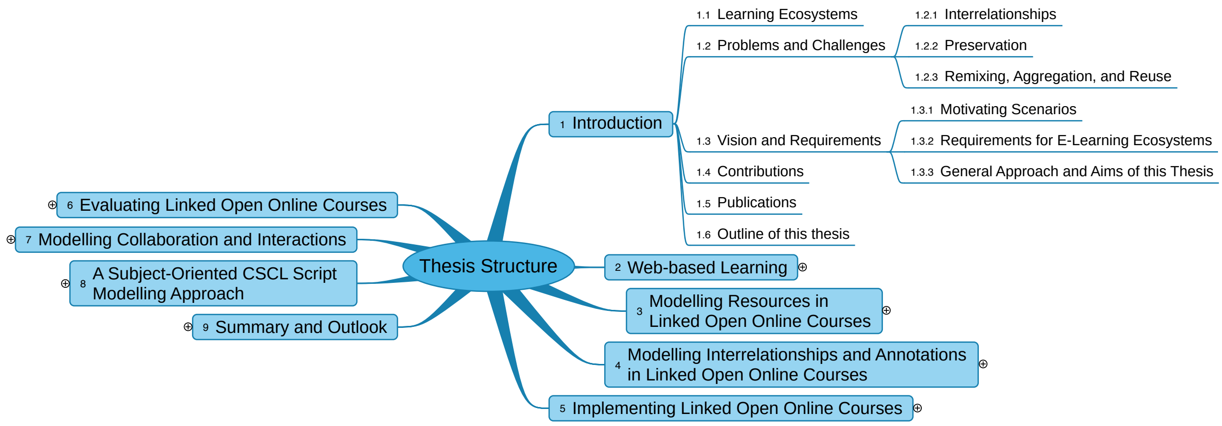


Chapter 1

Introduction

During the past decades, e-learning has evolved considerably. When we consider the evolution and history of e-learning starting from pre-packed, offline computer-based learning offerings, to online, monolithic Learning Management Systems, web-based learning solutions, and nowadays open online courses, especially represented by MOOCs (Massive Open Online Courses), we can see that learning offerings are becoming increasingly decentralized. This is in line with the decentralized character of the Web that builds an important platform for and of learning. The appearance of Web 2.0 underlines this trend, where all users are potential content authors, following a new create-remix-share model.

When spreading out the carpet of the e-learning landscape, we discover a broad range of elements. There are different kinds of learning resources that are created, modified, and used by both teachers and learners. We see connections between learning resources, but also between learning resources and participants, and among participants themselves. Such connections are also important parts of the e-learning landscape as they contextualise and glue the different elements. Furthermore, there are processes participants do perform with the learning resources.

Considering all these elements in their integrating entirety leads us to the definition of learning ecosystems.

1.1 Learning Ecosystems

According to the Encyclopedia Britannica, an ecosystem is "*the complex of living organisms, their physical environment, and all their interrelationships in a particular unit of space*".[1] This definition can be applied to (e-)learning ecosystems very well.

In educational settings, the set of **living organisms** typically consists of educators and students, i.e. the participants. We abstract here from other organisms like relatives, friends, colleagues and the like. In an (e-)learning ecosystem it is important to engage the organisms in the (e-)learning space.

[1] http://www.britannica.com/

The **environment** includes information resources and artefacts such as slides, lecture recordings, documents, blog entries, and forum discussions. A physical environment, as another example, includes books and handouts.

The **space** is the place where teaching or learning is happening and where such processes are conducted. For a long period of time, learning spaces existed in the form of classrooms and lecture halls in the sense of Newton's conception of absolute space that explains space as an inflexible, unmovable, infinite three-dimensional basin, also known as *Newtonian Absolutism*. We see a change of this educational space paradigm to a consideration of space in the sense of Leibniz, which is known as *Leibnizian Relativism* [Ray91, Lö01]. Leibniz considered space as the totality of spatial relations among objects. In this sense, learning spaces are not limited to classrooms, but spill over to the virtual space. Virtual learning spaces include learning management systems (LMS), discussion forums, blogs, online social networks (OSN), lecture recording systems, and other systems that support teaching and learning processes.

The **interrelationships** exist between people, people and information resources, and information resources themselves. The interrelationships between people build up social networks.

We extend the definition of ecosystems with the aspect of **interaction** that includes both teaching and learning processes describing how organisms communicate with each other and interact with the environment. In this context, Moore defines three types of interactions: learner-instructor, learner-learner, and learner-content interaction [Moo89].

Learning ecosystems arise from teaching or learning about a certain topic. A learning ecosystem is constructed by the participating organisms, their social relations, the relations between organisms and artefacts, and lastly, by the relations between artefacts themselves.

1.2 Problems and Challenges

The current state of the art still faces some major challenges and problems, as outlined in the following section.

1.2.1 Interrelationships

Problem: Insufficient representation of interrelationships

A major problem is that research only focuses on single systems or applications like a lecture recording application, but rarely on the totality of a learning ecosystem including the interrelationships between its elements. For instance, besides lecture recordings, corresponding forum discussions or documents created by educators and learners are part of the learning ecosystem, too. Speaking in biological terms again, a learning ecosystem is like a mycelium that consists of a mass of growing and branching hyphae [2] that interconnects (energy) resources, c.f., Figure 1.1. [3]

Insufficient representation of interrelationships causes several problems:

- Participants are not aware of the existence of learning resources. For instance, if students watch lecture recordings, they might not be aware that there is an ongoing discussion in a discussion forum related to the recording.
- Many learning systems are like isolated islands: participants can share resources and knowledge within an island but not across them.

[2] Such branchings can extend over several square kilometres, which makes fungi the biggest living organisms in the world.

[3] Licensed under Creative Commons Attribution-Share Alike 3.0 via Wikimedia Commons. http://commons.wikimedia.org/wiki/File:A_niger_hyphae.jpg#mediaviewer/File:A_niger_hyphae.jpg

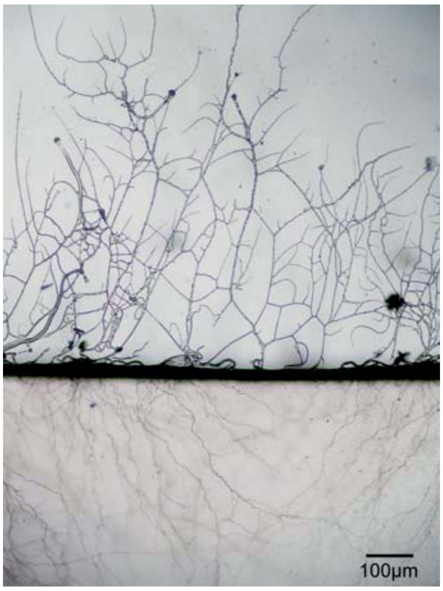


Figure 1.1.: Microscopic image of an Aspergillus niger hyphae

- Reusing resources appears like solving a puzzle because each single learning ecosystem element needs to be extracted instead of extracting one resource with its related resources.
- Isolated learning resources have less value than in a community of resources and contributing participants. As Niall Sclater states: "Where learning activities involve web-based forums, wikis, blogging and commenting on blogs, opportunities for reflection and the deepening of understanding are likely to be greater than when OERs [Open Educational Resources] are provided in isolation" [Scl11].

Challenge: Explicit representation of interrelationships and anchors

The interrelationships between information resources of the environment, resources and organisms, and organisms themselves need to be modelled in order to explicit describe the interrelationships between these elements. The representation of interrelationships is comprised of connections within and across learning ecosystems as well as anchors describing the tie points. Interrelationships should be available on both the data and the presentation layer.

1.2.2 Preservation

Problem: Limited preservation of e-learning ecosystems

Courses, which are as a whole learning ecosystems, are often very fragile and fickle. After a course ends its parts dissolve. In this context, George Siemens has emphasized the need for archiving and preserving the entirety of learning ecologies [Sie03]:[4]

> *[...] a course is an artificial construct, erected at the start of the term, that assumes to provide learners with the information and knowledge they need...and is torn down twelve weeks later. A learner who has a knowledge need six months later doesn't have access to the environment where he/she initially learned. After four years, the entire environment (i.e. the program) that awarded the degree is gone (inaccessible by the learner). A learner*

[4] Siemens speaks of "ecology" instead of "ecosystem". We use the term "ecosystem", because "ecology" refers to the science and study of the relationships between organisms and their environment [Sch12a].

certainly still has the ability to contact instructors after the program is finished, but the richness of the learning environment has largely faded. In this situation, not only the knowledge specific construct (course), but the entire ecology (program) is gone. A better, more permanent, option is required.

Challenge: Utmost digital representation of entire e-learning ecosystems in a suitable form for preservation

In order to preserve an entire course represented as a learning ecosystem, not only the interrelationships but also its elements must be preserved. This includes digital representations of learning resources, participants, and also learning and teaching processes. The preservation must be done in a way that it can be accessed, retrieved, and reused later. Reuse demands for application-independent representation of e-learning ecosystems to guarantee interoperability.

1.2.3 Remixing, Aggregation, and Reuse

Problem: Limited reuse of e-learning ecosystems

A characteristic of ecosystems is their diversity. Nardi and O'Day even think that diversity is important for the health of information ecosystems, which have many parallels to learning ecosystems [NO00]. E-learning offerings on the Web are nowadays also very diverse. They appear not only as centralized, closed learning management systems, but also in open formats such as massive open online course (MOOC) platforms. However, this diversity runs into a problem of interoperability. Although there are many e-learning resources available on the Web, it is difficult to decompose, rearrange, aggregate, and reuse them. Existing standards like SCORM and IMS CC support reusing learning ecosystems as learning packages or cartridges, but do not support remixing their content. Therefore, many learning resources are left unexploited. However, reuse includes remixing, and aggregating remixes from different learning ecosystems, also known as "authoring by aggregation". Therefore, it should be possible to access, integrate, and reuse parts of learning ecosystems from distributed sources.

Challenge: Modelling of e-learning ecosystems to achieve multi-granularity reuse

In order to facilitate the reuse of digital representations of e-learning ecosystems two challenges need to be addressed. Firstly, e-learning ecosystems must be modelled in a way that they are interoperable and exchangeable with other e-learning ecosystems to remix, aggregate, and reuse their content and processes. Secondly, digital representations of e-learning ecosystems and all their elements should be reusable at multiple levels of granularity.

1.3 Vision and Requirements

To illustrate the vision of reusable learning ecosystems, this section provides two motivating scenarios. On the basis of these scenarios and on the previously described problems and challenges, several requirements are identified.

1.3.1 Motivating Scenarios

Subsequently, we present two scenarios to illustrate the richness of learning ecosystems and how they might be remixed and reused.

Scenario 1: The evolution of a learning ecosystem

In a university course, the educator provides several learning materials to their students. This includes typical elements like recordings of lectures and exercise sheets. Students consume the provided materials, but also augment them with other resources. Such additional resources include additional materials and discussions. For instance, if students do not know the meaning of a term on a slide, they search the Web for adequate explanations. After they have found one, they augment the slide with the Web page explaining the term. Another student may have difficulties in understanding the content of a slide. This student may then search for an alternative presentation of the content that better fits her understanding. Again, the alternative explanation is digitally linked with the corresponding slide(s). By augmenting the provided learning materials with additional materials found or created by students or even the teacher, both students and educators can profit from these augmentations. Students find material supporting their understanding, and teachers can get an impression of which topics are difficult for students and could be better presented by alternative presentations of the teaching material or by additional content that helps close knowledge gaps.

Besides connecting additional learning resources to teaching materials, discussions should also be digitally inter-linkable with both lecture recordings and exercise sheets. In this way, students can see when watching a recording or when viewing an exercise that there is also a discussion. At best, there is not only a connection from the material to the discussion, but also vice versa.

This small scenario demonstrates the evolution of a learning ecosystem with its organisms (educators and students) acting in different spaces such as discussion forum and lecture recording system, the resource in the environment which includes slides, lecture recordings, exercise sheets, discussions, and websites, and the interrelationships among organisms and among resources as well as interrelationships between organisms and resources.

Scenario 2: Reusing learning ecosystems

In this scenario, a teacher wants to compose a course for her class.[5] The teacher already has some lecture recordings from previous terms, but wants to add additional topics to her lecture. For this purpose, she searches for lecture recordings about a certain topic that should be at a beginner's level and no longer than ten minutes. She finds a suitable recording from another university and integrates this recording with her own recordings to provide the overall material in a flipped classroom scenario. She notices that the reused recording also includes some connected Web pages and discussions. She reviews this additional content and prunes the discussions, reducing it to relevant content. After finishing the creation of the new course material, the teacher embeds it in her university's learning space.

During the term, the teacher uses and augments the provided learning materials with additional resources like Web pages and forum discussions. After the term has finished, the teacher reviews the material in the learning ecosystem, appraises it, and then selects material worth retaining. At the end of this process, the learning ecosystem becomes a library object, ready for reuse.

A learning ecosystem's life cycle

Following the actions in the above scenarios, a life cycle for learning ecosystems can be identified, which consists of the following phases (see Figure 1.2):

[5] A student could also be the main actor of the scenario with the goal of compiling her personal learning material about a given topic.

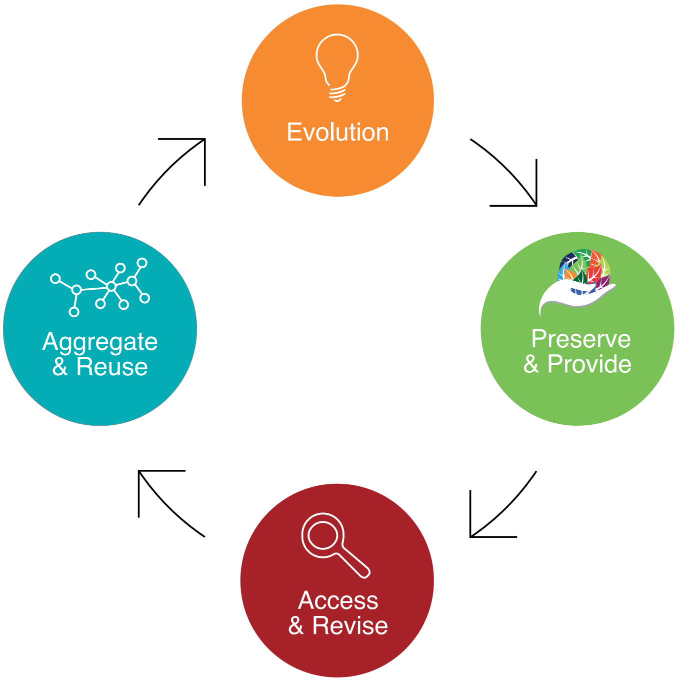


Figure 1.2.: The life cycle of learning ecosystems

1. *Evolution*: In the beginning, a learning ecosystem evolves. The organisms use the existing resources and the resources available in the "wild" Web, augment them with additional information, and add new resources.

2. *Preserve and provide*: The learning ecosystem is provided for access and reuse. A digital preservation of a learning ecosystem is an optional step if the current state of the learning ecosystem should be saved.

3. *Access and revise*: The elements of learning ecosystems are accessed, selected and revised.

4. *Aggregate and reuse*: Selected elements are aggregated and integrated in other learning ecosystems, which evolve again.

1.3.2 Requirements for E-Learning Ecosystems

Considering the scenarios and the e-learning system life cycle, several requirements can be derived.

For representing the entire richness of learning ecosystems, their elements and the interrelationships, including link anchors, must be described. This includes interrelationships between users, users and resources, and among resources. Preservation and reuse demand a representation of learning ecosystems in an application- and platform-independent way to ensure interoperability between e-learning ecosystems. Furthermore, preserved or provided data must be accessible and retrievable. The phase of revision demands a flexible data model that facilitates both restructuring and aggregation with new data.

In order to address the discussed problems and the derived requirements, a model for e-learning ecosystems needs to provide:

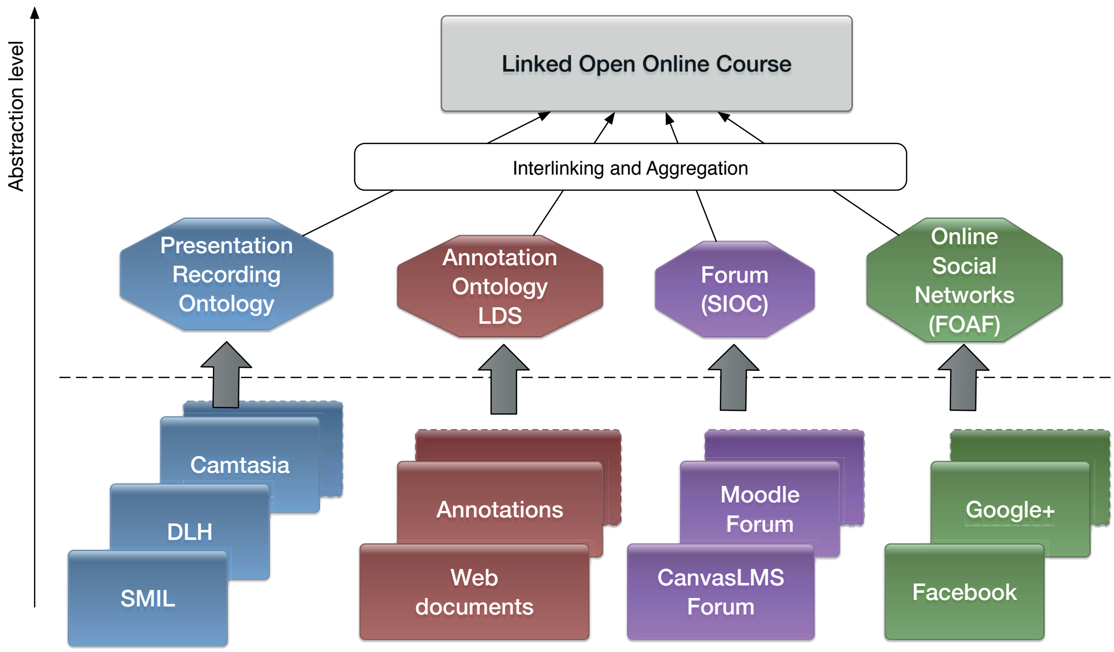


Figure 1.3.: Abstraction levels from applications over ontologies to Linked Open Online Courses

1. *Reusability* to support reusing (parts of) e-learning ecosystems. This includes both learning material and processes.
2. *Interlinkability* to glue the elements of e-learning ecosystems and to describe the connections and relations between them.
3. *Interoperability* to facilitate reuse in different spaces (e-learning environments) and applications.
4. *Flexibility* to easily prune, aggregate, and add additional information (content, metadata, etc.).
5. *Retrievability* to support finding learning materials.

These requirements will be refined in section 2.3 that lists the main requirements after the presentation of preliminary user studies.

1.3.3 General Approach and Aims of this Thesis

In this work, we focus on a special form of digitally modelled e-learning ecosystem that we call **LOOCs**, short for **Linked Open Online Course**. The abbreviation refers to the following aspects:

- *Linked* refers to an extensive use of Semantic Web technologies and Linked Data principles to facilitate interlinkability, reusability, exchangeability, and interoperability of learning resources,
- *Open* refers not necessarily to free courses but to open content and open educational resources that can be (re-)used and exchanged on the Web,
- *Online* refers to using the Web as a learning platform,

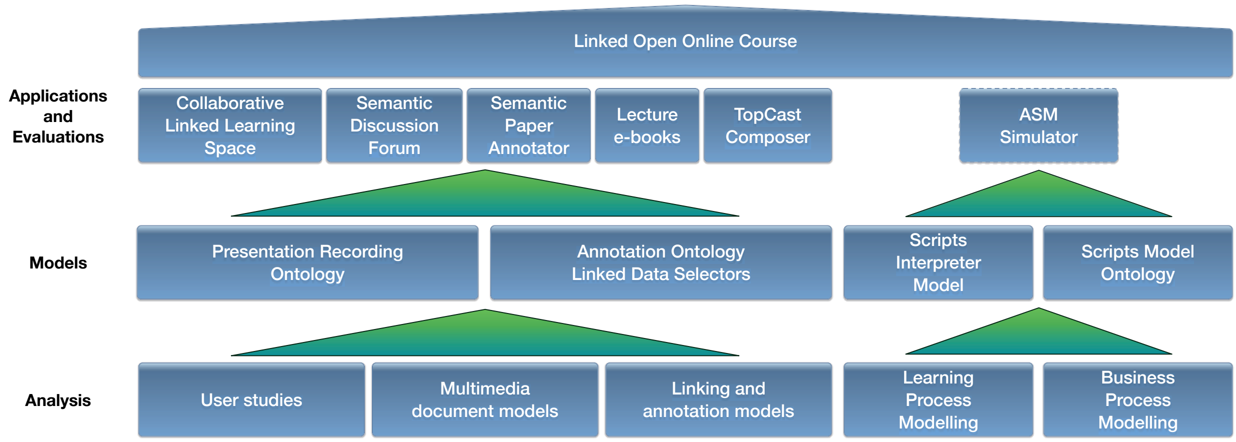


Figure 1.4.: Main contributions of the thesis and their relations

- *Course* refers to the integration of single components to an aggregated form. A course needs not be a complete educational course in the sense of a series of lessons, but can also be a compiled aggregation of an e-learning ecosystem on a specific topic to be considered as a library object. [6]

The composition of LOOCs is illustrated in Figure 1.3. At the bottom, there are application-dependent data formats such as Moodle discussion forum, Camtasia presentation recordings, and annotation systems. In order to facilitate reuse and interoperability between such applications, an application-independent representation at a higher abstract level is necessary. This is discussed in chapter 3. To integrate data from different applications, concepts for interlinking and aggregating resources are required. This is discussed in section 4 and implemented in section 5.

1.4 Contributions

This thesis introduces concepts and mechanisms to address the above-listed problems and requirements. The main contributions and their composition are summarized in Figure 1.4.

The main contributions are:

- Requirements elicitation on the basis of two surveys with 127 participants in total
- Formal specifications for modelling artefacts and interrelations between them in learning ecosystems. In particular, this includes:
  - an ontology for the multimedia presentation domain,
  - an ontology for describing annotations and annotation anchors to interlink learning resources, and
  - concepts for translating lecture recording models into e-books as a compilations of e-learning ecosystems.
- Implementation of a Linked Open Online Course as proof of concept. This includes:
  - a multimedia presentation system to present lecture recordings and to augment lecture recordings with additional Web resources,

[6] In fact, analysis of edX courses indicate an optimal length of course videos of 6 minutes or shorter. `https://www.edx.org/blog/optimal-video-length-student-engagement`

  - a Web annotation application for the collaborative annotation of PDF documents, and
  - a Semantic Web discussion forum.

- Evaluations of the developed concepts and applications including:
  - an evaluation of the use and acceptance of lecture e-books
  - an evaluation of the use and acceptance of a Linked Open Online Course
  - a user study regarding browsing, aggregating and preserving Linked Open Online Courses

- Analysis and formal specification of CSCL (computer-supported collaborative learning) scripts, in particular:
  - An analysis of existing approaches, in terms of the requirements of collaboration scripts
  - A formal interpreter model for collaboration script, on the basis of the S-BPM, by using the Abstract State Machine method. Script models can be executed for pre-implementation testing and validating with the Asmeta simulator [7]
  - A visual language for modelling collaboration scripts
  - A formal ontology for the collaboration scripts domain
  - Constraint rules integrated with the ontology for verifying the structural soundness of process models

1.5 Publications

Parts of this thesis are published in proceedings of international conferences. The vision and concepts of Linked Open Online Courses (LOOCs) have been published in [HM14d]. The preliminary user studies and the initial version of the Collaborative Linked Learning Space (CLLS) are presented in [HRM10, HHRM11, HHR11]. The survey on tools and applications for augmenting and annotating educational material and a related study have been published in [HR10, HHM10b]. Concepts for content exchange an interoperability between lecture recording applications are published in [HM13b, HM13d]. The concepts of lecture e-books and their evaluation have been published in [HM14f]. The evaluation of the LOOC troika applications is presented in [HM14b]. The concepts and design of CLLS can be found in [HvBHM12]. Mechanisms for publishing online discussions across different social platforms have been published in [HM13a]. The basic concepts to achieve interoperability between multimedia lecture recordings are explained in [HM13d, HM13b]. The concepts of Linked Data Selectors have been published in [HM13c]. The basic concepts of the ASM interpreter model for CSCL script processes has appeared in [HM14a]. An initial version of the subject-oriented ontology for describing CSCL scripts is published in [HM14e] with a corresponding domain specific language specification [HBM13]. Finally, learning analytics in Linked Open Online Courses are discussed in [HM14c].

1.6 Outline of this Thesis

After this introductory section, the subsequent chapter 2 provides background information on e-learning with a focus on Web-based learning and modern trends like Massive Open Online Courses. This background information is extended with two preliminary user studies about both students and educators and their requirements regarding Web-based learning environments. The vision of

[7] The simulator is not part of this thesis, see `http://asmeta.sourceforge.net/download/asmetas.html`

learning ecosystems and the results of the user studies result in the main requirements that are listed in section 2.3.

The introduction and the background chapter are followed by the two main parts of the thesis.

Part I focuses at first on modelling digital representations of resources in Linked Open Online Courses and at second on their interrelationships. For the modelling of digital representations of resources the requirements are refined. Afterwards, concepts of modelling and exchanging data on the Web are presented. After the presentation of foundations, we present existing concepts of modelling resources in LOOCs including online discussions, learning objects and multimedia documents. With a focus on presentation recordings, several multimedia document models are analysed. Based on the revealed missing features, a presentation recording ontology is introduced. In addition, concepts for augmenting lecture recordings with online discussions and their distribution across different platforms including Moodle, Canvas LMS, Facebook and Google+ is proposed.

Chapter 4 analyses the modelling of interrelationships between resources. After a survey of annotation tools for educational materials, basic linking concepts and annotation models, we suggest a formal specification of annotations and annotation anchors. In addition, a concept for automatically annotating lecture recordings slides with information from Wikipedia is presented.

Based on the concepts developed in chapter 3 and chapter 4, several semantic educational applications are presented in chapter 5, which are evaluated in chapter 6.

Part II of this thesis focuses on modelling learning processes, in particular CSCL (computer-supported collaborative learning) scripts. Several approaches to modelling CSCL scripts are presented and discussed. Based on this discussion, a formal interpreter model for CSCL scripts is presented. In addition, we propose an ontology for representing CSCL script models. The thesis concludes with chapter 9, which provides a summary and an outlook on future work highlighting the potential benefit of the ecological perspective of learning ecosystems for the learning analytics domain.

Figure 1.5 gives a visual presentation of the thesis structure for providing a better overview. The figure is repeated at the beginning of every chapter.

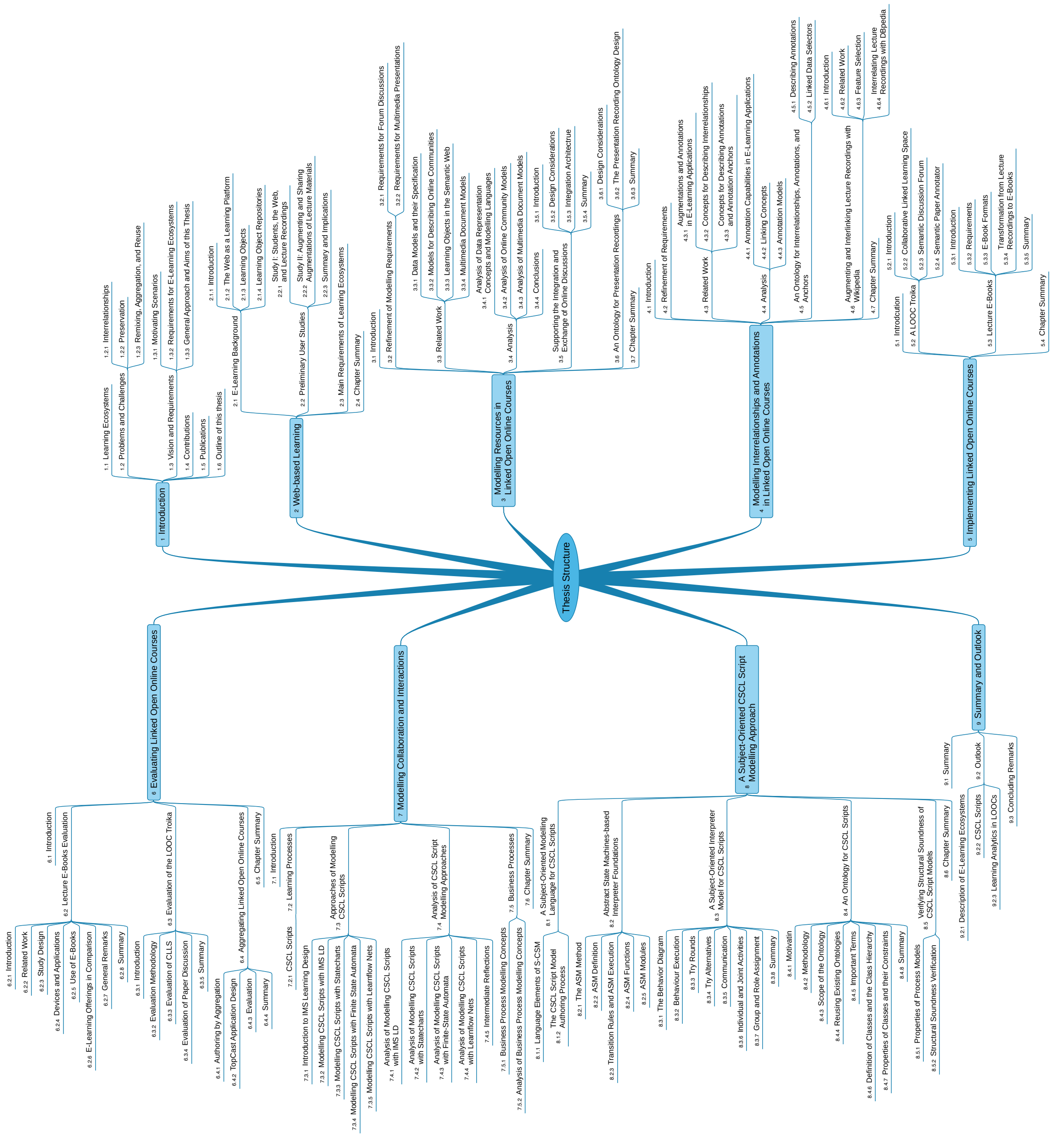
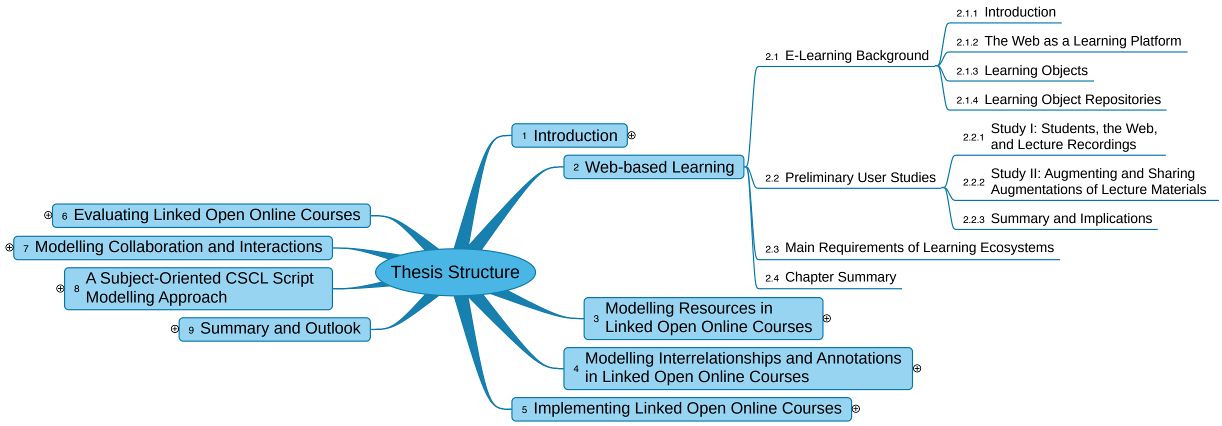


Figure 1.5.: Structure of this thesis



Chapter 2

Web-based Learning

This chapter provides a basis for the remainder of this thesis. In this chapter, we approach the field of Web-based learning and review its characteristics. We start with an overview on e-learning with a focus on Web-based learning. Then we present Web specific concepts for describing, modelling and exchanging data on the Web. To complete this overview of the Web learning landscape, we present two user studies to elicit the requirements of students regarding their demands for learning applications and important content types. As a result of this chapter we refine the main requirements of chapter 1 and define the focus of this thesis as a basis for the subsequent chapters.

2.1 E-Learning Background

The following section aims at providing background information for a better understanding of e-learning ecosystems.

2.1.1 Introduction

E-Learning has a long tradition since the 1960s, when computers started to be used for education and training. Of course, the meaning of the term “e-learning” has changed over time and some synonyms evolved like “digital learning”, “computer-mediated learning”, “technology-enhanced learning”, and “technology-based learning”. The evolution of e-learning has been especially influenced by the terms CBT (computer-based training) and WBT (Web-based training). Due to the history of e-learning being influenced by didactic models and especially technological evolutions, there is no strict definition.

To give some definition examples, Clark and Mayer [CM08] define e-learning as

> *We define e-learning as instruction delivered on a computer by way of CD-ROM, Internet, or intranet with the following features:*
>
> - *Includes content relevant to the learning objective*

- *Uses instructional methods such as examples and practice to help learning*
- *Uses media elements such as words and pictures to deliver the content and methods*
- *May be instructor-led (synchronous e-learning) or designed for self-paced individual study (asynchronous e-learning)*
- *Builds new knowledge and skills linked to individual learning goals or to improved organizational performance*

Mason and Rennie [MR06] define three criteria on which e-learning is based:

- *It is networked*
- *It is delivered to the end-user via a computer using standard Internet technology*
- *It is focused on the broadest view of learning.*

A variant of e-learning is *blended learning*, which refers to combinations of technology-enhanced with traditional teaching and learning settings. Usually, "blended learning combines face-to-face with technology-based learning and instruction" [Ife12]. An example of a combination of traditional classroom teaching with technology-based learning are so-called classroom response systems that include, e.g. electronic quizzes and class-wide discussions [KMB⁺13].

2.1.2 The Web as a Learning Platform

In this work, we focus on e-learning on the Web, short for World Wide Web [BLF99, TH09].[1] Here, the Web serves as an information space and as a platform. The latter "stands for the fact that the Web has become an application delivery platform of choice" [Ehl13, p. 37]. Applications not only run over the Internet but completely on the Web. This shift from client-site applications to Web applications also includes a shift from locally stored data to data stored on Web servers. "This development which Kerres (2006: 3) describes as a paradigm shift from local to remote and privacy to publicity naturally results in an enormous growth of publicly available incoherent and loose structured data" [Ehl13, p. 37]. We face this aspect in this work when discussing the modelling of e-learning ecosystems in chapters 3 and 4.

The advent of the Web had (and still has) a strong influence on e-learning and was predicted to be "the next big killer application" [MR06]. Hyperlinked Web pages were created to provide courseware although multimedia content was rarely used due to limited bandwidth at this time. In the Web's drive, the first learning management systems (LMS) appeared [Sch05].

E-Learning and Web 2.0

Although the original vision of "Web 1.0" already included intentions to allow users to read, create, and edit Web pages [BLF99], users typically had a passive role restricted to reading Web pages, comparable to passive consumption of classic lecturing setups. The above-mentioned shift to the Web as a platform included a shift in how the Web was considered, namely from a "read Web" to a "participative Web" or "read/write Web". The summarizing term was coined by Tim O'Reilly in 2005 as "Web 2.0" [O'R05]. A description of Web 2.0 is provided by Vickery and Wunsch-Vincent [VWV07]:

> *The use of the Internet is characterised by increased participation and interaction of users to create, express themselves and communicate. The 'participative web' is the most common term and underlying concept used to describe the more extensive use of the Internet's capabilities to expand creativity and communication.*

[1] http://www.w3.org/TR/webarch/

Shortly after the term Web 2.0 was coined, the e-learning community took up the term Web 2.0 in their domain to call it "e-learning 2.0" as the Web 2.0 principles seemed to be promising for learning as well [UBL+08]. Stephen Downes, who coined the term "e-learning 2.0", particularly saw Web 2.0 as an attitude, and the emergence of Web 2.0 not as a technological revolution but as social revolution [Dow05, Dow10]. Typical "Web 2.0" applications include blogs, wikis, social bookmarking, online social networks, and discussion forums. Literature extensively discusses potential and challenges of e-learning 2.0, for example [Ker06, Ebn07, Cou09, LL09, BR09, Bat10, RAMP10], but also its risks and dangers, e.g. [Sch09a, Sch09b, Rei09, Sch10].

Massive Open Online Courses

Ehlers sees "a significant growth of places and destinations where learning content is produced" [Ehl13, p.38]. On the one hand, there are Web 2.0 applications that support users in publishing information, on the other hand, there is a trend of publicly available online courses, which are described by the term *MOOCs* (*Massive Open Online Course*) that have appeared on the e-learning stage in recent years [Mar12, Sch13, SE13, Ren13]. The vision of MOOCs that was influenced by an open course philosophy is that a course should be open without any restrictions (*open*), no limitations of participant numbers (*massive*), and be delivered on the Web (*online*). McAuley et al. define: "a MOOC generally carries no fees, no prerequisites other than Internet access and interest, no predefined expectations for participation, and no formal accreditation" [MSSC10].

According to EdSurge, the number of universities offering MOOCs has doubled to cross 400 universities in 2014. In sum, these universities provide more than 2400 courses taken by about 18 million students. Currently, the largest provider is Coursera with about 10.5 million students.[2] In the last few years MOOCs have also been getting more popular among companies for employee training [Sav14]. To be successful, Yousef et al. identify 74 criteria for effective MOOC environments classified into the pedagogical and technical requirements [YCSW14].

Different kinds of MOOcs exist. The term *xMOOC* refers to "extended MOOC". Usually, xMOOCs are structured, video-based courses that are extended by quizzes and discussion forums [Sch13, Ren13]. Another view is offered by Downes who states: "It should be clear here that the 'xMOOC' sense is not of 'eXtended MOOC' but rather MOOC as eXtension of something else".[3] Some prominent representatives of xMOOC platforms are: Coursera [4], edX [5], Iversity [6], and Open-HPI [7]. They all have in common the provision of lecture recordings, quizzes, and discussion forums.

cMOOCs, short "connectivistic MOOCs", are based on the concepts of connectivism [Sie05b], and have educational goals that are framed in direct contrast to traditional methods and goals of schooling [Fel14], including a replacement of "I speak, you listen and understand" with "many people speak, we select and understand".

Downes explains connectivism as [Dow11]:

> *At its heart, connectivism is the thesis that knowledge is distributed across a network of connections, and therefore that learning consists of the ability to construct and traverse those networks. Knowledge, therefore, is not acquired, as though it were a thing. It is not transmitted, as though it were some type of communication. [. . .] And while it is convenient to talk as though knowledge and beliefs are composed of sentences and concepts*

2 https://www.edsurge.com/n/2014-12-26-moocs-in-2014-breaking-down-the-numbers
3 http://www.elearnspace.org/blog/2012/07/25/moocs-are-really-a-platform/
4 http://www.coursera.org/
5 http://www.edx.org/
6 http://www.iversity.com/
7 https://open.hpi.de/