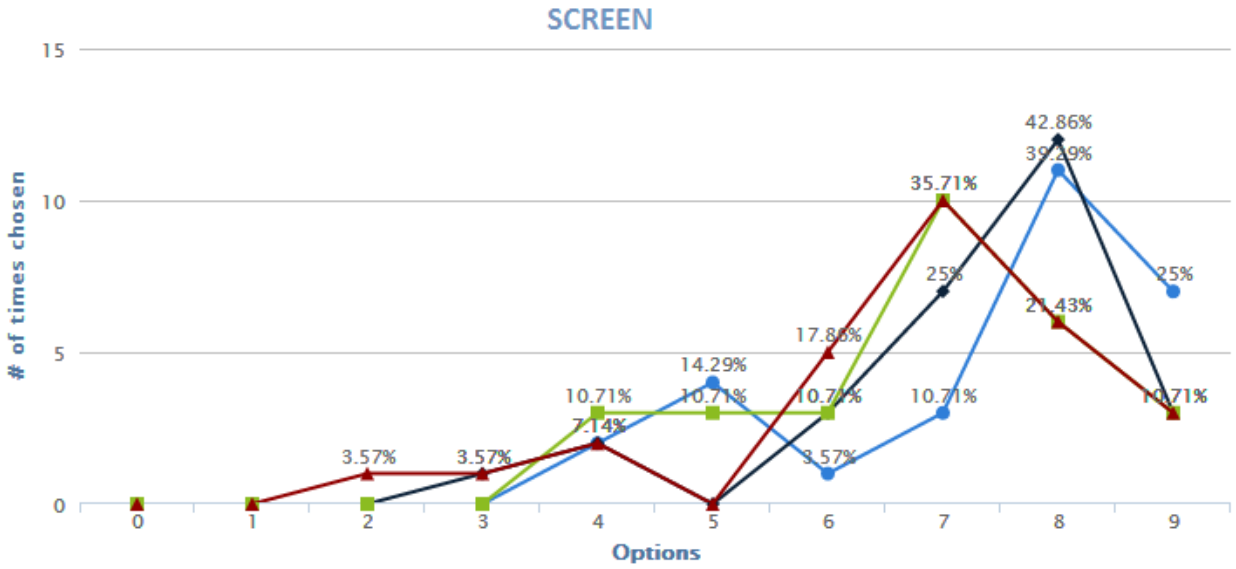
5.2.4. User Satisfaction Evaluation with Primary and Secondary Education teachers and students.

Apart from the above activities directly focusing on identifying usability issues, several sessions were organized with actual users to measure the perceived usefulness and ease of use of Octopus. Three workshops/pilot schools were organized in the context of ODS (http://www.opendiscoveryspace.eu/), TRANSIT (http://www.transit-project.eu/) projects. In the ODS Opening Day Conference organized in Greece/Athens, 60 secondary education teachers used Octopus to develop learning scenarios from specific educational templates and share them through the ODS portal. 25 persons participated in the TRANSIT Pilot School organized in Greece/Panormo and 22 scenarios were developed with Octopus and published in ODS portal. Moreover, Octopus has been used in the context of the “Pre-school education – teaching practices” course of the Department of Preschool Education of the University of Crete. The teacher of the course used Octopus to develop a template that was given to the students (50 in total) to develop their teaching scenarios.

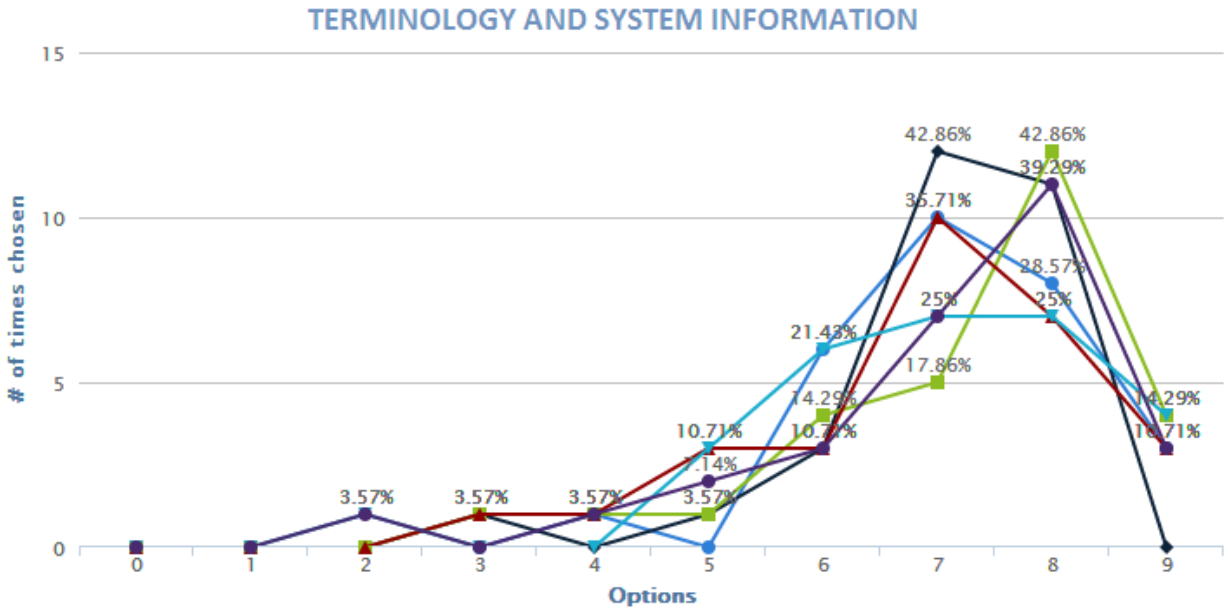
After their experience with the tool the educators/teachers and pedagogy experts completed two questionnaires to measure their satisfaction with the tool: a) the Questionnaire for User Interface Satisfaction (Chin et al., 1998) and b) the Perceived Usefulness and Perceived Ease of Use Questionnaire (Davis, 1989). The results of the Questionnaire for User Interface Satisfaction, Perceived Usefulness and Perceived Ease of Use Questionnaire are show below. The results show that the vast majority of the pedagogy experts/educators found Octopus highly usable and very useful for their jobs as it is illustrated in the following graphs.



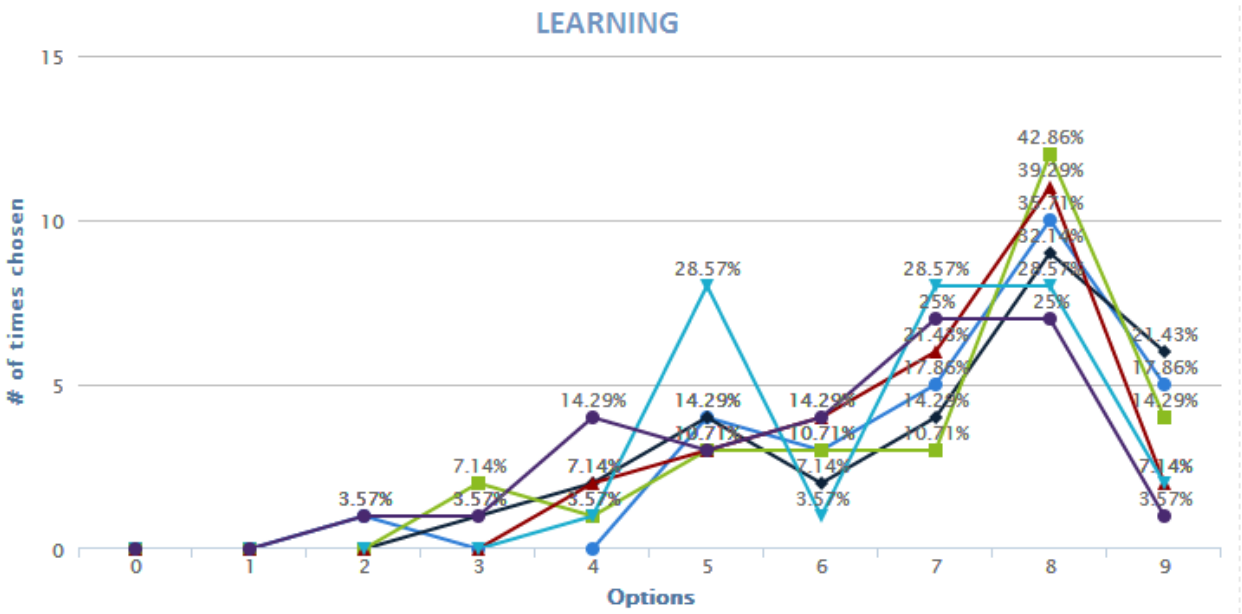
Screen



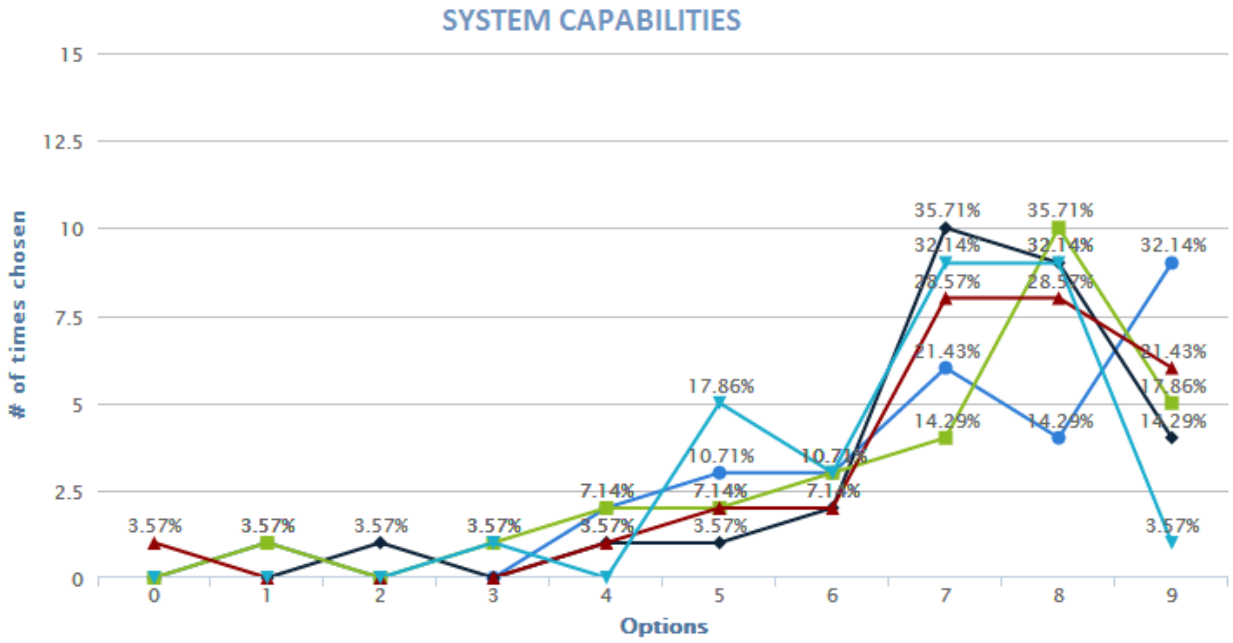
Reading characters on the screen (0: hard - 9: easy) **Highlighting simplifies task (0: not at all - 9: very much),** **Organization of information (0: confusing - 9: very clear),** **Sequence of screens (0: confusing - 9: very clear)**



Use of terms throughout system (0: inconsistent, 9: consistent), **Terminology related to task (0: never - 9: always),** **Position of messages on screen (0: inconsistent - 9: consistent),** **Prompts for input (0: confusing - 9: clear),** **Computer informs about its progress (0: never - 9: always),** **Error messages (0: unhelpful - 9: helpful)**

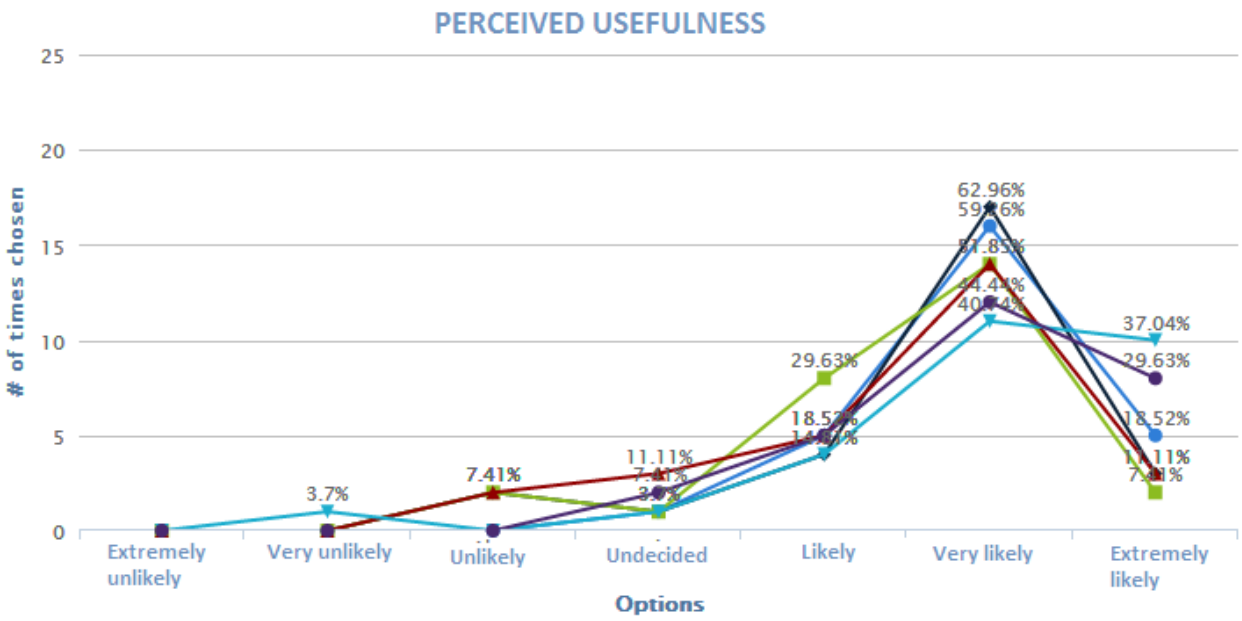


Learning to operate system (0: difficult - 9: easy), Exploring new features by trial and error (0: difficult - 9: easy), Remembering names and use of commands (0: difficult - 9: easy), Performing tasks is straightforward (0: never - 9: always), Help messages on the screen (0: unhelpful - 9: helpful), Supplemental reference materials (0: confusing - 9: clear)

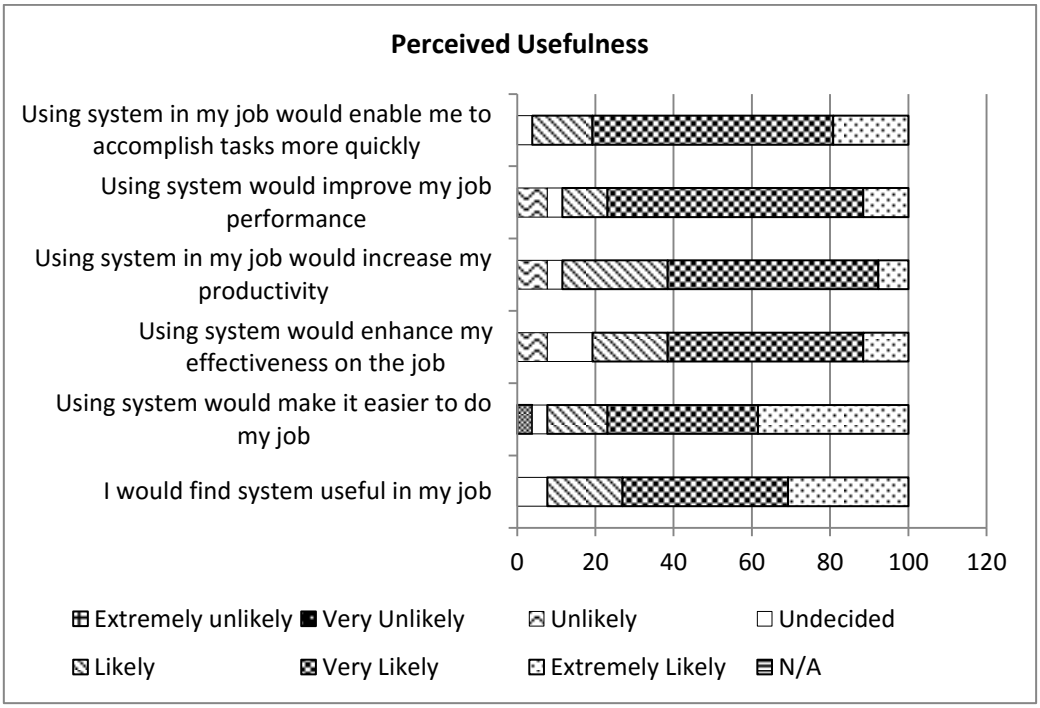


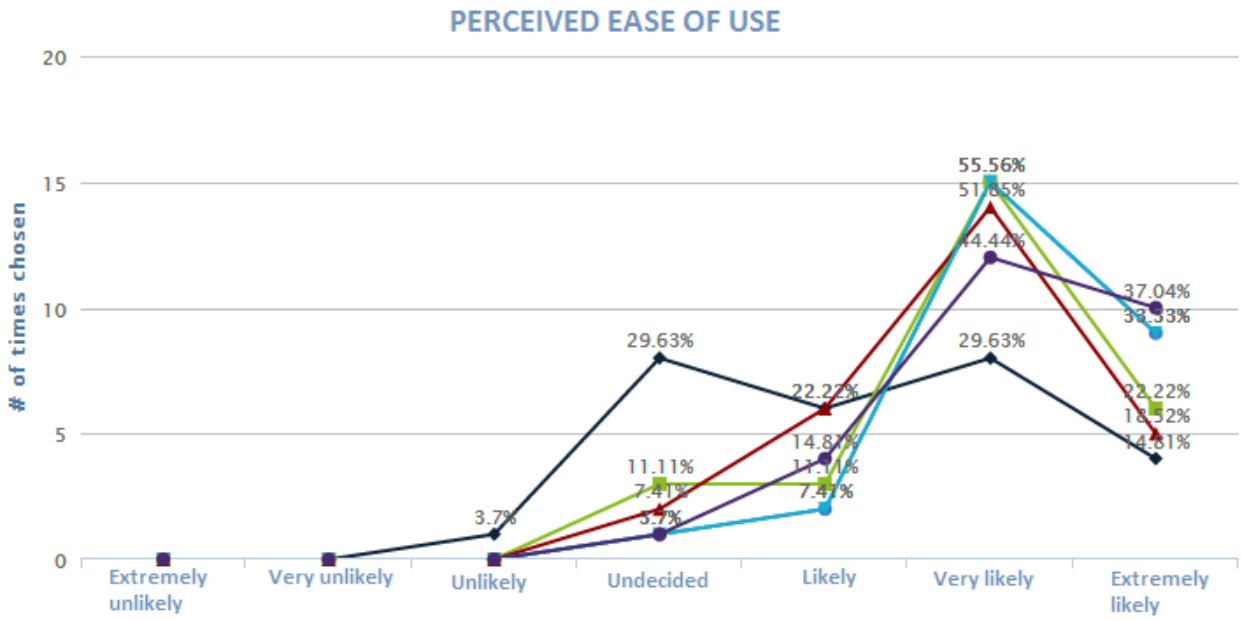
System speed (0: too slow - 9: fast enough), System reliability (0: unreliable - 9: reliable), System tends to be (0: noisy - 9: quiet), Correcting your mistakes (0: difficult - 9: easy), Designed for all levels of users (0: never - 9: always)

Perceived usefulness

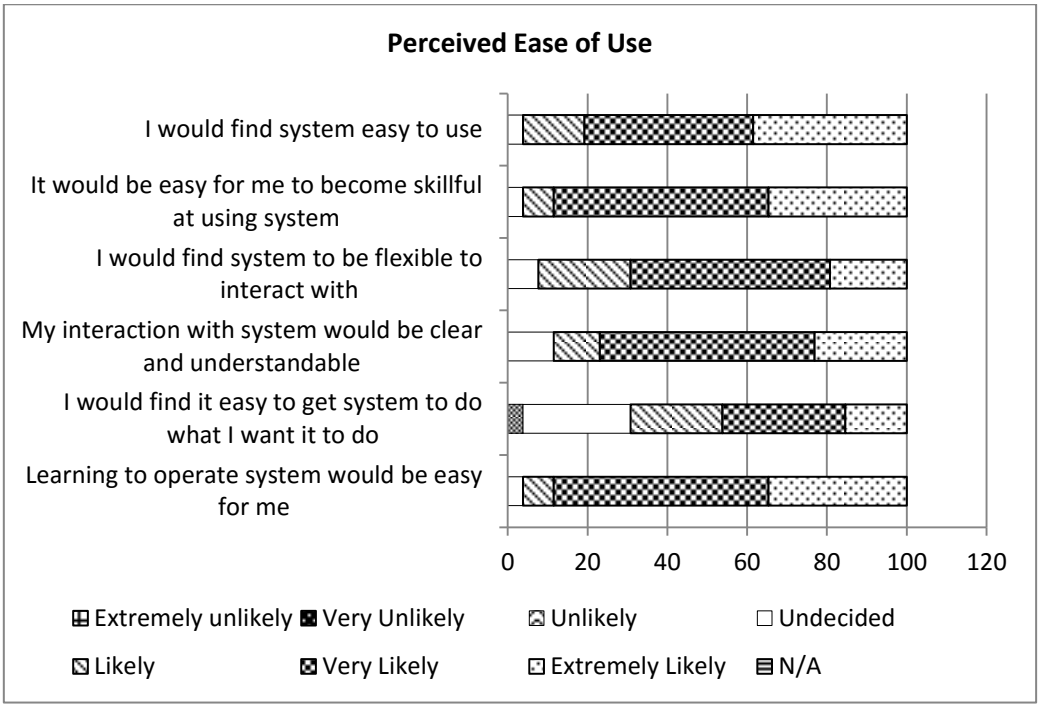


Using system in my job would enable me to accomplish tasks more quickly, Using system would improve my job performance, Using system in my job would increase my productivity, Using system would enhance my effectiveness on the job, Using system would make it easier to do my job, I would find system useful in my job





Learning to operate system would be easy for me, I would find it easy to get system to do what I want it to do, My interaction with system would be clear and understandable, I would find system to be flexible to interact with, It would be easy for me to become skillful at using system, I would find system easy to use



5.3. Summary

We have presented the evaluation and the dissemination activities were performed during the development of the Octopus tool.

The next chapter will present the conclusions of this thesis while suggestions for future work will be introduced.

Chapter 6. Interoperability aspects and components

6.1. Introduction

One of the major challenges for learning organizations today is sharing learning resources by facilitating discovery and retrieval of the learning content they develop and store in their repositories [1]. While learning content repositories already cater for their local users, there are no agreed profiles that address the needs of the learning domain, and no established practices for combining existing specifications into complete solutions [2]. Individual organizations are developing their own ad hoc solutions, following different technical approaches, mechanisms, and metadata models. As a result, the opportunity to establish broader interoperability is limited. Establishing practices that combine existing specifications into integrated solutions in the form of agreed profiles, in order to address the needs of specific learning communities in terms of learning object sharing, discovery, and exchange, will be beneficial to all stakeholders [2]:

- Educators will become more productive by being able to easily discover learning content that addresses the needs of their students, thus maximizing re-use and reducing the cost of reproducing new resources.
- Students will gain access to the highest-quality learning resources available, making a significant impact on the quality of their learning experience and their learning outcomes.
- Content providers will have the opportunity to advertise their products making them globally discoverable.
- System vendors will be able to make their systems compliant with major federations of learning resources, by only supporting a minimum set of specifications, and
- Federation builders will secure their investment by developing durable infrastructures based on standard specifications.

A concrete evidence of the significance of this challenge is the fact that the IMS Global Learning Consortium, has established a group on Learning Object Discovery and Exchange (LODE) [2] aiming to facilitate the discovery and retrieval of learning content. The group examines and adapts specifications

that are being applied to digital libraries, generic repositories and learning repositories to address the current lack of agreed profiles addressing the needs of the learning domain and practices for combining existing specifications into complete solutions. The project group will study search mechanisms, meta-data harvesting, learning content exchange, content identification as well as collection and service description. It will also define a small number of scenarios for the discovery and exchange of learning resources (e.g., federated searching, harvesting, etc.) with the objective to develop:

- A set of specification profiles to support the scenarios
- Sample implementation(s)
- A conformance domain-profile

The ultimate goal is interoperability among systems involved in those scenarios. Interoperability is achieved when a system (e.g., a LMS) end user is able to discover a compatible learning object hosted on a separate system (e.g., a learning object repository) using a LODE-compliant discovery service. Addressing federated discovery (through either federated search or harvest-driven centralized search) presents the greatest interoperability challenge. Establishing interoperability in terms of LODE requires that the federations should be based on LODE search and LODE registry specifications. However, federation is not a requirement for compliance. The term “federated” is used in a loose sense to refer to a group of distributed, independently managed and potentially heterogeneous repositories, whether or not any agreements, trust relationships etc. exist between them. In this paper we report on the design and implementation issues related to the support of learning content sharing requirements on top of an existing Learning Management System (LMS). We focus on those aspects that are related with the use of learning metadata standards and their Application Profiles (APs) for the description of learning resources, as well as the implementation of harvesting protocols that will make them available to large repositories/federations, technical issues that should be addressed in eLearning infrastructures. Our learning infrastructure is based on the MOLE (Multimedia Open Learning Environment – http://www.moleportal.eu/) system. MOLE is a multilingual multimedia information system for managing courses, supporting learning processes and

learning communities through the Web. The MOLE multi-tenant architecture supports multiple instances of MOLE using the same core to serve the needs of multiple communities. Each particular community has specific needs for the descriptions of the learning material that are more or less different from the needs of other communities. In this sense, applying the framework described in this paper to MOLE was appropriate in order to support different Application Profiles to suit those community-specific needs and overcome the problems of semantic interoperability. We have adopted the Learning Object Metadata standard (LOM). Our annotation tool is an intuitive web-based LOM editor that is not strictly bound to a specific AP, as it is the case for most LOM metadata editors. The LOM editor can use multiple APs, thus supporting efficient metadata specifications in any application-specific context. The metadata records are managed by a repository that implements the common repository services (search/expose, submit/store, request/deliver). Appropriate user interfaces have been implemented exploiting those services to expose the metadata management functionality to end-users. Finally, an OAI-PMH interface has been implemented on top of the repository. This interface supports metadata harvesting from large repositories/federations (e.g. ARIADNE, Organic.Edunet etc.).

This way, the learning content created by an organization could be made known and exploited by other organizations that are connected to those federations. We focus on the learning resources metadata management and sharing in MOLE and implements the general architectural framework we propose. Section 2 presents the proposed architectural framework for supporting metadata management and sharing of learning resources on top of a LMS. Section 3 provides details regarding the implementation of this framework in the case of MOLE and considers various technical issues that should be considered for implementing the framework in other Learning Management Systems. Related work is presented in section 4, while section 5 concludes and presents directions of future research and developments.

6.2. Repository

The Repository handles both content and metadata and adopts the OAIS Reference Model [12] for the ingestion, maintenance and dissemination of Information Packages (IPs). To this end, it accommodates modules for the

ingestion, archival, indexing, and accessing of educational templates/scenarios, metadata, workspaces, users etc. Fig. 1 presents the overall architecture of the Octopus Repository, with emphasis to the internal software modules (i.e., Ingest Module, Archival Module, Indexing Module, and Access Module) that the repository employs.

The **Ingest Module** is responsible for the ingestion of an information package (i.e., educational templates and scenarios, metadata, workspace and user information) to store it as a new Archival Information Package (AIP) to the repository, or to update/delete an existing AIP. Any submitted information package should be validated and processed to identify and create the required AIPs that should be transferred for archival. The only actor on this module is the Octopus authoring environment, which serves as a SIP Producer.

The **Archival Module** receives AIPs from the Ingest Module for storage purposes, as well as AIP retrieval requests from the Access Module for dissemination purposes. In order to support storage and retrieval operations, it employs a DB Storage/Retrieval Manager. After the storage, update, or deletion of an AIP, the Archival Module notifies the Indexing Module of any new/updated/deleted AIP.

The **Indexing Module** receives AIPs from the Archival Module in order to build and maintain AIP index structures, as well as AIP retrieval requests from the Access Module for dissemination purposes. In order to support both the maintenance and retrieval operations from the index, it employs an Indexing Manager component which is flexibly implemented to support any search platform.

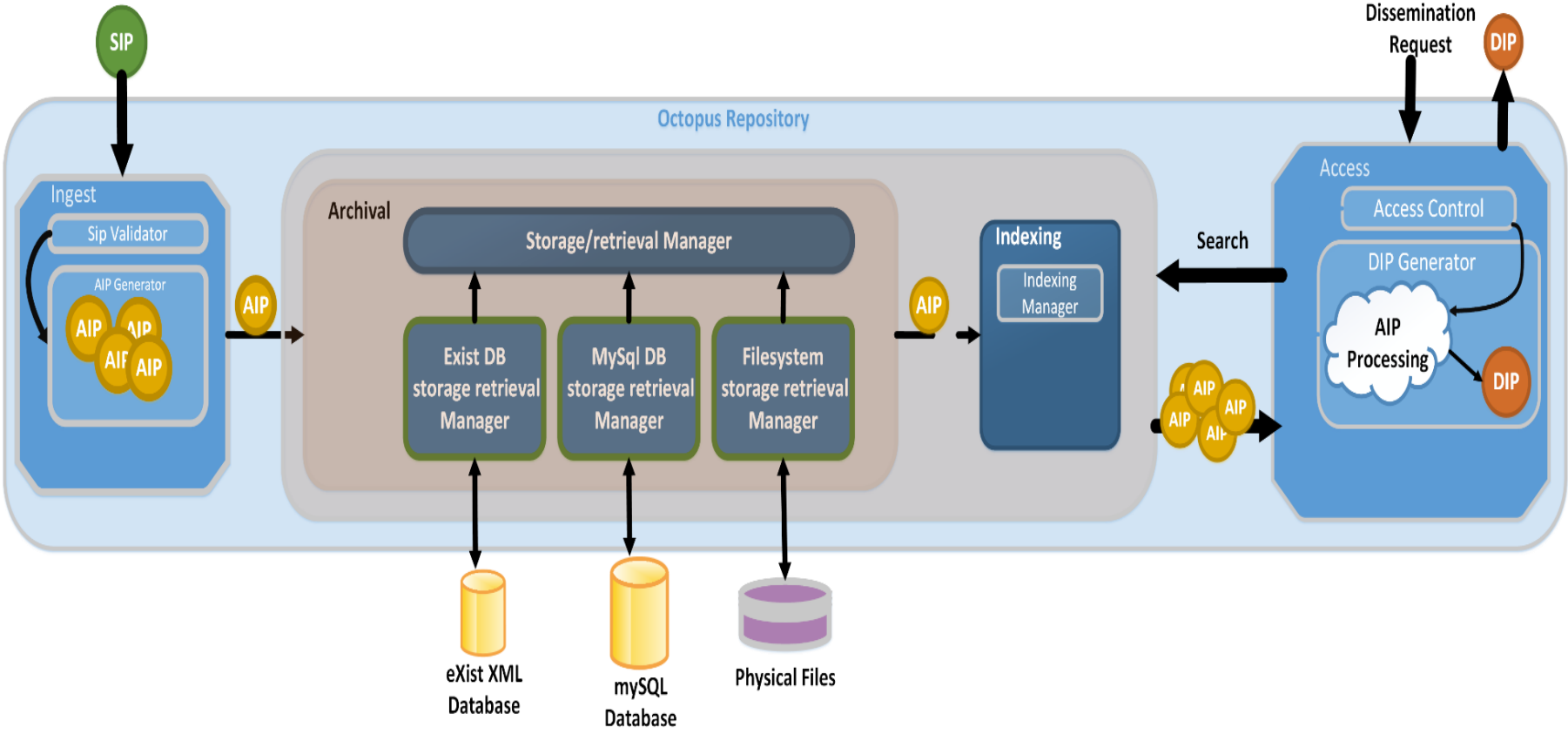


Figure 1. Octopus repository architecture

The **Access Module** provides a number of services allowing Dissemination Information Package (DIP) Consumers (i.e., the Octopus, harvester applications and external tools/environments) to request and receive information stored in the Octopus Repository. It provides functionality for receiving information access requests, applying access control policies through the Access Control component and retrieving the requested AIPs from the Archival module while exploiting any available indices maintained by the Indexing module. The AIPs retrieved from the Archival and/or Indexing Modules are passed to the DIP Generator component in order to be further processed for creating the final DIP that will be delivered to the DIP Consumer. Additionally, the Access Module offers an OAI-PMH interface and, allowing the dissemination of educational templates and scenarios metadata to external repositories. Moreover, it offers an OpenSearch interface allowing educational templates and scenarios created with Octopus to be searched and used by other tools/environments.

6.3. Use Cases for the Octopus Repository

The Octopus Repository serves as the back-end infrastructure of the Octopus Authoring Tool. It manages the entire information spectrum relevant to this tool including configurations of the Octopus Tool, the user accounts, the learning designs and their graphical representations, the actual content of the designs, the units of learning of them, as well as the corresponding metadata. In this section, we will describe the Octopus Repository's functionality, based on the support that should be provided to the Octopus for the management of the learning designs (educational pathway templates), the metadata management and the dissemination tasks.

The Octopus Repository adopts the OAIS Reference Model (6) for the ingestion, maintenance and dissemination of information packages. It accommodates modules for the ingestion, archival, indexing, and accessing of accessing of EPTs, EPTs metadata and Users. The Octopus Repository is

basically used to serve operations like storage, update, deletion, indexing, and retrieval of an information package. Consequently, the main use cases of the Octopus Repository are mainly related to the information package management and can be roughly categorized in:

(a) the ingest,

(b) the archival,

(c) the indexing, and

(d) (d) the access of:

- *Learning Designs*
- *Physical Files*
- *Units of learning*
- *Related metadata*
- *User accounts*

Regarding the primary actors of the Octopus Repository, two different types are identified:

(a) the SIP Producers and

(b) the DIP Consumers.

A SIP Producer refers to a system, which submits various types of information packages to the Octopus Repository, in order to create a new AIP, or update/delete an already existing AIP from the repository. According to the architecture, the SIP Producer interacting with the Octopus Repository. On the other hand, a DIP Consumer refers to a system receiving information packages from the Octopus Repository as a result of an accessing operation. DIP Consumers acting upon the Octopus Repository include the Authoring Tool, as well as the harvester application.

In order to provide a thorough view of the system's use cases and analyze the Octopus Repository's internal behavior in depth, it is divided into four basic modules:

(a) Ingest Module,
(b) Archival Module,
(c) Indexing Module, and
(d) Access Module.

Each module actually serves a main use case of the Octopus Repository.

Figure 73 presents the Use Case Context Diagram of the Octopus Repository, illustrating its basic modules (as subsystems), as well as the external actors acting upon it. The subsections that follow, analyze each module's functionality and behavior in depth.

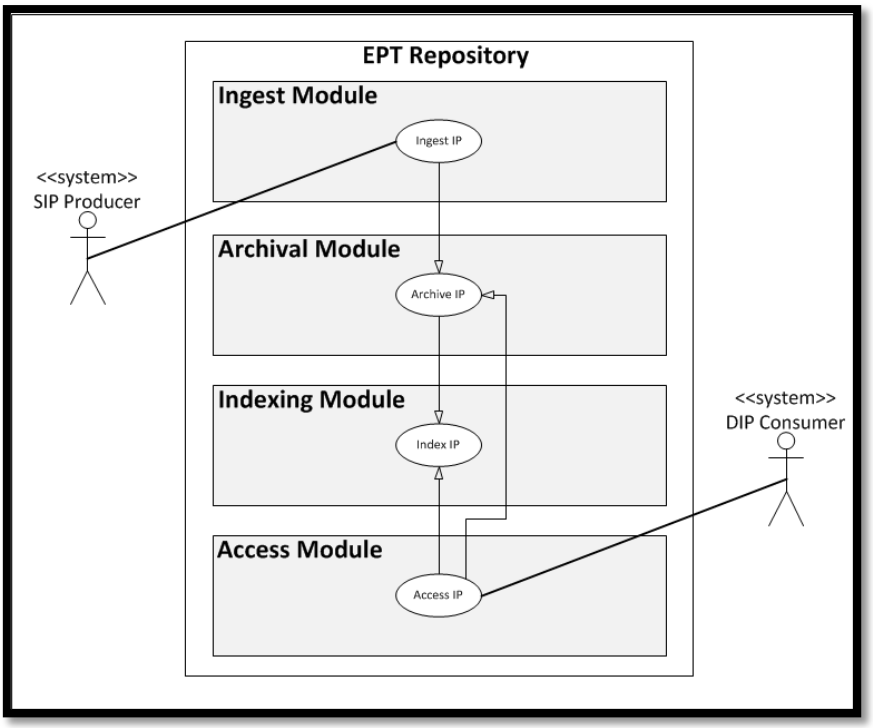


Figure 73 : Use Case Context Diagram of the Octopus Repository.

6.3.1. Ingest Module

The ingest module of the Octopus Repository is the responsible module for the ingestion of an information package. As stated above, an information package for the Octopus Repository could consist of different sets of information, as info related to the user accounts, the learning designs, the actual content of the designs, as well as the corresponding metadata as well as the necessary information related to the configuration of the Octopus tool (i.e. language set). This information is used to store a new AIP to the repository, or update/delete an existing one. The submitted information packages should be processed in order to identify and create the required AIPs that will be transferred for archival.

Figure 74 depicts an overview of the ingestion module's functionality as use case diagram, presenting the module's primary actors, their goals, as use cases, as well as any dependencies among those goals. It is important to state that the SIP producer for the Octopus Repository in only the Octopus Tool.

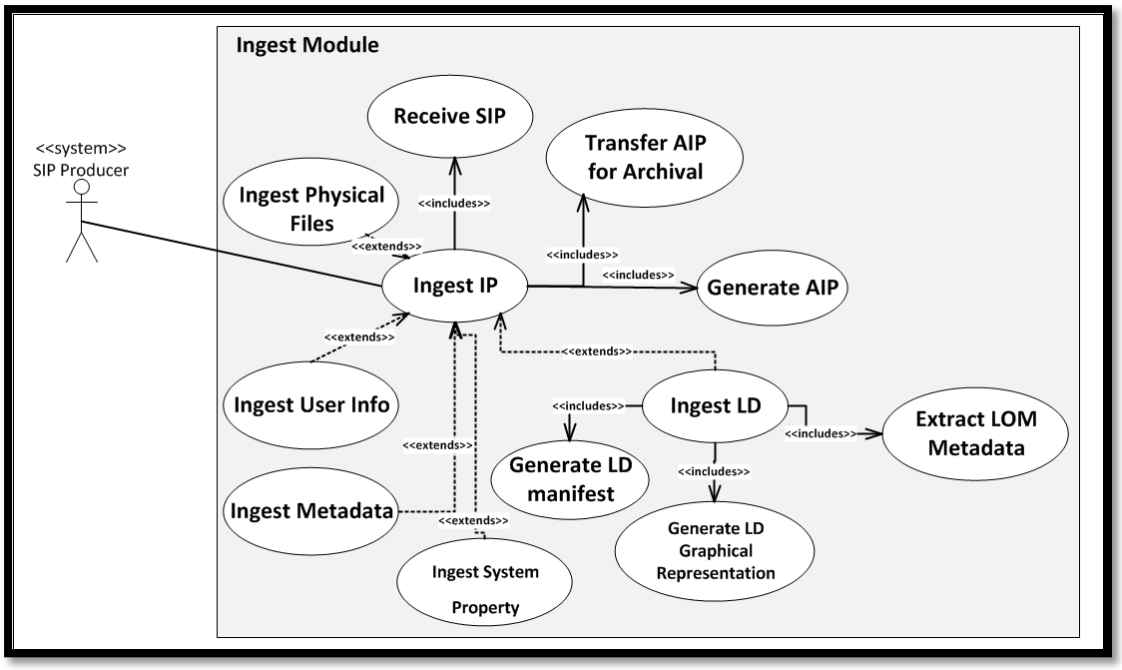


Figure 74 : Use Case Context Diagram for the Ingest Module of the Octopus Repository.

Table 3 provides an overview of the actions performed in order to achieve each of the goals presented in Figure 74 (e.g., the ingestion of an information package, etc.).

#	Primary Actor	Goal	Overview
1	SIP Producer	Ingest IP	The Producer sends a Submission Information Package (SIP) to the Octopus Repository. The information package validator validates the received SIP. The necessary Archival Information Packages (AIPs) are prepared. The generated AIPs are transferred to the Archival Module, either for insertion to the corresponding database, or for the update/delete of already existing AIPs.
1.1		Receive SIP	The Producer transfers the Submission Information Package (SIP) to the Octopus Repository. The Ingest Module provides the

			appropriate storage capability to receive a SIP.
1.2		Validate SIP	The information package validator conducts various checks to validate that the received SIP is well formed and authenticates the user account info. The validator produces a validation error in case the SIP failed to pass the validation tests.
1.3		Generate AIP	The AIP Generator receives the IP submitted by the Producer. One or more AIPs are generated depending on the SIP's type.
1.4		Transfer AIP for Archival	Every AIP generated by the AIP Generator of the Ingest Module is temporary stored. After the AIP generation has finished, the generated AIPs are transferred one by one to the Archival Module either for insertion to the database, or for the update/delete of already existing AIPs. Finally, the temporary AIPs are deleted.
2	SIP Producer	Ingest User Info	The Producer sends a Submission Information Package (SIP) containing an User Account info to the Octopus Repository. The information package validator validates user info. A new AIP is prepared and transferred to the Archival Module for the insertion of a new user to the corresponding database or for the update/delete of existing user accounts.

3	SIP Producer	Ingest Physical File	The Producer sends a Submission Information Package (SIP) containing the related to the file information. A new AIP is prepared and transferred to the Archival Module for the storage of the file.
4	SIP Producer	Ingest LD	The Producer sends a Submission Information Package (SIP) containing the related to the corresponding Learning Design info. The information package validator validates the received SIP. Three different files will be produced. One related with the IMS LD manifest file, a second related to the graphical representation of that Learning design and finally the LOM metadata will be extracted from the SIP.
4.1		Generate LD Manifest	The LD Manifest Generator receives a SIP related to Learning design and separates the learning design manifest from the SIP. The generated manifest is returned.
4.3		Extract LOM Metadata	The LD Metadata Separator receives a SIP related to Learning design and separates the learning design LOM metadata from the SIP. The generated LOM metadata is returned.
5	SIP Producer	Ingest Metadata	The Producer sends a Submission Information Package (SIP) containing a LOM metadata record related with a Learning Design to the Octopus Repository. The information package validator validates

			the received SIP. The necessary Archival Information Packages (AIPs) are prepared. The generated AIPs are transferred to the Archival Module for insertion to the database, or for the update/delete of already existing AIPs.
5	SIP Producer	Ingest System Property	The Producer sends a Submission Information Package (SIP) containing the system property. The necessary Archival Information Packages (AIPs) are prepared. The generated AIPs are transferred to the Archival Module for insertion to the database, or for the update/delete of already existing AIPs.

Table 3: The Ingest Module's Use Cases.

6.3.2. Archival Module

The Archival Module is responsible for the storage of the information packages (as stated above) received by the Ingest Module, as well as for the transfer of one or more existing AIPs to the Access Module after a retrieval request. In case of a Learning Design metadata record storage/update/deletion the Archival Module is responsible for transferring the required AIPs to the Indexing Module, in order to perform an AIP update to the index. There is no external actor (in terms of the ETP Repository) acting upon this module.

Figure 75 depicts an overview of the archival module's functionality as a use case diagram, presenting the module's use cases, as well as any dependencies among those goals.

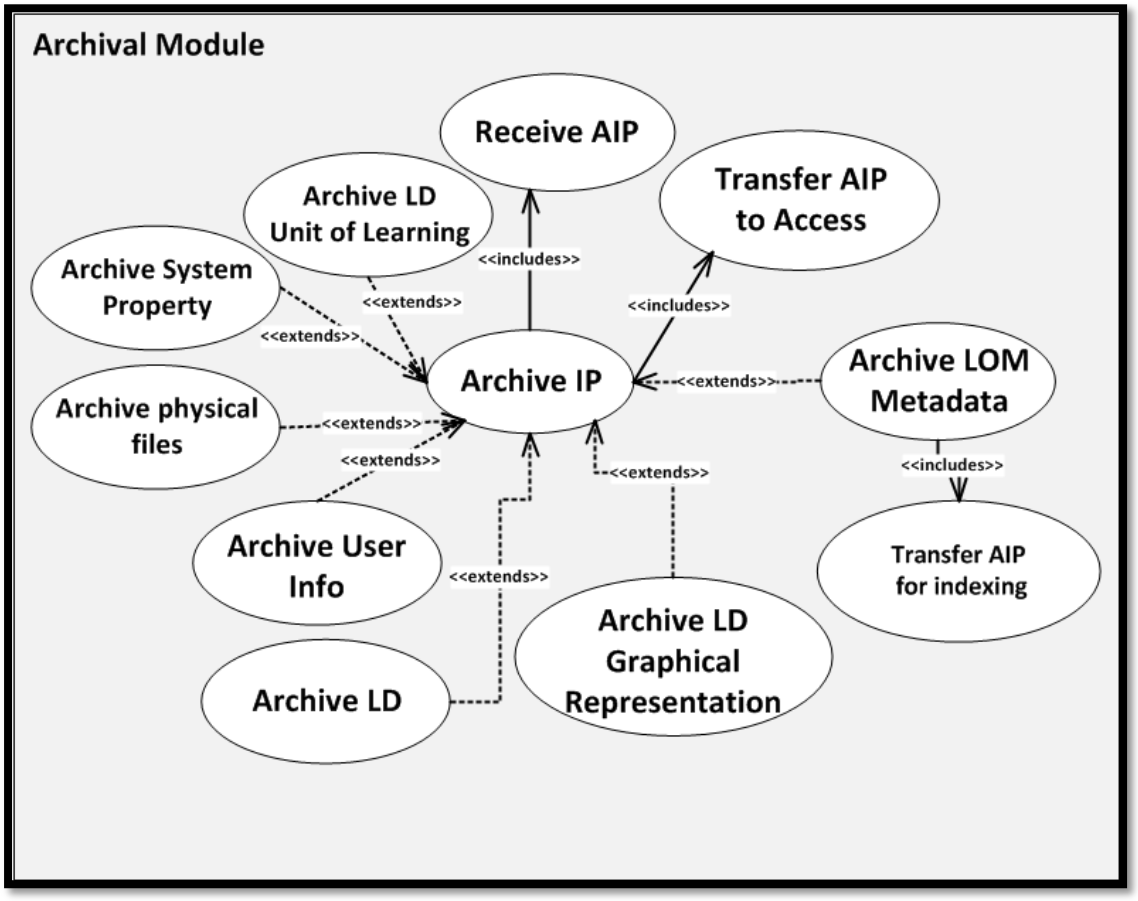


Figure 75 : Use Case Context Diagram for the Archival Module of the Octopus Repository.

Table 4 provides an overview of the actions performed in order to achieve each of the goals presented in Figure 75 (e.g., the ingestion of an information package, etc.).

#	Primary Actor	Goal	Overview
1		Archive IP	The Archival Module receives a request for storage/retrieval of an AIP. Storage requests are submitted by the Ingest Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Ingest Module sends an AIP to the Archival Module. The received AIP is inserted to the database, updated if it

			already exists, or deleted from the database according to the request's type. The received requests along with the AIP are dispatched to the Indexing Module depending on the AIP's type. In case of a retrieval request, the Archival Module retrieves one or more AIPs from the database. The retrieved AIPs are forwarded to the Access Module.
1.1		Receive AIP	The Ingest Module transfers an Archive Information Package (AIP) to the Archival Module. The Archival Module provides the appropriate storage capability to receive an AIP.
1.2		Transfer AIP to Access	The AIPs retrieved from the database, as a result of an Access Module's request are collected. A copy for each retrieved AIP is created. The AIPs' copies are transferred to the Access Module for further processing.
2		Archive User Info	The Archival Module receives a request for storage/retrieval of a User AIP record. Storage requests are submitted by the Ingest Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Ingest Module sends a User AIP to the Archival Module. The received AIP is inserted to the database, updated if it already exists, or deleted from the database according to the request's type. In case of a retrieval request, the Archival Module retrieves one User AIP records from the database. The retrieved

			AIPs are transferred to the Access Module.
3		Archive LD	The Archival Module receives a request for storage of a Learning Design, LD, AIP. Storage requests are submitted by the Ingest Module. In case of a storage request, the Ingest Module sends a LD, AIP to the Archival Module. The received LD AIP is inserted to the database, updated if it already exists, or deleted from the database according to the request's type.
4		Archive LOM Metadata	The Archival Module receives a request for storage/retrieval of a LD LOM metadata AIP record. Storage requests are submitted by the Ingest Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Ingest Module sends a LD LOM metadata AIP to the Archival Module. The received AIP is inserted to the database, updated if it already exists, or deleted from the database according to the request's type. The received requests along with the LD LOM metadata AIP record are transmitted to the Indexing Module. In case of a retrieval request, the Archival Module retrieves one or more LD LOM metadata AIP records from the database. The retrieved AIPs are

			forwarded to the Access Module.
4.1		Transfer AIP to Indexing Module	The LD LOM metadata AIP records which have been successfully inserted/updated/deleted are collected. A copy of each LD LOM Metadata AIP is created. The LD LOM metadata AIPs' copies are transferred to the Indexing Module along with the request received by the Ingest Module.
6		Archive Physical Files	The Archival Module receives a request for storage/retrieval of a file AIP record. Storage requests are submitted by the Ingest Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Ingest Module sends a file AIP to the Archival Module. The received AIP is inserted to the database, updated if it already exists, or deleted from the database according to the request's type. In case of a retrieval request, the Archival Module retrieves one or more file AIP records from the database. The retrieved AIPs are transferred to the Access Module.

7		Archive LD Unit of Learning	The Archival Module receives a request for storage/retrieval of a LD Unit of Learning AIP record. Storage requests are submitted by the Ingest Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Ingest Module sends a LD Unit of Learning AIP to the Archival Module. The received AIP is inserted to the database, updated if it already exists, or deleted from the database according to the request's type. In case of a retrieval request, the Archival Module retrieves one LD Unit of Learning AIP record from the database. The retrieved AIPs are transferred to the Access Module.
8`		Archive System Property	The Archival Module receives a request for storage/retrieval of a System Property record. Storage requests are submitted by the Ingest Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Ingest Module sends a System Property AIP to the Archival Module. The received AIP is inserted to the database, updated if it already exists, or deleted from the database according to the request's type. In case of a retrieval request, the Archival Module retrieves one or more System Property AIP record from the database. The retrieved AIPs are transferred to the Access Module.

Table 4: The Archival Module's Use Cases.

6.3.3. Indexing Module

The Indexing Module is responsible for the indexing of the Learning Design's metadata information packages received by the Archival Module, as well as for the transfer of one or more existing AIPs to the Access Module after a retrieval request. The Learning Design's metadata AIPs should be indexed to various metadata elements in order to allow their efficient access by the Access Module. There is no external actor (in terms of the Octopus Repository) acting upon this module.

The Figure 76 depicts an overview of the indexing module's functionality as a use case diagram, presenting the module's use cases, as well as any dependencies among those goals.

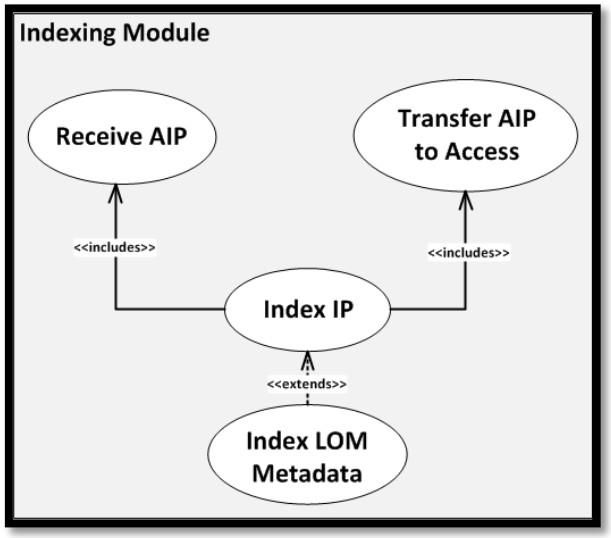


Figure 76 : Use Case Context Diagram for the Indexing Module of the Octopus Repository.

Figure 76 provides an overview of the actions performed in order to achieve each of the goals presented in Figure 75 (e.g., the indexing of an information package, etc.).

#	Primary Actor	Goal	Overview

1		Index IP	The Indexing Module receives a request for storage/retrieval of an AIP record. Indexing requests are submitted by the Archival Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Archival Module sends an AIP to the Indexing Module. The received AIP is indexed to various metadata elements in order to allow its efficient access. In case of a retrieval request, the Indexing Module retrieves one or more AIPs. The AIPs are transferred to the Access Module.
1.1		Receive AIP	The Archival Module transfers an Archive Information Package (AIP) to the Indexing Module. The Indexing Module provides the appropriate storage capability to receive an AIP.
1.2		Transfer AIP to Access	The AIPs retrieved from the index, as a result of an Access Module's request are collected. A copy for each retrieved AIP is created. The AIPs' copies are transferred to the Access Module for further processing.
2		Index LOM Metadata	The Indexing Module receives a request for storage/retrieval of a LOM Metadata AIP record. Indexing requests are submitted by the Archival Module, while retrieval requests are submitted by the Access Module. In case of a storage request, the Archival Module sends a LOM Metadata AIP record to the Indexing

			Module. The received LOM Metadata AIP record is indexed to various metadata elements in order to allow its efficient access. In case of a retrieval request, the Indexing Module retrieves one or more LOM Metadata AIP records. The AIPs are transferred to the Access Module.

Table 5: The Indexing Module's Use Cases.

6.3.4. Access Module

The Access Module is responsible for the dissemination of the archived information packages (i.e., LD manifest, LD unit of learning, LD LOM metadata, User Information) to a DIP Consumer after a retrieval request. This module analyzes the received request, evaluates the authorization access and sends the required AIP requests to both the Archival and Indexing Modules, in order to receive the requested AIPs and process them before the delivering to the DIP Consumer. The actors acting upon this module and serve as DIP Consumers are the Octopus Tool, the Educational Pathway Authoring Tool , as well as the harvester application of the Natural Europe Learning Infrastructure.

In order to provide a graphical overview of the Ingest Module's functionality, Figure 77 presents a Use Case Context Diagram, illustrating the actors of the module, their goals (represented as use cases), as well as any dependencies between those goals.

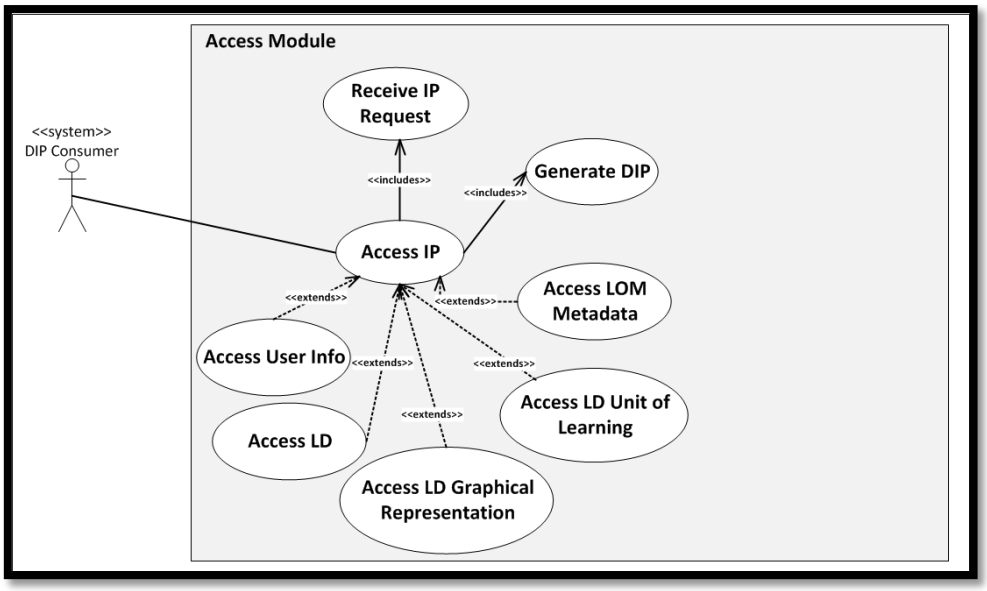


Figure 77 : Use Case Context Diagram for the Access Module of the Octopus Repository.

Table 6 provides an overview of the actions performed in order to achieve each of the goals presented in Figure 77 (e.g., the access of an information package, etc.).

#	Primary Actor	Goal	Overview
1	DIP Consumer	Access IP	The Consumer sends an information package request to the Octopus Repository. The Access Module evaluates the authorization access. In case that the authorization access evaluation is passed, an AIP request is submitted to the Archival Module and/or to the Indexing Module depending on the initial request's type. The Access Module receives the requested AIPs from the Archival/Indexing Modules. The received AIPs are further processed and the necessary Dissemination

#	Primary Actor	Goal	Overview
			Information Package (DIP) is prepared. The generated DIP is transfered to the Consumer.
1.1		Receive IP Request	The Consumer submits an information package request to the Access Module. The Access Module performs further analysis in order to process the request.
1.2		Evaluate Authorization Access	The Access Module conducts further analysis on the request in order to evaluate the authorization access. The evaluator produces an error in case that the request cannot be handled due to authorization access issues.
1.3		Generate DIP	The DIP Generator receives the AIPs from the Archival/Indexing Modules. The AIPs are further processed depending on the request's type. A DIP is generated using the resulted AIPs.
1.4		Deliver Response to Consumer	The DIP generated by the DIP Generator of the Access Module is fetched. The Access Module delivers the generated DIP to the Consumer.

#	Primary Actor	Goal	Overview
2	DIP Consumer	Access LD	The Consumer sends a LD request to the Octopus Repository. The Access Module evaluates the authorization access. In case that the authorization access evaluation is passed, a LD AIP request is submitted to the Archival Module. The Access Module receives the requested AIPs from the Archival Module. The received LD AIPs processed and the necessary Dissemination Information Package (DIP) is prepared. The generated LD DIP is transferred to the Consumer.
3	DIP Consumer	Access LD Graphical Representation	The Consumer sends a LD Graphical Representation request to the Octopus Repository. The Access Module evaluates the authorization access. In case that the authorization access evaluation is passed, a Graphical Representation AIP request is submitted to the Archival Module. The Access Module receives the requested AIPs from the Archival Module. The received Graphical Representation AIPs processed and the necessary Dissemination Information Package (DIP) is prepared. The generated LD DIP is transferred to the Consumer.

#	Primary Actor	Goal	Overview
4	DIP Consumer	Access LOM Metadata	The Consumer sends a LD LOM metadata record request to the Octopus Repository. The Access Module evaluates the authorization access. In case that the authorization access evaluation is passed, a LD LOM Metadata AIP request is submitted to the Indexing Module. The Access Module receives the requested AIPs from the Indexing Module. The received LD LOM metadata AIP records are further processed and the necessary Dissemination Information Package (DIP) is prepared. The generated LD LOM metadata DIP is transferred to the Consumer.
5	DIP Consumer	Access LD Unit of Learning	The Consumer sends a LD Unit of Learning record request to the Octopus Repository. The Access Module evaluates the authorization access. In case that the authorization access evaluation is passed, a LD Unit of Learning AIP request is submitted to the Indexing Module. The Access Module receives the requested AIPs from the Indexing Module. The received LD Unit

#	Primary Actor	Goal	Overview
			of Learning AIP records are further processed and the necessary Dissemination Information Package (DIP) is prepared. The generated LD Unit of Learning DIP is transferred to the Consumer.
5	DIP Consumer	Access User Info	The Consumer sends a User information record request to the Octopus Repository. The Access Module evaluates the authorization access. In case that the authorization access evaluation is passed, a User AIP request is submitted to the Archival Module. The Access Module receives the requested AIPs from the Archival Module. The received User AIPs are further processed and the necessary Dissemination Information Package (DIP) is prepared. The generated User DIP is transfered to the Consumer.

Table 6: The Access Module's Use Cases

6.4. Metadata Management and Sharing Framework and Architecture

A typical LMS can be conceptually represented with the architecture on the left part of Fig. 78. In this architecture, a LMS consists of the following:

- A set of Learning/Collaboration services

- a set of Course Creation/Management Services, and
- a Learning Resources Repository for the storage of the learning resources (physically of by reference) and their metadata.

In this section we present a framework and an architecture for learning resource management and sharing aiming at facilitating the implementation of such functionality on top of existing Learning Management Systems. The main component of this architecture that allows for the extension of an LMS for effective resource management and sharing is called the Metadata Management and Sharing System.

The Metadata Management and Sharing System allows for the creation of LOM metadata descriptions based on different APs, supporting the needs of different communities in different educational contexts. The technical experts can take advantage of the system, in order to develop an appropriate AP by using the Application Profile Builder that the users can later use in order to create the corresponding LOM metadata descriptions through the LOM editor. The LOM XML documents that are produced can be searched and edited through appropriate user interfaces. Moreover, the OAI-PMH Interface implementing the OAI-PMH protocol on top of the LOM Metadata Repository allows for the exposure of the metadata to Learning Resources Federations/Consumers.

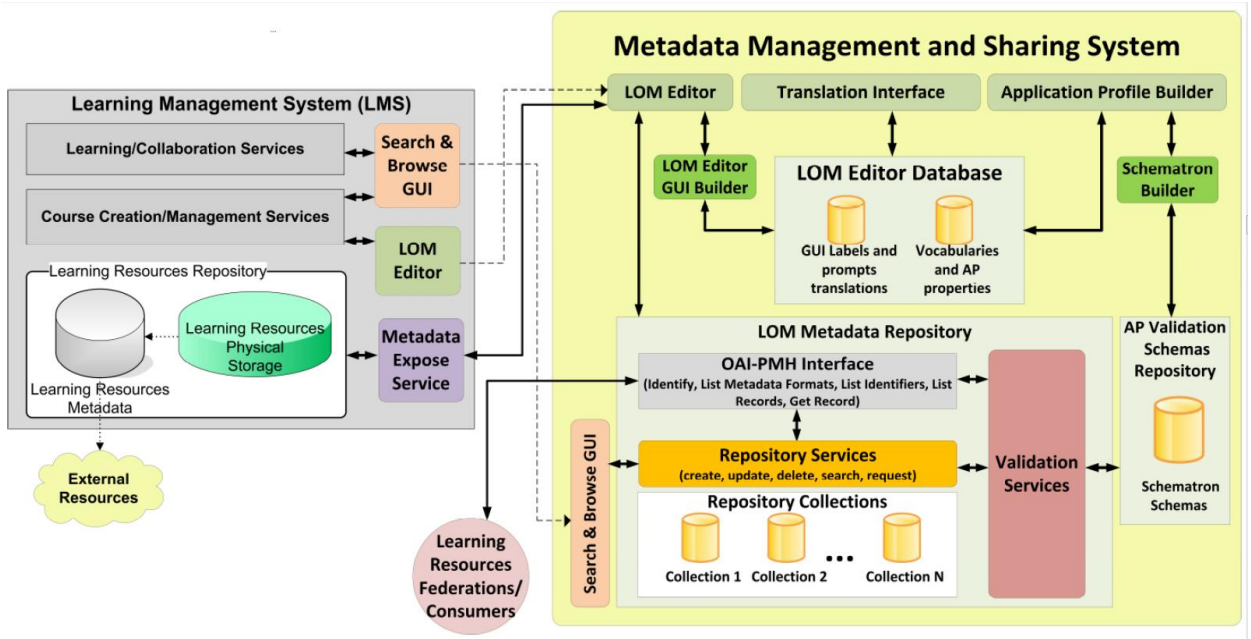


Figure 78:. The Metadata Management and Sharing Architecture

Fig. 1 illustrates in detail the architecture of the Metadata Management and Sharing System (MMSS) and its connection points (interfaces) with the LMS. The MMSS consists of the following components:

- The Application Profile Builder is a web based utility (user interface) that offers a graphical representation of the LOM metadata elements and their structure. Through that utility, the AP expert can navigate through the LOM elements, setting their multiplicity and the vocabularies, taxonomies or ontologies that will be used as value spaces for each of them. Moreover, the expert can state which elements are mandatory, recommended or optional. Furthermore, the expert can create custom vocabularies using list of values, taxonomies or domain ontologies that can be later used in specific metadata elements. That information is saved in the LOM Editor Database.
- The LOM Editor Database is responsible for the storage of the system properties, the vocabularies, the translations of the GUI and the help descriptions. It also stores the relevant information that is necessary for the system in order to support the APs.

- The Translation Interface is a web based wizard utility that can be used by the experts in order to translate the LOM editor's user interface, labels, prompt messages and help information related to each metadata element into different languages. It takes advantage of the "Google Translate API", suggesting translations to the user simplifying the translation procedure. The information related to translations is also kept in the LOM Editor Database.
- The LOM Editor is a web application that offers to the users a formal way to create or edit LOM metadata descriptions. The elements that are presented on the editor's user interface are each time adapted to the AP that is being used. The elements associated with vocabularies are supported by auto complete services. For each element a short description (help) is available, explaining the usage of the corresponding element for each AP. The LOM metadata description is finally saved in the LOM Metadata Repository.
- The LOM Editor GUI Builder utilizes the information that is kept in the LOM Editor Database and builds the LOM Editor's user interface. The Schematron Builder is a component invoked by the Application Profile Builder as soon as an AP is saved. It is responsible for the creation of schematron schemas [3] according to the corresponding APs. These schemas are stored in the AP Validation Schemas Repository" and are used for the validation of the XML documents.
- The AP Validation Schemas Repository is the responsible component for the storage of the Application Profile validation schemas (schematron).
- The LOM Metadata Repository is responsible for the storage and management of the generated LOM XML descriptions. It consists of the following parts:
    - The Validation Services that are used to validate the XML documents that are generated by the LOM Editor, utilizing the information that is kept in the AP Validation Schemas Repository. The documents that are invalid are also kept in the repository in order to be later completed by the user, but will not

be published through the OAI-PMH interface until they reach their final state.

  - Repository Services is a set of services over the repository collections that conform to the IMS Digital Repositories Interoperability (IMS DRI) Specification [4]. The IMS DRI specification provides recommendations for the interoperation of the most common repository functions enabling diverse components to communicate with one another: search/expose, submit/store, gather/expose and request/deliver.
  - The OAI-PMH interface is the responsible part for the exposure of the metadata descriptions. It is an implementation of the OAI-PMH protocol, a widely accepted protocol for the exposure of repositories information. The LOM XML documents that are exposed by this protocol have been previously validated based on the corresponding Application Profile and the Validation Services.
- The Search & Browse GUI is a web based graphical user interface that can be used to search and browse the content of the LOM Metadata Repository, utilizing the Repository Services.

The connection points between the Learning Management System and the Metadata Management and Sharing System are the following, as illustrated in Fig. 1:

- The LOM Editor box on the side of the LMS corresponds to the integration of the LOM Editor in the LMS. This requires no effort, since the LOM editor integration is easily done using technologies like iframes without any changes needed to be done on the side of the LMS. The web interface of the LOM editor can be customized using the LOM Editor GUI Builder in order to fit the web interface of the LMS.
- The Search & Browse GUI box on the side of the LMS. As in the case of LOM Editor, the Search & Browse GUI can be easily integrated using iframes.

Implementation and Usage

The MMSS has been successfully implemented on top of both Octopus and MOLE (Multimedia Open Learning Environment – http://www.moleportal.eu/).

Mole is developed by the Laboratory of Distributed Multimedia Information Systems and Applications (TUC/MUSIC) of the Technical University of Crete. Throw MOLE, MMSS has been utilized and supported different educational communities, secondary education teachers and organic farming professionals, established in the context of four EU Projects (pSkills - http://pskills.ced.tuc.gr, Organic.Mednet - http://www.organic-mednet.eu, CerOrganic - http://www.cerorganic.eu, and Organic.Balkanet - http://www.organic-balkanet.eu). Their MOLE instances are available from http://pskills.moleportal.eu/, http://om.moleportal.eu, http://cerorganic.moleportal.eu, and http://ob.moleportal.eu respectively.

Chapter 7. Conclusion and future work

7.1. Contributions of this thesis

Exploiting usability engineering approaches, as in the case of Octopus, can address the current shortcomings of instructional design tools and enable effective collaboration and support for instructional designers and teachers while, at the same time, exploit the dominant standard for instructional design, namely IMS LD. Our experience supports the findings of Demt et al. [6] that "conceptual complexity does not impede effective IMS LD authoring, so the barriers to adoption appear to lie elsewhere". Effective user interface metaphors can hide the most difficult parts of the IMS LD model and raise the perceived ease of use and usefulness of tools. Consequently, the main contribution of our work is that usability engineering principles and methodologies are important to ensure alignment of instructional design tools with users' needs and expectations without sacrificing compliance with standards.

The work presented in this thesis has been exploited in five European Projects, ODS (Open Discovery Space), ALICE, Natural Europe, Transit, pSkills, Organic.Mednet, CerOrganic, and Organic.Balkanet.

Furthermore, parts of the work done in this thesis have been published in a number of peer reviewed conference publications as well as in a number of technical reports.

A number of papers presenting work performed in the context of this thesis have been published in the following Conference Proceedings:

1. Octopus: A Collaborative Environment Supporting the Development of Effective Instructional Design Publication Authors: **Mylonakis M**., Arapi P., Moumoutzis N., Christodoulakis S., Ampartzaki M. Publication Info: In Proceedings of International Conference on E-Learning and E-Technologies in Education (ICEEE2013), Lodz, Poland, on Sept. 23-25, 2013.
2. "Metadata Management and Sharing in Multimedia Open Learning Environment (MOLE)"Publication Authors: **Mylonakis M.**, Arapi P.,

Pappas N., Moumoutzis N., Christodoulakis S.Publication Info: In Proceedings of Metadata Semantics and Research Conference 2011 (MTSR2011) - Special track on Metadata & Semantics for Learning Infrastructures, Izmir, Turkey, October 2011

3. The Multimedia Open Learning Environment (MOLE)" Publication Authors: Pappas N., Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S. Publication Info: In Proceedings of EDEN2011 Open Classroom Conference, Athens, Greece, October 2011
4. COLearn: Supporting Collaborative Learning on top of Existing Learning Infrastructures. Publication Authors: Stylianakis G., Moumoutzis N., Arapi P., Mylonakis M., Christodoulakis S. Publication Info: Bulletin of the IEEE Technical Committee on Learning Technology, Volume 17, Number 1-2, April 2015 Publication Type: Journal Publications
5. COLearn and open discovery space portal alignment: A case of enriching open learning infrastructures with collaborative learning capabilities Publication Authors: Stylianakis G., Moumoutzis N., Arapi P., Mylonakis M., Christodoulakis S. Publication Info: 2014 International Conference on Interactive Mobile Communication Technologies and Learning (IMCL) 2014 Publication Type: Conference Publications
6. "The IQTOOL Project: Developing a Quality Assurance Tool for Elearning"
   Publication Authors: Moumoutzis N., Christoulakis M., Arapi P., **Mylonakis M**., Christodoulakis S.Publication Info: In the Proceedings of LOGOS Open Conference `New Technology Platforms for Learning - Revisited`, Budapest, Hungary, January 19-20, 2009
7. "Design, Implementation and Experimental Evaluation of a Pedagogy-Driven Framework to Support Personalized Learning Experiences" Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Stylianakis G., Theodorakis G., Christodoulakis S.Publication Info: In the Proceedings of the 2nd LOGOS Open Workshop on Cross-Media and Personalized Learning Applications with Intelligent Content (LAIC

2008) in conj. with AIMSA2008 Conference, Varna, Bulgaria, September 2008

8. “A Framework and an Architecture for Supporting Interoperability between Digital Libraries and eLearning Applications (1)” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S.Publication Info: In the Proceedings of the DELOS Conference on Digital Libraries, Tirrenia, Pisa, Italy, February 2007
9. “A Pedagogy-driven Personalization Framework to Support Adaptive Learning Experiences” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S.Publication Info: In the Proceedings of the 7th IEEE International Conference on Advanced Learning Technologies (ICALT 2007), Niigata, Japan, July 2007
10. “Supporting Personalized Learning Experiences within the LOGOS Cross-Media Learning Platform” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Theodorakis G., Stylianakis G.Publication Info: In the Proceedings of the Workshop on Cross-Media and Personalized Learning Applications on top of Digital Libraries (LADL2007) in conj. with ECDL2007 Conference, Budapest, Hungary, September 2007
11. “A Framework and an Architecture for Supporting Interoperability between Digital Libraries and eLearning Applications” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Christodoulakis S.Publication Info: Book chapter in Digital Libraries: Research and Development, Lecture Notes in Computer Science, Springer Berlin/Heidelberg, Volume 4877/2007, pp. 137-146 2007
12. “A Pedagogy-driven Personalization Framework to Support Automatic Construction of Adaptive Learning Experiences” Publication Authors: Arapi P., Moumoutzis N., **Mylonakis M.**, Theodorakis G., Christodoulakis S.Publication Info: In the Proceedings of the 6th International Conference on Web-based Learning (ICWL 2007), Edinburgh, United Kingdom, August 2007
13. “Interoperability of eLearning Applications with Digital Libraries” Publication Authors: Christodoulakis S., Arapi P., Moumoutzis N.,

Mylonakis M., Patel M., Kapidakis S., Papatheodorou C., Arahova A., Vagiati B., Konsolaki H.Publication Info: Poster on the 10th European Conference on Research and Advanced Technology for Digital Libraries (ECDL 2006), DELOS Research Activities 2006, C. Thanos (Eds.), DELOS Network of Excellence: pp. 83-85, Alicante, Spain, September 2006

7.2. Octopus in the Open Discovery Space: A socially-powered and multilingual open learning infrastructure to boost the adoption of eLearning resources (FP7-ICT-PSP:297229)

The Open Discovery Space project addresses various challenges that face the eLearning environment in the European context targeting three principal objectives: Firstly, it will offer a single, integrated access point for eLearning resources from dispersed educational repositories. Secondly, it will promote the engagement in meaningful educational activities by using a social-network style multilingual portal, offering eLearning resources as well as services for the production of educational activities. Thirdly, it will assess the impact of the new educational activities, which could serve as a prototype to be adopted by stakeholders in school education.

The Open Discovery Space project is bringing innovation to three key areas:

Proposing innovative ways to encourage educational communities to use eLearning resources and exchange their experience and views on ease of use and quality of those resources.

Proposing an innovative educational design and an educational metadata organisation scheme. These measures will seek to exploit the elements of the learning context in eLearning resources (i.e., educational objectives, pedagogical models, learners' personal characteristics and needs, etc), as well as the teachers' competence profiles (knowledge, skills and attitudes) making it possible to measure and assess the impact of eLearning resources ON schools both in terms of learning outcomes and learning activities.

Proposing innovative solutions that could remove linguistic and cultural barriers, improving the ease of use in existing repositories in order to deliver

relevant Learning Resources to teachers, students and parents more effectively.

Upon the completion of this project, Open Discovery Space will have contributed to the modernisation of school education, supported stakeholders in acquiring digital competences, stimulated demand for innovative eLearning resources and engaged teachers and pupils in the development of innovative educational practices. Crucially, this project will strengthen European integration by increasing cooperation across state borders, bringing together different cultures and supporting multi-lingual practices

7.3. Octopus in ALICE: Adults' Learning for Intergenerational Creative Experience (518106-LLP-1-2011-1-IT-GRUNDTVIG-GMP)

In the complex contemporary European society, social cohesion needs to be built considering a new integrated and complex dimension of social tissue, where diversity (among cultures, age, gender) is considered an opportunity.

Intergenerational learning (IL) bring to the fore the question of “differences” that enrich: in fact, IL can be a twofold purpose process, that improve dialogue among generations through civic participation in common social and institutional spaces, while at the same time enacts processes of informal learning towards the achievement, both by adults and children, of key competences for lifelong learning. The processes of IL are hence, a mean and an end to foster social cohesion.

This project aims to work with parents, grandparents, volunteers and other adults interested to interact with children through new spaces of edutainment, to train them to the importance of use of creative languages (art, storytelling, social media) to build rich and caring environments for children to grow up.

This learning process will in time provide adults with key competences 1 , 4, 5, 7 and 8 . Adults will be engaged in at least six local specific informal educational experiences to better interact with children, through creative languages; experiences will cover a range of activities, from "use of art to communicate and express", "storytelling in Europe", "games and social media

for all", aiming at discussing the complex role of adults as informal educators and hence promoters of learning beyond the school.

The project will look for engagement of two types of adult-learners (at risk, like immigrant parents, and volunteers) in order to strengthen social support networks. In order to promote the better quality of adults' learning activities, the project will launch a transversal, European training of adults' trainers as reflective support to local activities through eLearning methodology to discuss the topic of intergenerational learning at European level.

7.4. Octopus in NaturalEurope: Natural History & Environmental Cultural Heritage in European Digital Libraries for Education (FP7-POLICIES)

In an era where natural history and environmental education inadequacy in formal and informal contexts is becoming an increasingly challenging issue, harvesting the potential of European digital libraries appears as a very attractive option. However, an impressive abundance of high quality digital content that is available in Natural History Museums (NHMs) around Europe remains largely unexploited due to a number of barriers, such as: the lack of interconnection and interoperability between the management systems of NHMs, the lack of centralised access through a European point of reference like Europeana, as well as the inefficiency of current content organization and the metadata used.

A major problem is however the lack of effective support of digital library applications like learning. Applications are well known to be long living, and typically they have longer life than systems. Thus they tend to create their own standards and support infrastructures based on those standards. These independent infrastructures and applications however do not exploit the vast wealth of information in the European digital libraries, and they do not interoperate effectively and efficiently with them.

The Natural Europe project suggests a coordinated solution at European level in order to overcome the aforementioned barriers. More specifically, Natural Europe aims to deliver the following services/solutions:

1. connect the digital collections of European NHMs with Europeana, helping them overcome obstacles such as the lack of interoperable systems and metadata;
2. study the educational methods and deploy the necessary software tools that will allow educators to design innovative online pathways through the digital collections of NHMs;
3. facilitate the storage, search and retrieval of learning objects from Europeana according to international learning standards;
4. facilitate the search and retrieval from Europeana of digital library objects related to educational profiles, objectives and curricula on Natural History, Environmental Education, and Biological Sciences;
5. facilitate existing educational search software to interface with the Europeana digital library;
6. design and deploy novel graphical interfaces that will facilitate the navigation of educational pathways within digital collections, both from Europeana and the Museum's Web sites;
7. adapt and test innovative interactive installations at the NHMs that will allow visitors to follow educational pathways through Europeana's content on Natural History and Sciences, as part of the Museums' exhibition;
8. evaluate and validate the delivered services/solutions through extensive pilot trials with projectinternal and external organisations and user groups.

To implement the Natural Europe vision, the consortium brings together a balanced mix of high quality NHMs, pedagogues, educational technologists, metadata experts, user groups and standardization bodies. After the approach is tested through a set of "proof-of-concept" experiments

that will try out the different theoretical approaches, it will extensively validate the proposed approach in real-life usage contexts employing the user groups represented in the consortium. Through the significant networking capacity of the Natural Europe consortium, the overall aim is to achieve a pan-European standardization process in the field of engaging the cultural heritage of NHMs of Europe and the Europeana infrastructure, in order to enhance natural history and environmental education.

Target users and their needs Natural Europe will focus on the specific user groups and their particular needs. The main identified user segments are:

- Students: Students studying natural history, environmental education and science in secondary education and university level. This target group will have a multi-fold interaction with the Natural Europe service either through web access to the portal within the classroom context, either through student web access at home or through physical visits to local NHMs.
- Teachers: Teachers need to leverage the existing legacy of educational content and scenarios. The Natural Europe will offer versatile creation and reuse of educational scenarios (learning activities) through an intuitive platform. Furthermore, building on the context sensitivity of the platform, teachers will be offered with relevant search results, recommendations and links.
- Museum visitors: Museum visitors will be offered access to a broader range of relevant digital resources. In addition, weight will be placed also on the pre- and post- visit phases of the visitor experience, offering web access to information before the visit, allowing for personal path design within the museum and for the post- visit phase where the visitor can access digital resources related to the physical exhibits he/she just visited.
- Informal learning web visitors: As Internet penetration becomes a predominant phenomenon in Europe, more and more of the web users make the most of the Internet in informal learning contexts. To answer their needs for “edutainment” the Natural Europe project will build a

context sensitive service offering a vast range of digital content. Most importantly, this “content package” will be delivered custom-tailored to the user needs

7.5. Octopus in Transit - TRANSversal key competences for lifelong learning: TraIning teachers in competence based education

The aim of the project is to have a positive impact on the development of students’ key competencies through building teachers capacity on competence oriented education. To achieve this, a pilot teachers training methodology will be developed on the didactics and e-assessment of key transversal competences, which could be adopted by interested stakeholders promoting educational change. The methods of the project are founded on a holistic view of students learning, personal and social development, going beyond subject boundaries and finding application in a wide spectrum of curriculum subjects. The TRANSIt approach contributes to the development of creativity, adaptation to the rapidly changing circumstances, intercultural and multilingual competences, social development, “learning to learn” competences and an improved perception of one’s own capacity to solve problems. The proposed project aims to add its contribution towards the improvement of the quality of competence education by improving a) teachers’ awareness of key competences and b) teachers’ professional skills regarding the didactics and e-assessment of the key competences with the use of ePortfolios, supporting them to bring European and national policies into practice. The impact of the training material will be assessed by authentic (nontraditional) assessment methods analysing qualitative dimensions, such as the behavioural change of teachers towards the importance of competence acquisition by their students, qualitative and quantitative characteristics of user-generated content uploaded in the e-portfolios. An effective training approach will directly contribute to designing such teaching and learning activities that may increase students’ motivation and thereby supporting and enhancing the acquisition of transversal key competencies by all students, closely reflecting the aim of the LLP programme in terms of improving students’ motivation to learn, and learning to learn skills.

7.6. Future work

The experience gained during the use of Octopus by actual teachers in diverse contexts, points to two important aspects for future work:

1. Provide functionality to support development and monitoring of project-based student learning scenarios. In particular, this functionality will allow a teacher to create a working space for his/her students (either working in solo in in groups). In this working space, each student group will be able to enrich with student-generated content the project-based scenario given by the teacher and the teacher will be able to monitor the progress of the students and provide guidance during their work.
2. Develop a mobile app that will exploit the generic architecture of Octopus to enable the inclusion of images, videos and other content that could be created using a mobile device, within learning scenarios. This content can be used during the implementation of the scenario to provide contextualized information during student visits in museums, archaeological sites and other physical places.
3. Combine functionalities (1) and (2) to enable student-generated content management during mobile-learning scenarios implementation.

Appendix A: Web services descriptions and communication with external applications

This section describes the services were developed in order to support the communication of the tool with foreign platforms and applications.

This appendix describes a list of the web services that are provided by the system. The data format supported is JSON or XML depending of the service type.

All the services have been extensively tested and used with third party tools as for example the ODS project, MOLE platform and

OAuth Authorization Model

OAuth is a simple, secure, and quick way to publish and access protected data (photos, videos, contact list). It's an open authorization model based primarily on existing standards that ensures secure credentials can be provisioned and verified by different software platforms.

In other words, OAuth allows to share private resources stored on one site with another site without having to hand out the user username and password.

For a visitor to a site, OAuth is completely transparent. The user experience will be specific to the implementation of both the site requesting access and the one storing the resources, and will adjust to the device being used (web browser, mobile phone, PDA, set-top box).

The following example analyses the steps must be followed by a developer in order to implement the OAUTH authentication protocol with the developer has created an application which will allow his users to represent their presence using the Yahoo Status web service. Once the developer signs up for an OAuth API Key and Secret (provided by Yahoo), they may access Yahoo's OAuth API to establish the credentials used to access this data from Yahoo Status. When a user interacts with the developer's application, they are redirected to Yahoo's authorization page, where they sign into their Yahoo account, then grant the application access to their Yahoo Status data. A user-authorized token is returned to the application which can be used to access this data.

Services supporting the communication between octopus and ODS

add_user_in_community

Service Name	**add_user_in_community**

Request Type	HTTP GET
URL	http://www.learn.ced.tuc.gr/octopus/api/add_user_in_community
Authorization	YES
Required parameters	
community_id	

User_data	{
	"user_id": "the unique user id",
	"user_name": "username",
	"first_name": "User first name",
	"last_name": "User last name",
	"email": "user email",
	"org": "user organisation belongs to"
	}

Optional parameters	
Response JSON Format (sample)	
{ **"result": "OK",** **“done”:true** **}**	

7.6.1. remove_user_from_comminity

Service Name	**remove_user_from_comminity**
Request Type	HTTP DELETE
URL	https://www.learn.ced.tuc.gr/octopus/remove_user_from_com

	minity
Authorization	YES
Required parameters	
community_id	Community id

User_data	{
	"user_id": "the unique user id",
	"user_name": "username",
	"first_name": "User first name",
	"last_name": "User last name",
	"email": "user email",
	"org": "user organisation belongs to"
	}

Optional parameters	
Response JSON Format (sample)	
{ **"result": "OK",** **“done”:true** **}**	

7.6.2. create_community

Service Name	**create_community**
Request Type	HTTP GET
URL	https://www.learn.ced.tuc.gr/octopus/create_community
Authorization	YES
Required parameters	
community_data	{

	"community_id": "the unique community id in the source web site", "community_title": "given commintity title", "community_dsc": "given community description", "organization": "given organization", "community_preview": "image preview url", "community_privacy": "private or public" }

user_data	{
	"user_id": "the unique user id",
	"user_name": "username",
	"first_name": "User first name",
	"last_name": "User last name",
	"email": "user email",
	"org": "user organisation belongs to"
	}

Optional parameters	
Response JSON Format (sample)	
{ **"result": "OK",** **“done”:true** **}**	

7.6.3. update_community

Service Name	**update_community**
Request Type	HTTP GET
URL	https://www.learn.ced.tuc.gr/octopus/create_community
Authorization	YES

Required parameters	

community_data	{
	"community_id": "the unique community id in the source web site",
	"community_title": "given commintity title",
	"community_dsc": "given community description",
	"organization": "given organization",
	"community_preview": "image preview url",
	"community_privacy": "private or public"
	}

Optional parameters	
Response JSON Format (sample)	
{ **"result": "OK",** **“done”:true** **}**	

7.6.4. delete_community

Service Name	**delete_community**
Request Type	HTTP delete
URL	https://www.learn.ced.tuc.gr/octopus/create_community
Authorization	YES
Required parameters	
community_id	the unique community id
user_data	{ "user_id": "the unique user id", "user_name": "username",

	"first_name": "User first name", "last_name": "User last name", "email": "user email", "org": "user organisation belongs to" }
Optional parameters	
Response JSON Format (sample)	
{ **"result": "OK",** **“done”:true** **}**	

7.6.5. list_community_ojects

Service Name	**list_community_ojects**
Request Type	HTTP GET
URL	https://www.learn.ced.tuc.gr/octopus/api/
Authorization	YES
Required parameters	
community_id	"community_id": "the unique community id"
object_type	”ld→learnign design, t→templates”
Optional parameters	
Response JSON Format (sample)	
{ **"success": true,** **"total": 123,** **"results": [**	

```
  {
    "id": "object id",
    "title": "the object's title",
    "dsc": "the object's short description",
    "preview_image": "the preview image of the object",
    "author": {
      "first_name": "first name",
      "last_name": "last name",
      "email": "user email",
      "userid": "user unique id"
    }
  },
  {
    "id": "object id",
    "title": "the object's title",
    "dsc": "the object's short description",
    "preview_image": "the preview image of the object",
    "author": {
      "first_name": "first name",
      "last_name": "last name",
      "email": "user email",
      "userid": "user unique id"
    }
  }
 ]
}
```


7.6.6. remove_object_from_community

Service Name	remove_object_from_community
Request Type	HTTP delete
URL	https://www.learn.ced.tuc.gr/octopus/api/remove_obj

	ect_from_community
Authorization	YES
Required parameters	
community_id	the unique community id
object_id	the unique object id
Optional parameters	
Response JSON Format (sample)	
{ **"result": "OK",** **“done”:true** **}**	

7.6.7. get_object_edit_url

Service Name	**get_object_edit_url**
Request Type	HTTP delete
URL	https://www.learn.ced.tuc.gr/octopus/api/ get_object_edit_url
Authorization	YES
Required parameters	
community_id	the unique community id
object_id	the unique object id
Optional parameters	
Response JSON Format (sample)	
{	

"result": "OK", **“done”:true** **}**

7.6.8. get_object_view_url

Service Name	**get_object_view_url**
Request Type	HTTP delete
URL	https://www.learn.ced.tuc.gr/octopus/api/ get_object_view_url
Authorization	YES
Required parameters	
community_id	the unique community id
object_id	the unique object id
Optional parameters	
Response JSON Format (sample)	
{ **"result": "OK",** **“done”:true** **}**	

7.6.9. add_user_in_community

Service Name	**add_user_in_community**
Request Type	HTTP GET
URL	https://www.learn.ced.tuc.gr/octopus/api/add_use

	r_in_community
Required parameters	
object_type	”ld→learnign design, t→template”
user_id	The creator’s unique user id
Optional parameters	
Response JSON Format (sample)	
{result:”OK”.redirect=”redirection url”}	

Services supporting the OAI-PMH

ListIdentifiers

Service Name	**ListIdentifiers**
Request Type	HTTP GET
URL	http://learn.ced.tuc.gr/octopus/oai
Required parameters	
metadataPrefix	Specifies that headers should be returned only if the metadata format matching the supplied metadataPrefix is available or, depending on the repository's support for deletions, has been deleted. The metadata formats supported by a repository and for a particular item can be retrieved using the ListMetadataFormats request.
resumptionToken	an exclusive argument with a value that is the flow control token returned by a previous ListIdentifiers request that issued an incomplete list.
Optional parameters	
from	argument with a UTCdatetime value, which

	specifies a lower bound for datestamp-based selective harvesting.
until	argument with a UTCdatetime value, which specifies a upper bound for datestamp-based selective harvesting.
set	specifies set criteria for selective harvesting.

Response XML Format

```
<?xml version="1.0" encoding="UTF-8"?>
<OAI-PMH xmlns="http://www.openarchives.org/OAI/2.0/"
        xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
        xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/
        http://www.openarchives.org/OAI/2.0/OAI-PMH.xsd">
  <responseDate>2002-06-01T19:20:30Z</responseDate>
  <request verb="ListIdentifiers" from="1998-01-15"
          metadataPrefix="oldarXiv"
          set="physics:hep">http://an.oa.org/OAI-script</request>
  <ListIdentifiers>
   <header>
    <identifier>oai:arXiv.org:hep-th/9801001</identifier>
    <datestamp>1999-02-23</datestamp>
    <setSpec>physic:hep</setSpec>
   </header>
   <header>
    <identifier>oai:arXiv.org:hep-th/9801002</identifier>
    <datestamp>1999-03-20</datestamp>
    <setSpec>physic:hep</setSpec>
    <setSpec>physic:exp</setSpec>
   </header>
   <header>
    <identifier>oai:arXiv.org:hep-th/9801005</identifier>
    <datestamp>2000-01-18</datestamp>
    <setSpec>physic:hep</setSpec>
   </header>
   <header status="deleted">
    <identifier>oai:arXiv.org:hep-th/9801010</identifier>
    <datestamp>1999-02-23</datestamp>
    <setSpec>physic:hep</setSpec>
    <setSpec>math</setSpec>
   </header>
   <resumptionToken expirationDate="2002-06-01T23:20:00Z"
     completeListSize="6"
     cursor="0">xxx45abttyz</resumptionToken>
  </ListIdentifiers>
</OAI-PMH>
```

Services supporting the communication with LOM editor

Service Name	**getMetadata**
Request Type	HTTP GET

URL	https://www.learn.ced.tuc.gr/octopus/api/
Required parameters	
Id	The metadata record id
Optional parameters	
Response XML Format	

```
<?xml version="1.0" encoding="UTF-8"?>
<?oxygen SCHSchema="http://lom-fr.fr/sch/lomfrv1.0/lomfr.sch"?>
<lom:lom xmlns:lom="http://ltsc.ieee.org/xsd/LOM" xmlns:lomfr="http://www.lom-fr.fr/xsd/LOMFR">
   <lom:general>
      <lom:identifier>
         <lom:catalog>URI</lom:catalog>
         <lom:entry>http://www.e-filipe.org/courses/ID005</lom:entry>
      </lom:identifier>
      <lom:title>
         <lom:string language="fre">Introduction à la gestion de projet</lom:string>
      </lom:title>
      <lom:language>fre</lom:language>
      <lom:description>
         <lom:string language="fre"
            >Ce matériel pédagogique est spécifiquement destiné à des étudiants étrangers non francophones et orientés vers l'apprentissage du français langue étrangère dans les spécialités scientifiques. Un parcours guidé d'environ 50 exercices de français exploite un exposé oral de 24 mn, enregistré et médiatisé (vidéo et diapositives synchronisée).</lom:string>
      </lom:description>
      <lom:keyword>
         <lom:string language="fre">gestion de projet</lom:string>
      </lom:keyword>
      <lom:keyword>
         <lom:string language="fre">FLE</lom:string>
      </lom:keyword>
      <lom:keyword>
         <lom:string language="fre">Filipe</lom:string>
      </lom:keyword>
      <lom:aggregationLevel>
         <lom:source>LOMv1.0</lom:source>
         <lom:value>3</lom:value>
      </lom:aggregationLevel>
      <lomfr:documentType>
         <lomfr:source>LOMFRv1.0</lomfr:source>
         <lomfr:value>texte</lomfr:value>
      </lomfr:documentType>
      <lomfr:documentType>
         <lomfr:source>LOMFRv1.0</lomfr:source>
         <lomfr:value>image en mouvement</lomfr:value>
      </lomfr:documentType>
      <lomfr:documentType>
         <lomfr:source>LOMFRv1.0</lomfr:source>
         <lomfr:value>ressource interactive</lomfr:value>
```

```
      </lomfr:documentType>
      <lomfr:documentType>
         <lomfr:source>LOMFRv1.0</lomfr:source>
         <lomfr:value>son</lomfr:value>
      </lomfr:documentType>
   </lom:general>
   <lom:lifeCycle>
      <lom:version>
         <lom:string language="fre">V1 février 2007</lom:string>
      </lom:version>
      <lom:status>
         <lom:source>LOMv1.0</lom:source>
         <lom:value>revised</lom:value>
      </lom:status>
      <lom:contribute>
         <lom:role>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>author</lom:value>
         </lom:role>
         <lom:entity>BEGIN:VCARD
            VERSION:3.0
            N:Tollenaere;Michel;;
            FN:Tollenaere Michel
            END:VCARD</lom:entity>
         <lom:date>
            <lom:dateTime>2005-01-01</lom:dateTime>
         </lom:date>
      </lom:contribute>
      <lom:contribute>
         <lom:role>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>author</lom:value>
         </lom:role>
         <lom:entity>BEGIN:VCARD
            VERSION:3.0
            N:Gardoni;Mickaël;;
            FN:Gardoni Mickaël
            END:VCARD</lom:entity>
         <lom:date>
            <lom:dateTime>2005-01-01</lom:dateTime>
         </lom:date>
      </lom:contribute>
      <lom:contribute>
         <lom:role>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>author</lom:value>
         </lom:role>
         <lom:entity>BEGIN:VCARD
            VERSION:3.0
            N:Dutto;Estelle;;
            FN:Dutto Estelle
            END:VCARD</lom:entity>
         <lom:date>
            <lom:dateTime>2005-01-01</lom:dateTime>
         </lom:date>
      </lom:contribute>
      <lom:contribute>
         <lom:role>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>publisher</lom:value>
```

```
        </lom:role>
        <lom:entity>BEGIN:VCARD
          VERSION:3.0
          N:;;;
          FN:INPG
          ORG:INPG;;
          END:VCARD</lom:entity>
        <lom:date>
          <lom:dateTime>2005-02-01</lom:dateTime>
        </lom:date>
      </lom:contribute>
    </lom:lifeCycle>
    <lom:metaMetadata>
      <lom:identifier>
        <lom:catalog>URI</lom:catalog>
        <lom:entry>http://www.unit.eu/metadata/lomfr/ID005</lom:entry>
      </lom:identifier>
      <lom:metadataSchema>LOMFRv1.0</lom:metadataSchema>
      <lom:language>fre</lom:language>
    </lom:metaMetadata>
    <lom:technical>
      <lom:location>http://www.e-filipe.org/modules/GP/index.htm</lom:location>
      <lom:requirement>
        <lom:orComposite>
          <lom:type>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>browser</lom:value>
          </lom:type>
          <lom:name>
            <lom:source>LOMFRv1.0</lom:source>
            <lom:value>firefox</lom:value>
          </lom:name>
        </lom:orComposite>
        <lom:orComposite>
          <lom:type>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>browser</lom:value>
          </lom:type>
          <lom:name>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>ms-internet explorer</lom:value>
          </lom:name>
        </lom:orComposite>
      </lom:requirement>
      <lom:requirement>
        <lom:orComposite>
          <lom:type>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>operating system</lom:value>
          </lom:type>
          <lom:name>
            <lom:source>LOMv1.0</lom:source>
            <lom:value>multi-os</lom:value>
          </lom:name>
        </lom:orComposite>
      </lom:requirement>
      <lom:otherPlatformRequirements>
        <lom:string language="fre">Plugin : Flash Player 7 et + Affichage 1024 x
768</lom:string>
      </lom:otherPlatformRequirements>
```

```
    </lom:technical>
    <lom:educational>
      <lom:learningResourceType>
        <lom:source>LOMv1.0</lom:source>
        <lom:value>exam</lom:value>
      </lom:learningResourceType>
      <lom:learningResourceType>
        <lom:source>LOMv1.0</lom:source>
        <lom:value>exercise</lom:value>
      </lom:learningResourceType>
      <lom:learningResourceType>
        <lom:source>LOMv1.0</lom:source>
        <lom:value>lecture</lom:value>
      </lom:learningResourceType>
      <lom:learningResourceType>
        <lom:source>LOMFRv1.0</lom:source>
        <lom:value>évaluation</lom:value>
      </lom:learningResourceType>
      <lom:intendedEndUserRole>
        <lom:source>LOMv1.0</lom:source>
        <lom:value>learner</lom:value>
      </lom:intendedEndUserRole>
      <lom:context>
        <lom:source>LOMv1.0</lom:source>
        <lom:value>higher education</lom:value>
      </lom:context>
      <lom:context>
        <lom:source>LOMFRv1.0</lom:source>
        <lom:value>master</lom:value>
      </lom:context>
      <lom:typicalAgeRange>
        <lom:string language="fre">18-25 ans</lom:string>
      </lom:typicalAgeRange>
      <lom:typicalLearningTime>
        <lom:duration>PT20H</lom:duration>
      </lom:typicalLearningTime>
      <lom:description>
        <lom:string language="fre"
          >comprendre un cours oral en français sur la gestion de projet, prendre des
notes pendant un cours scientifiques en français</lom:string>
      </lom:description>
      <lom:language>fr</lom:language>
      <lomfr:activity>
        <lomfr:source>LOMFRv1.0</lomfr:source>
        <lomfr:value>apprendre</lomfr:value>
      </lomfr:activity>
      <lomfr:activity>
        <lomfr:source>LOMFRv1.0</lomfr:source>
        <lomfr:value>s'auto-former</lomfr:value>
      </lomfr:activity>
    </lom:educational>
    <lom:rights>
      <lom:copyrightAndOtherRestrictions>
        <lom:source>LOMv1.0</lom:source>
        <lom:value>yes</lom:value>
      </lom:copyrightAndOtherRestrictions>
      <lom:description>
        <lom:string language="fre"
        >les résultats des travaux sont la propriété de l'INP Grenoble et
d'UNIT.</lom:string>
```

```
      </lom:description>
   </lom:rights>
   <lom:classification>
      <lom:purpose>
         <lom:source>LOMv1.0</lom:source>
         <lom:value>discipline</lom:value>
      </lom:purpose>
      <lom:taxonPath>
         <lom:source>
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         </lom:source>
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l'ingénieur</lom:string>
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         </lom:source>
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         </lom:taxon>
      </lom:taxonPath>
   </lom:classification>
</lom:lom>
```

Annex 1, The results of the Pluralistic Walkthrough Evaluation

Improvements of the user-interface of Octopus have been made after continuous feedback from users (e.g. pedagogy experts, teachers etc.) in a number of tool releases. Usability evaluation with the method of pluralistic walkthrough was performed, as well as heuristic evaluation and think-aloud evaluation in more mature versions of the tool. Moreover, extensible usability studies have been performed in a number of pedagogy expert/educator workshops.

Two pluralistic usability walkthrough sessions were organized: a) In Natural Europe 6th coordination meeting held in March 2013 in Helsinki with the participation of 14 users (e.g. pedagogy experts, educators, system designers, and usability experts), and b) in the context of the “Pre-school education – teaching practices” course of the Department of Preschool Education of the University of Crete were 54 users participated divided in 3 groups of 18 users each. In both cases the users were asked (a) to create an educational template and (b) use it to develop an educational scenario. These two high level goals were analyzed in a number of sub-goals associated with particular screens. After the analysis of these sessions, 13 user interface issues were detected and fixed. Moreover, some interesting ideas and recommendations came up from the users and were implemented in the system. Below is presented a table containing the results of the heuristic evaluation.

		CREATE A PATHWAY TEMPLATE																		
		Start a New Template			Edit Template Description	Add a Phase	Add an Activity Structure		Add an Activity	Edit Activity Description	Save Template	Save Template (alternative)	Close Template	Create a pathway from a Template			Add a New Resource to an Activity			
Screen		1a	1b	1c	1d	1e	1f	1g	1h	1i	1j	1k	1l	2a	2b	2c	2d	2e	2f	
UNIVERSITY OF CRETE, RETHYMNON	User1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	
	User2	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1	1	1	0	
	User3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User5	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	1	
	User6	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	
	User7	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	0	
	User8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User10	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User11	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User12	1	1	1	1	1	0	0	0	0	1	1	1	0	0	1	1	1	1	
	User13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User14	1	1	1	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	
	User15	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User16	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User17	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User18	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User19	1	1	1	0	1	1	1	1	0	1	1	1	0	0	1	1	1	1	
	User20	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	
	User21	0	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User22	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	
	User23	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	
	User24	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User26	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User28	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User29	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User30	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User31	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User32	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	
	User33	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
	User34																			

Σφάλμα! Χρησιμοποιήστε την καρτέλα "Κεντρική σελίδα", για να εφαρμόσετε το Heading 1 στο κείμενο που θέλετε να εμφανίζεται εδώ. 1

	User35	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User36	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User37	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User38	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User39	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User40	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User41	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User42	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User43	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User44	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1
	User45	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
	User46	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User47	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User48	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	1
	User49	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User50	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User51	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User52	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User53	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User54	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1
	User55	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Score (%)		96.30	98.15	###	79.63	98.15	###	96.30	96.30	96.30	100.00	100.00	100.00	66.67	88.89	###	98.15	94.44	92.59

NATURAL EUROPE	User56	0	1	1	1	0	1	0.5	1	1	1	1	1	0	0	1	1	0	1
	User57	1	1	1	0.5	1						1	1	0.5	0	1	0	1	
	User58	0	1	1	1		1	0	0	1	1	1	1	0	0	1	0	0	1
	User59	1	1	1		0	1	1	1	1	1	1	1	0.5	1	1	1	1	1
	User60	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1
	User61	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User62	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User63	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User64						1	1	1	1	1	1	1	0	0	1	1	1	1
	User65	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User66	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1
	User67	0	1	1	1	0	1	1	0.5	1	1	1	0	0	0	1	1	1	1
	User68	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	User69	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Score (%)		76.92	###	###	95.83	75.00	###	88.46	80.77	100.00	100.00	100.00	92.86	35.71	64.29	###	85.71	85.71	###

TOTAL Score ALL (%)	86.61	99.07	###	87.73	86.57	###	92.38	88.53	98.15	100.00	100.00	96.43	51.19	76.59	###	91.93	90.08	96.30

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