Facilitating student understanding of Internetworking via e-learning

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Abstract

Learning Management Systems (LMSs) are widely used in higher education to improve the learning, teaching, and administrative tasks for both students and instructors. Such systems enrich the educational experience by integrating a wide range of services such as on-demand course material and training, thus empowering students to achieve their learning outcomes at their own pace.

Courses in fields of Computer Science that provide rich electronic learning (e-learning) experience depend on exercise material being offered in the forms of quizzes, programming exercises, laboratories, simulations etc. Providing hands on experience in courses such as Internetworking could be facilitated by providing laboratory exercises based on virtual machine environments where the student studies the performance of different internet protocols under different conditions (such as different throughput bounds ~~and~~ error rates and patterns). The integration of such exercises and their tailored virtual environments is not yet very popular in LMSs.

The thesis project investigates the generation of on-demand virtual exercise environments using cloud infrastructures and integration with an LMS to provide a rich e-learning in an Internetworking course.

- e-learning, lms, capabilites
- Importance of hands on training, lack of online exercises for internetworking
- briefly mention the goals / outcome of the thesis

Acknowledgements

I would like to acknowledge ...

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List of Acronyms and Abbreviations

e-learning electronic learning

LMS Learning Management System

LTI Learning Tools Interoperability

EC2 Elastic Compute Cloud

Chapter 1

Introduction

The use of electronic learning (e-learning) technologies has been well established in modern education to assist both students and instructors in their learning, teaching and administrative tasks. One of the most widely adopted e-learning technologies by the academic community is Learning Management Systems (LMSs). A LMS is a software application that handles all aspects of the learning process [1], enabling instructors to design rich e-learning courses and students to experience a self-paced learning using a variety of features such as on-demand course material, video lectures, automatic delivery and evaluation of assignments, collaboration tools etc.

Many courses, especially in fields of Computer Science depend on training events in forms of programming assignments, laboratory exercises, simulations etc which are crucial for students getting hands-on experience with complex concepts and systems [2]. Although LMSs support on-line training events such as interactive quizzes with automatic evaluation and analysis of results, providing training events that depend on using complex virtual environment setups and software are not yet that popular.

One of the main advantages of using LMS is that they support the integration of external applications to provide personalized, domain specific e-learning such as messaging and video streaming services, on-line office suites, collaboration tools, or even training environments with exercises tailored to the needs of specific courses.

1.1 Background

Hands-on experience is very important to achieve understanding of complex systems and concepts. For example, when studying computer networks, laboratory exercises are a common student practice. An Internetworking course often involves training where the students studies the performance of different Internet protocols under different conditions (such as varying throughput bounds and error rates and patterns).

These experiments depend on specific software, network topologies and local or

virtual hardware. Traditional approaches for ~~practicing~~ environments depend on student's hardware~~,~~ or on-site computer labs with pre-configured software~~.~~[5]. More modern approaches involve remote access to virtual machines running on central servers or cloud infrastructures [4].

LMSs don't have built-in support for such laboratory environments. One of the main advantages of designing an on-line course on an LMS ~~is~~ that ~~it~~ supports the integration of extenal applications ~~that~~ provide tailored functionality for the course specific needs. Canvas [10] LMS implements the ~~IMS Global Learning~~ Tools Interoperability ~~(LTI)~~ specification which allows the exchange of information between the LMS and third party components and exposes internal functionality of the system to external applications.

Supporting virtual laboratory environments in a LMS for the needs of an Internetworking course ~~is a matter of~~ designing a software framework that implements the ~~same~~ interoperability specification ~~and~~ exchanges relevant information ~~with~~ the LMS.

Set the problem context for your project.
(Give detailed background information in Chapter 2.)
Sometimes it is useful to insert a system diagram here so that the reader knows what are the different elements and their relationship to each other. This also introduces the names/terms/? that you are going to use throughout your thesis (be consistent). This figure will also help you later delimit what you are going to do and what others have done or will do.

1.2 Problem definition

State the purpose of your thesis and the purpose of your degree project. Describe who benefits and how they benefit if you achieve your goals. Include anticipated ethical, sustainability, social issues, etc. related to your project. (Return to these in your reflections in Section 6.4.)

Using LMS to support online training events for an Internetworking course is not yet popular.

- what are the difficulties
- what are the requirements (exercise, classroom, professor, student)

Most ~~of~~ training exercises are not designed to extract analytics for the instructor (an instructor usually wishes to evaluate student's level of understanding of different concepts). ~~This~~ is done using additional training material, such as quizzes or assignments in forms of reports which are evaluated ~~manually~~ by instructors~~,~~ or by students in forms of peer reviewing.

1.3 Goals

This project aims to design a software framework that supports instantiation of on-demand exercise environments using cloud based technologies ~~that will~~ enrich the learning experience of students and allow them to proceed at their own pace. We want to generate such exercise environments dynamically and allow teacher to customize according to different exercise requirements.

The main focus of this project is designing a software framework ~~for~~ integrates with Canvas LMS ~~to~~ support laboratory exercises for an Internetworking course. ~~In more detail the~~ framework needs to satisfy the following requirements:

- Easily build virtual laboratory environments
- Integration of the framework with the LMS
  students ~~should be able~~ to access the training environments via the LMS
- On demand availability of these environments
  students ~~should be able~~ to practive whenever they want – self-paced
- ~~S~~upport evaluation ~~or~~ analysis methods ~~for~~ the exercises
  results ~~are~~ useful for both instructors and students

1.4 Research Methodology

Design science research involves the design of novel or innovative artifacts and the analysis of the use and/or performance of such artifacts to improve and understand the behavior of aspects of Information Systems. [6]

this is from wikipedia

Design science research can be seen as an embodiment of three closely related cycles of activities.[7] The relevance cycle initiates design science research with an application context that not only provides the requirements for the research as inputs but also defines acceptance criteria for the ultimate evaluation of the research results. The rigor cycle provides past knowledge to the research project to ensure its innovation. It is contingent on the researchers to thoroughly research and reference the knowledge base in order to guarantee that the designs produced are research contributions and not routine designs based upon the application of well-known processes. The central Design Cycle iterates between the core activities of building and evaluating the design artifacts and processes of the research.

this is from wikipedia, and it should be analyzed in chapter 3

1.5 Deliminations

Describe the boundary/limits of your thesis project and what you are explicitly not going to do. This will help you bound your efforts ? as you have clearly defined what is out of the scope of this thesis project.

- Scalability of the designed system regarding number of users is out of the scope.
  Most probably we will design a system that can be scaled up on AWS by using larger instances (vertical scaling) and having enough instances available for students to practice (horizontal scaling), but since these types of scaling cost $$ they won't be investigated.
- Extensibility for other courses is out of the scope.
- Supporting other than LTI standards or another LMS is also out of the scope.
  IMS LTI specification only.

1.6 Structure of the thesis

Chapter 2

Background

What does a reader (another x student – where x is your study line) need to know to understand your report? What have others already done? (This is the ?related work?.)

...

What goes here? Maybe intro for the sections of this chaper?

2.1 LMS and LTI

2.1.1 LMS

LMSs are software applications that automate the training, teaching and administrative tasks of the learning process [1]. They have been widely adopted by institutions in higher education to automate their organizational functions and provide rich e-learning experience for both instructors and students.

Such systems are designed to provide self-guided services, rapid delivery and composition of learning material, tracking and reporting of training programs, classroom or on-line events, personalized content and centralization and automation of administration [3]. From a learner's perspective the most common use cases of a LMS are planning the learning experience and collaboration with colleagues while, from an instructor's perspective are design and delivery of educational content, tracking and analysis of students' learning evolution [8].

The main functionality of a LMS is designed around content organization and delivery, communication and collaboration and finally assesment of student's learning process. Some of the most commonly used features for e-learning are video streaming of lectures, on-line notes and presentations, quizzes and practicing environments, automatic evaluation of assignments (usually exercises with predefined input and output), wikis, discussion forums etc [9].

The above mentioned services are either offered directly by the LMS or by integrating external applications that are designed according to specific interoperability standards. Section 2.1.2 describes interoperability and integrations in detail.

There are several LMSs in the market that are used by different institutions. In the scope of this project the chosen learning management platform is Canvas [10].

maybe skip this

This system is open source, supports a well defined interoperability specification and it will be used by KTH.

2.1.2 LTI

- A comparative study on LMS Interoperability
- Beyond SCORM
- IMS Global Learning Consortium LTI
  LTI provider, and consumer
- Integrating rich learning applications in LMS
- LTI Open edX
- Why learning tool interoperability should be part of your elearning application

2.2 Background area 2

Some useful references for exercise material and setup to expand on:

- A Comparison of Virtual Lab Solutions for Online Cyber Security Education
- Hands-On Experience to a Massive Open Online Course on openHPI
- Some Experiences in Using Virtual Machines for Teaching Computer Networks
- TOP 10 HANDS-ON CYBERSECURITY EXERCISES
- V-Lab: A Mobile Virtual Lab for Network Security Studies
- IK1550

More info

- What are the requirements for successfully completing an exercise?

  What information about a student's progress in or success with the exercise should (or could) be communicated back to the LMS?

- How are these requirements met by the chosen technologies?

2.3 Related work

2.3.1 EDURange

EDURange is an open source framework that provides interactive security exercises in an elastic cloud environment [11]. Designing on-line training environments for the field of cyber security requires to overcome technical constraints such as high availability and scalability, and pedagogical limitations such as teaching analysis skills to understand complex systems and concepts via practicing [2].

EDURange as a software framework, ~~is~~ designed to work on Amazon Elastic Compute Cloud (EC2) [12], ~~which~~ allows to easily build and scale dynamic virtual environments to host cybersecurity training [13]. This framework provides ease of use for instructors, by offering flexibility to specify exercises at high level and allowing them to configure different aspects of the training scenarios in order to provide a tailored learning experience that focuses on analysis skills.

Should expand on what is the problem they tried to solve

2.3.2 LTI

GLUE [14]

2.4 Summary

It is nice to bring this chapter to a close with a summary. For example, you might include a table that summarizes the ideas of others and the advantages and disadvantages of each ? so that later you can compare your solution to each of these. This will also help guide you in defining the metrics that you will use for your evaluation.

Chapter 3

Methodology

What scientific or engineering methodology are you going to use and why have you chosen this method. What other methods did you consider and why did you reject them. What are your goals? (What should you be able to do as a result of your solution - which could not be done well before you started?) What you are going to do? How? Why? For example, if you have implemented an artifact what did you do and why? How will your evaluate it.

..

You might explain why Canvas is being used:

- it is likely that this will be the LMS at KTH
- it is open source so you were able to build your own instance and experiment with it.

3.1 Research Process

3.2 Research Paradigm

HTTP traffic widget from FORGE http://ict-forge.eu/wp-content/uploads/2016/01/FORGE-2015-P-D312-Final.pdf

3.3 Data collection

(This should also show that you are aware of the social and ethical concerns that might be relevant to your data collection method.).

3.3.1 Sampling

3.3.2 Sample size

3.3.3 Target Population

3.4 Experimental design

3.4.1 Test environment

3.4.2 Hardware/Software to be used

3.5 Assessing reliability and validity of the data collected

3.5.1 Reliability

3.5.2 Validity

3.6 Planned Data Analysis

3.6.1 Data Analysis Technique

3.6.2 Software Tools

3.7 Evaluation Framework

Chapter 4

Implementation

Chapter 5

Analysis

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5.1 Major results

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5.2 Reliability Analysis

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5.3 Validity Analysis

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5.4 Discussion

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Chapter 6

Conclusions and Future Work

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6.1 Conclusions

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6.2 Limitations

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6.3 Future work

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6.4 Reflections

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References

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Appendix A

Appendix Name X

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