Manuscript

Designing a pedagogical independent online course

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Abstract

Online learning has been emphasized more and more with the rise of massive open online courses. Many universities are pushing more and more course to online platforms and trying to make them fully online. This makes online learning and motivational design important in the modern world. There are existing guidelines on what an online course should include but there are no practical frameworks. This paper tackles the existing problem and creates a course design framework that takes pedagogical aspects into account and integrates them as parts into the course design. Initial test provides promising results and indicates a partial success of the framework that can be improved in a future work.

Keywords: online course design; geographical information system; independent learning

1. Introduction

Online courses and eLearning have risen in popularity during the last decade. Most online courses are evaluated based on different evaluation rubrics. General guidelines for course design can be found in literature (“Higher Ed Course Design Rubric | Quality Matters,” n.d.; Rukobo et al., 2012; Swan et al., 2012). There are no practical online course design frameworks, which provide guidelines how activities of an online course should be designed.

The primary goal of this research is to create a practical design framework for online courses to enable efficient online course creation in the future. The design of this framework is formulated by conducting a
systematic literature review to find out what type of frameworks and designs already exists and what parts make an online course effective for overall students’ learning and quality of learning.

Research questions
The main research question in this paper is: “How to create an independent online course that facilitates quality in online learning?” Independent online course means that students will do everything in the course by themselves without any mandatory communication with others. When creating courses, teaching and learning pedagogies should be considered. There are three components that closely relate to learning (Silvén, 1991):

- Motivation or interest
- Use of already learned methods or knowledge
- Controlling feelings, attitudes and relationships that guide learning

Students’ motivation determines what students learn and prior knowledge influences how they learn and apply what they know. The learning environment affects the feelings and attitudes of the students, which impact the learning experience (Ambrose et al., 2010) (“Learning Principles-Teaching Excellence & Educational Innovation - Carnegie Mellon University,” n.d.).

From the three components, following sub-questions are formulated to encapsulate detailed online learning (OL) experience in this research:

- How to make a course motivational?
- How to make a course interesting?
- How to make learning effective?
- How to make a high-quality course?

Motivation and interest are evaluated by the learners. The term motivating is defined as “Having the student to keep learning throughout the course and not dropping out” and “having the student continue learning more about the subject outside the material or course” (Schunk et al., 2014).

The term interesting is defined as “Students find the material engaging” and “students get increased motivation from the material” (“Interesting | Define Interesting at Dictionary.com,” n.d.).

2. Literature review on online learning and on online course design

This research use the systematic literature review (A. Kitchenham, 2007). Two separate systematic literature reviews are done to cover more ground. First systematic literature review is done on online course design & framework and the second is done on online learning. The following scientific databases are used: ACM, Science Direct, IEEE and Sage journals. All papers need to be available as a full text for Lappeenranta University of Technology. Both systematic literature reviews have been conducted in July 2017.

2.1. Online course design

The chosen articles in the systematic literature review are between the years 2007 and 2017 and the search results, terms and sources are shown in Table 1.

Table 1. Online course design systematic literature review search results

<table>
<thead>
<tr>
<th>Source</th>
<th>Search terms</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACM</td>
<td>“online course” + framework (metadata)</td>
<td>30</td>
</tr>
<tr>
<td>ACM</td>
<td>“online course design” (full text)</td>
<td>2</td>
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</tbody>
</table>
The articles found by the initial search are screened by title and abstract using the following inclusion and exclusion criteria as shown in Table 2.

Table 2. Systematic literature review first screening inclusion and exclusion criteria

<table>
<thead>
<tr>
<th>Inclusion / Exclusion</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusion</td>
<td>Related to online courses</td>
</tr>
<tr>
<td>Inclusion</td>
<td>Related to course design</td>
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<td>Inclusion</td>
<td>Related to online course evaluation</td>
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<tr>
<td>Exclusion</td>
<td>No relation to online courses</td>
</tr>
</tbody>
</table>

Ninety articles made it through the title and abstract screening to full reading. Finally, 36 articles were chosen for this literature review after screening them with the following criteria in Table 3.

Table 3. Systematic literature review second screening inclusion and exclusion criteria

<table>
<thead>
<tr>
<th>Inclusion / Exclusion</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusion</td>
<td>Results on what affects course quality</td>
</tr>
<tr>
<td>Inclusion</td>
<td>Results on what affects student satisfaction</td>
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<tr>
<td>Inclusion</td>
<td>Results on what affects interest</td>
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<tr>
<td>Inclusion</td>
<td>Results on what increases learning effectiveness</td>
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<td>Exclusion</td>
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</tbody>
</table>

2.2. Review of the articles

During the literature review no ready-made practical framework for online course development is found. There are high-level abstract frameworks but there are little to no frameworks telling how the lectures, assignments, exercises, quizzes, and other parts should be structured and organized beside each other. From the final articles, 17 common attributes that affect the quality of an online course, are collected and shown in Table 4.
Table 4. Common course quality attributes

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Attribute</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ap</td>
<td>Application (content applicable to working life or real-world)</td>
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<td>2. Col</td>
<td>Collaboration</td>
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<tr>
<td>3. Com</td>
<td>Competency (teacher and student)</td>
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<td>4. Cre</td>
<td>Content relevancy and completeness</td>
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<tr>
<td>5. Cde</td>
<td>Content and course delivery</td>
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<td>6. CSt</td>
<td>Course structure</td>
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<td>7. Enc</td>
<td>Encouragement</td>
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<td>8. Eng</td>
<td>Engagement</td>
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<td>9. Fdb</td>
<td>Feedback</td>
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<td>10. Fle</td>
<td>Flexibility and accessibility</td>
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<td>11. Int</td>
<td>Interaction / interactivity</td>
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<td>12. Mot</td>
<td>Motivation</td>
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<td>13. Ped</td>
<td>Pedagogy (in general)</td>
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<td>14. Rea</td>
<td>Real-world examples, assignments etc.</td>
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<td>15. Squ</td>
<td>Service quality</td>
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<td>16. Sup</td>
<td>Support</td>
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<tr>
<td>17. Usa</td>
<td>Usability</td>
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</table>

Twenty-two articles are mapped into a table below to find out the most relevant attributes. These articles show a positive effect of adding an attribute or negative effect when removing an attribute. None of the reviewed articles show a negative effect when adding one of the attributes or a positive effect when removing an attribute. Some articles provide an online course evaluation matrix, some articles provide a general design structure for an online course and other articles research the effects of few different attributes.
Table 5. Articles mapped based on attributes

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Table 5 shows that course delivery and design, interaction, and collaboration are the top three relevant attributes for an online course. Pedagogy is used as a generalized attribute or divided into specific attributes, such as collaboration, interactivity, feedback, and motivation.

Aside from the 17 attributes, some articles have information that helps in designing course content and delivery. Voice-over-PowerPoint (VoPP) is seen as one of the most popular and effective methods of teaching. Videos should have a maximum length of 10 minutes and not scripted for students to learn more efficiently (Corke et al., 2016). The instructor should specify the anticipated amount of time for task and they should describe how key topics are reinforced (Caron, 2013). Rest of the 36 articles that did not fit in the attribute table have other information related to online learning.

Students can be divided into five separate categories: viewers, solvers, all-rounders, collectors, and bystanders (Anderson et al., 2014). For a fully online course, having someone with visual memorizing, reflective information processing and sequential understanding is the most beneficial (Bae et al., 2015). This means that it is important to try to satisfy multiple different types with various tasks. Same applies to different pedagogic learning models such as resource-based learning (RBL) and problem-based learning (PBL) (Kessler, 2007). Case analyses, practice problems and quizzes are considered to be effective for improving critical thinking, problem solving, creativity, and research skills (Morin et al., 2015).

The course page should show goals, learning objectives, priorities, assessments, and constraints for students to see (Jaggars and Xu, 2016)(May and Moore, 2012). Supporting students and good online instructions will increase the motivation and satisfaction in online courses (Sun, 2016, p.)(Daud et al., 2013). The course itself should be divided into weekly modules consisting of the lesson, graded assignment and discussion (J. H. Lee, 2010) (Duan and Qi, 2014). Students tend to watch videos first before doing other activities (Hackbarth et al., 2010). Trying to conduct live sessions in an online course can be difficult and students’ interest can dwindle (Ambrose, 2010).

With an effective design and good instructions, it is possible to motivate students to learn. Currently an effective design is just a general term used in multiple research papers, but a detailed design is missing. This is the reason why it is necessary to create such a design for easier online course creation. Some of the attributes cannot be accounted for in detail within the framework, such as the content relevancy, as they rely on the implementation of a course and need to be accounted for case by case.

2.3. Online learning

The articles chosen for the systematic literature review are between the years 2010 and 2017 and the search results, terms and sources are shown in Table 6.

Table 6. Online learning systematic literature review search results
After collecting all 984 articles, they are screened with their titles and abstracts. The inclusion and exclusion criteria are presented in Table 7.

Table 7. Systematic literature review first screening inclusion and exclusion criteria

<table>
<thead>
<tr>
<th>Inclusion / Exclusion</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusion</td>
<td>Related to course creation</td>
</tr>
<tr>
<td>Inclusion</td>
<td>Related to motivation</td>
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<tr>
<td>Inclusion</td>
<td>Related to course quality</td>
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<tr>
<td>Inclusion</td>
<td>Related to teaching pedagogies</td>
</tr>
<tr>
<td>Inclusion</td>
<td>Related to learning</td>
</tr>
<tr>
<td>Exclusion</td>
<td>No relation to online environment</td>
</tr>
<tr>
<td>Exclusion</td>
<td>No relation to university level courses</td>
</tr>
</tbody>
</table>

The first screening is done by going through the titles and abstracts from each article. If the article meets at least one inclusion criteria and no exclusion criteria, it is accepted to full reading. After the first screening, 118 are chosen for full reading. The inclusion and exclusion criteria for the full reading are in Table 8. Fifty-one articles were chosen for full reading.

Table 8. Systematic literature review second screening inclusion and exclusion criteria

<table>
<thead>
<tr>
<th>Inclusion / Exclusion</th>
<th>Criteria</th>
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<tbody>
<tr>
<td>Inclusion</td>
<td>What affects course quality</td>
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<td>Inclusion</td>
<td>What affects motivation</td>
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</tbody>
</table>
Inclusion

What affects interest

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What affects learning

Inclusion

Results of comparing online learning with other methods of learning

2.4. Review of the articles

There are three ways to learn new things: formal, informal and passive learning. Students attending online courses value passive and formal learning more than informal (Levy, 2008).

According to Mayer’s design principles (Mayer, 2001), text and pictures are better for learning than text alone and animation and audio are better than animation and text (Li et al., 2013) (Lehtola et al., 2014) (Manna, 2012). Videos have a higher social presence compared to normal text and it increases student satisfaction (Thomas et al., 2017). Using a pointer can help students to focus and guide them through the text or image if combined with audio (Ando and Ueno, 2008). Students are often overconfident in how well they learn from video lectures. The most optimal way for students to learn and remember is interpolating video lectures with small tests (Szpunar et al., 2014). Abd-Hamid and Walkner (Abd-Hamid and Walkner, 2017) recommend multimedia and visual design solutions, integration of game-based learning, simulation-like or scenario based questions, providing feedback, and pretest/posttest assessments. These practices promote the students’ learning and remembering by making the content more interesting or relevant in their own life. Some argue that videos should not replace reading but videos can increase reading indirectly by motivating the students to read more (Chtouki et al., 2012).

Students can watch videos multiple times, watch specific parts and it helps them to understand the information. However, students might not understand something and would like to ask questions. With no expert present, asking questions is difficult and it may dissatisfy students (Kelly et al., 2009). Students value face-to-face (F2F) format more if they find the course interesting because the interaction with others works better (Artino, 2010) (Paechter and Maier, 2010).

When considering the final grade in OL and F2F environments, there is no statistically significant difference between them (McGready and Brookmeyer, 2013). The biggest difference is the perceived difficulty and time spend on studying. OL students spend more time studying and F2F students think the homework is more challenging (Lu and Cavazos Vela, 2015).

Students can perform worse in online environment but the reason is the students’ inability to manage their time (Keramidas, 2012). Online courses can provide equal learning results and satisfaction, if the course is done pedagogically correctly (Driscoll et al., 2012b) (Hadley et al., 2010) even with mixed results (Ou et al., 2016) (Sridharan et al., 2010).

Motivation is divided into intrinsic and extrinsic motivation. Motivation is a major component when designing a course material as motivation leads to completion, which leads to better grades. For example in Japan, an intrinsic motivation to achieve self-development is high (Hasegawa et al., 2013). Students should also be told why the specific task or lesson is important or relevant to increase motivation (Chen and Jang, 2010).

In a MOOC research, the researchers map out different motivation keywords and out of all, “knowledge” has the most hits while “easier to understand” has the least hits. There are some challenges as “lack of time” or “bad previous experience” (Shapiro et al., 2017). MOOCs have a high number of students enrolling but they also have an extremely high dropout rate as only 10-20 % of the students actually complete the course. One huge issue with MOOCs is that they offer little to no interaction between students or students and
students (Hew and Cheung, 2014). If the students feel that the course is too difficult, they are more likely to withdraw from the course (Overbaugh and Nickel, 2011).

Online discussion can be at least as effective as F2F discussion (Campbell et al., 2008) but student-student interaction does not increase the perceived learning significantly. Student-instructor and student-system interactions are more significant. Learning complex things require knowledge and information, which leads to interactions with more knowledgeable people such as the instructor (Overbaugh and Nickel, 2011) (Arbaugh and Benbunan-Fich, 2007) (Dolan et al., 2015).

The instructor is in a vital role when evaluating online learning (Wang and Qi, 2009). Instructor attitude, availability and student time are directly related to student learning. If the instructor’s attitude towards implementing the online material and availability for support is negative, it will negatively affect the students’ learning (Yusof and Ahmad, 2012) (Yusof et al., 2010). Students are also more satisfied when they receive support and feedback during the course (Marinakou, 2013) (Ma et al., 2015) (Lee et al., 2011). The instructor has an impact on achieving a deep and meaningful learning experience as it relies on the instructor’s efforts, such as course design and instructional scaffolding (Cho and Kim, 2013). If the instructor can identify students with high procrastination, they can try different methods to encourage those students to start being more involved (Michinov et al., 2011).

Motivation is considered to be one of the biggest success factors for an e-learning system and it leads to better results (Hasegawa et al., 2013)(Chen and Jang, 2010)(Lee et al., 2011) (Bani-Salameh and Fakher, 2015). Satisfactory course design can increase the students’ motivation (Shapiro et al., 2017). Instructor has a vital role by giving support to the learners (Yusof and Ahmad, 2012) (Yusof et al., 2010) as well as designing the course content. (Li et al., 2013) This leads to the causal connection of:

Designing a satisfactory course + instructor support $\rightarrow$ increased motivation $\rightarrow$ better grades $\rightarrow$ new students will know the course is good.

3. A framework for online course development

3.1. A framework for online course development

A: Flexibility & accessibility, course structure

At its simplest form, a F2F course is made of lectures accompanied with reading material. Independent study courses at their simplest forms only have reading material. Having only lectures and reading material require the students to diligently study using their own time which requires a high level of self-regulation to be successful (“Lecture | Teaching Commons,” 2017).

In the modern course paradigm, the courses often have lectures accompanied by exercises, homework, or both. This is an effective way to make sure students learn by applying theoretical knowledge. In F2F format, lectures are a one-time occasion if they are not saved somewhere. With online courses, students can jump between lectures and other activities and view them more than once.

In an online format, students have the option to go through the course with their own pace and are not limited to a weekly lecture limit. Students can go through the course content slowly or they can go through everything in a few days. The teacher can give guidelines and recommend a particular order and timespan, but it is up to the student to decide if they want to follow it.

An online course should follow a modular design, i.e. the content is divided into separate modules. The most optimal case would be to have all modules independent. The student would not be restricted by any predetermined rules designed by the instructor and the only restriction would be the students’ own competence (eLearning. Osaamisen kehittämisen digitaiset keinot, n.d.).
B: Support and collaboration
Support is extremely important for students to be satisfied. Students might need support with the online platform or with installing and using software meant for the course (Gamage et al., 2015). Additionally, students can have troubles with the course content or homework. They might not understand what the teacher wants them to do and need some clarifications. All this support can be given by the teacher or other students. Contact with a teacher can happen over emails or whatever the teacher chooses. For a student–student support, some sort of discussion board or forum could be implemented. This enables the students to discuss amongst themselves and the teacher can use the same tools to discuss with the students. The teacher can set up a frequently asked questions-section (FAQ) when similar questions appear but this is only possible after the course has gone through a few iterations.

C: Competency
Graded assignments should be developed so that they measure the competency in students because in a master level course, developing competencies is one of the key aspects (Mendenhall, 2012).

D: Real-world examples and application
Real-world examples increase the students’ interest on the topic and they learn faster because they can connect theory to the real world (Selvi, 2010). With the help of assignments based on the real world, the students can learn to apply their knowledge in real-world situations (Kilicay-Ergin and Laplante, 2013).

E: Content and course delivery
In an online format, the content is often delivered with reading material and video lectures. As mentioned before, delivering the content with only reading material is a poor option. Some students do not learn with only reading and using multiple senses is more effective. The recommended and most used lecture material format is using VoPP videos (Kessler, 2007).

The slides should be provided for students to download. Additional content such as references, source or extra material should be added for the course. The teacher cannot teach everything in a course and the teacher should point out where the students can find more information.

Quizzes are valuable tools when conducting learning assessment in online courses (Morin et al., 2015). Other possible assignments include projects, written assignments, and practical assignments. Assignments should be designed so that students use newly acquired knowledge and skills while also enforcing the previously learned subjects (“Characteristics of Effective Online Assignments | The Sheridan Center for Teaching and Learning,” 2017).

F: Interaction / interactivity and usability
Interactions can be divided into three different categories from the students’ point of view: student–student, student–teacher, and student–system interaction (Gamage et al., 2015). The student–student and the student–teacher interactions can be handled with the collaboration but student–system interaction depends on how the used system works. Most important aspect in this interaction is usability. Usability is related to the satisfaction and quality of experience (QoE). Usability can be divided into multiple subparts: efficiency or ease of use, error management or stability, and learnability (Nielsen, 2012).

Ease of use is affected by the design and structure of the course. The system needs to be easy to use and the course must be designed to be simple and easy to understand. Creating an easy to understand structure will increase the ease of use, usability, and the satisfaction of the course (Sun, 2016). Learnability can be increased
by increasing the ease of use. Another way to increase learnability is to create a guide. Stability is difficult to increase by the teacher but by reporting errors and problems to administrators, the teacher can increase the stability of the system.

**G: Feedback**

For students it is important to get feedback from graded activities but they should get feedback from other activities as well (Kilicay-Ergin and Laplante, 2013). In F2F courses, feedback can be given instantaneously by the teacher after a presentation. Students value the instant feedback more than getting feedback after a time because the feedback is easier to remember when it can be associated with the activity itself (Opitz et al., 2011).

In an online environment, if the activity requires the teacher to go through student submissions, the feedback is rarely instantaneous. There are some assignments where the teacher can give immediate feedback in online environment. Quizzes and other questionnaires can be made to give immediate feedback to the students from predetermined feedback settings.

**H: Encouragement and engagement**

In F2F lectures, teachers can talk for the whole lecture without stopping, which is what often happens in online lectures as the lecture is recorded and put online for students to watch. However, in classroom environment, the teacher has the option to stop talking and ask questions, creating interaction with students and engaging them. Teachers can also give the students exercises during lectures. This is something that could be done with online lectures as well. Lecture videos can be split into multiple parts and between those videos, the teacher can put questions or exercises to create interaction with the students, engage them into learning and not just have them put videos on auto-play, see Fig 2.

**I: Content relevancy and completeness**

The content taught in the course should be up to date and it needs to be relevant considering the outcomes of the course and the real-world situations. When teaching a subject, some things need to be taught to the students while some things can be left out. If there is some topic that is being taught in the course, the topics that are closely related to it should often be taught.
**J: Service quality**
Service quality can be divided into reliability and responsiveness that are mostly affected by the platform (Lin, 2010). The teacher can affect reliability and responsiveness with the course design. It is up to the teacher to make sure material from other sources and course activities are reliable and responsive.

**K: Motivation and pedagogy**
Motivation is important because if students are not motivated, it is highly unlikely that they would learn well. There are many ways to motivate the student. The teacher can try to motivate the students through encouraging, real-world examples, and change. Change means that the course should not be monotony. Some of the lectures or assignments could be different or if the platform allows it, there could be hidden surprises in the course page (“Motivating Students,” 2017).

Pedagogical design is the key to all course designs and the most important aspect. Pedagogical design includes multiple different attributes that have all been considered such as collaboration, support, interaction, engaging, encouraging, real-world situations and motivation. If these attributes are fulfilled in the course design, the course should have pedagogical design. In Fig 2, the whole course activity structure is shown and how it relates to all 17 attributes mentioned.
4. Case study: Independent online GIS course

4.1. Course material design

The course is designed to use Oskari (Open Source KARttalkkuna) as the GIS software (Oskari, 2017). Oskari is an open-source map platform that was started by National Land Survey of Finland. The course topics are chosen by comparing different online and university courses and selecting the topics that show up the most.

As the final topics for the course the following topics and structure is used:

1. Introduction
2. Data: General look of spatial data, databases, view and analysis
3. Map layout & projections
4. Coordinate systems
5. Data: Storing, selecting and editing geographic data
6. Relational databases and data handling
7. Spatial analysis with vectors
8. Spatial analysis with rasters
9. Geocoding and network analysis
10. Data and map processing tools
11. WebGIS
12. Remote sensing and satellite imagery
13. Digital elevation models
14. 3D modeling

Each topic consists of lecture material and exercises. Some topics can be more detailed depending on how much time is used per topic and topics can be added or removed from the end depending how much time goes to the ones higher in the hierarchy.

Without pre-existing GIS courses, all the basics need to be taught on the course. The course is meant to be at Master’s level. Two courses from the University of Oslo are used as reference for learning objectives. One 10 cr Master’s level course (“HGO4940 - Geographic Information Systems - University of Oslo,” n.d.) and the prerequisite Bachelor’s level course (“SGO1910 - Geographical Information Systems (GIS) - University of Oslo,” n.d.). The Bachelor’s level course is an introductory course to GIS while the Master’s level course is a more in-depth look to GIS and ArcGIS. The course in this case is a combination of both, working as an introductory course and going in-depth in some parts.

The course materials are collected from different sources to make sure the content is still valid and complete and organized according to the topics. Some topics and lessons have non-graded exercises to enforce learning of the lecture material. Lectures are mostly about the theoretical parts in GIS, the exercises are designed to enforce the learned theory and the graded assignments for the course are designed to implement theory in practice with the help of GIS software.

Different assignments have different expectations from students. In some assignments, students have to return a short video and in other assignments, the students are asked to fill out a premade form where they had to answer some questions. These forms are an alternative to returning a text document.

The course includes two different projects, one theoretical and one practical project. The theoretical project’s idea is to write a social and healthcare application design. This is a way to evaluate the students’
understanding of the theory and to measure their capability in applying the theoretical knowledge. The practical project is to create a plugin for the Oskari software. The students would figure out what kind of data they would need, where to get that data and how to put it all together in a program. This project would measure the students’ problem-solving skills, their data finding and creation skills, understanding the different GIS analyses, programming skills and Oskari usage skills.

The students are assessed based on the weekly quizzes, assignments and final projects. The quizzes amount to 5% of the grade, assignments 25%, first project 30% and second project 40% of the grade. The evaluation revolves around evaluating students’ competency.

The lecture materials are put into slides using the minimum amount of text necessary to convey the key information with text alone and the lectures consist of 7 to 13 slides. The slides have text and images to make them more interesting for the students. Most slides are animated for the presentation so that the text and images would only appear when the presenter wants them to. This way the text will not distract the student from listening. Animations also make it easier to follow the lectures.

Lecture videos are recorded using Screencast-o-Matic software (“Screencast-O-Matic,” n.d.). The total length of a lecture varied from 10 minutes to an hour. Because the lectures are so long, they are divided into parts that are less than 10 minutes long using MP4Splitter-software (“MP4Joiner - Home,” n.d.). The videos are not scripted to give a more natural output to students.

Questions in-between the lecture videos are created based on the previous video. These questions are basic questions the students could answer if they pay any attention. Questions for the quizzes are created based on the lectures and they are slightly more advanced. Some questions are theoretical questions and some questions are related to real-life situations or examples. Every answer to a question gives some feedback.

In addition to lecture videos, the course includes instructional videos. There are guided instruction videos on how to install Oskari, how to use some Oskari function and programming examples. This way the students learn more easily than by just following written instructions and they encounter less problems as they can see how things work. Watching the videos is not mandatory for the students. Additionally, the students can always go back to see the videos if needed.

4.2. Delivering the course online

This course is put online into the Moodle LMS platform. Students are given a progression guideline, see Fig 3. Students are not restricted by this guideline.

The lecture videos are uploaded to the YouTube and Moodle platform, and lectures are created using the Lesson module. This module allows the teacher to line up activities into one lesson. After every lecture video questions or exercises are presented to the student. These are not graded, and students can try them as many times as they want. Every wrong answer to a question redirects the student back to the lecture video and a right answer allows the user to go to the next part.

In the topic quizzes, every quiz has five questions a student needs to answer which are chosen randomly from a question bank. For a passing grade, students need an average of 3 out of 5 questions correct and students only have one attempt for each quiz. All the questions are multiple-choice questions.

The course has an ending deadline when everything needs to be done but none of the activities have an individual deadline. Activities do not have any restrictions between them, so students complete them in any order. Each topic includes a link to the uncut lecture video, lecture slides, and links to different websites, which are used as reference or have more information about the topic.
The course includes a built-in news section, discussion board, and a FAQ-section. These are used for communicating with and between the students. Moodle also has an internal messaging system if needed. Students can send emails to the teacher for the quickest communication option. The course is an independent online course, so everything the students do is done by themselves. The discussion boards can be used from course to course so new students can see what older students have asked or discussed. The discussion board can work similarly as Stack Overflow (“Stack Overflow - Where Developers Learn, Share, & Build Careers,” n.d.) works where people can look for issues others have had and the working solutions if there are any.

Fig 3. Progression guideline for the GIS course
5. Results / Findings

5.1. Preliminary survey

A small survey is conducted with five questions. The questions are simple agree/disagree questions with a scale from zero to 10. The survey has 13 responses where 11 are university students or graduates and two are technical college graduates. Eleven of the respondents are between the ages of 21 and 26 and two are between 27 and 32.

According to the responses, 69% of respondents will rather watch two less than 10 minutes long clips rather than one over 10 minutes long video if the total amount of time is same. This correlates with the theory that lecture videos should be less than 10 minutes long each.

Of the respondents, 92% agree that having a question or two or a short practical exercise after a video will help them learn and remember better, while having a reflection part is split both ways. All those respondents who prefer on having a short practical exercise agreed strongly to it, by rating it between 8 and 10. Of the respondents, 77% agree that guided exercises will be better than written instructions.

5.2. Testing with adult students

The course is put to test in an adult education project. The course content was split into two courses: first course was “Introduction to GIS” and it consists of the theoretical part including assignments and written project. The second course is “Improving GIS software” consisting of practical part including coding assignments and coding project. All lessons and quizzes are implemented in the first course and the second course has instructional programming videos for coding and assignments as students have access to both courses. As a prerequisite, the participants have to be ICT educated with a university background. They do not need to have programming knowledge for the first course but for the second course, it is highly recommended.

After the deadline for the courses, the participants are asked to fill two small surveys based on each course and an extensive survey based on both courses. Both surveys have slightly different questions and some open-ended questions as well. As the extensive survey is made by the researcher and is not validated, the questions might be misleading for the respondents.

The courses had 12 participants at the beginning but because of various reasons, some of them had to drop out. Eight participants successfully finish the first course and four participants successfully finish the second course. Six participants answered the more extensive survey and seven and six participants answered the small surveys.

Table 9. Small survey results

<table>
<thead>
<tr>
<th>Question</th>
<th>Introduction to GIS, number of answers</th>
<th>Average (range 1-5)</th>
<th>Improving GIS software, number of answers</th>
<th>Average (range 1-5)</th>
<th>Combined average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall grade</td>
<td>7</td>
<td>3.71</td>
<td>6</td>
<td>4.00</td>
<td>3.86</td>
</tr>
<tr>
<td>Relevancy of content</td>
<td>7</td>
<td>4.43</td>
<td>6</td>
<td>4.33</td>
<td>4.38</td>
</tr>
<tr>
<td>Clear course goals</td>
<td>7</td>
<td>3.57</td>
<td>6</td>
<td>4.00</td>
<td>3.79</td>
</tr>
<tr>
<td>Content applicability to practice</td>
<td>7</td>
<td>4.14</td>
<td>6</td>
<td>4.33</td>
<td>4.24</td>
</tr>
<tr>
<td>Instructor support</td>
<td>7</td>
<td>4.71</td>
<td>6</td>
<td>4.33</td>
<td>4.52</td>
</tr>
</tbody>
</table>
Aside from the questions in Table 9, there are two open questions for students: “What did I learn during the course?” and “Was something missing or was there too much of something? What parts were you happy with and what should be improved?”

Most students learned new things about geographical information, GIS and programming and completed the learning goals. Some respondents mentioned that immediate feedback for the assignments would have been great help before staring another assignment. Another issue was that few videos had not recorded sound. On the positive side, some students liked the short videos, as they were better for rehearsing and learning. Another plus came from the flexibility of the course design and instructor support.

In Table 10, results from the extensive survey are provided as the survey had 35 different questions. The most relevant questions are underlined in the table.

<table>
<thead>
<tr>
<th>Question</th>
<th>Number</th>
<th>Average (range 1-5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you find the material interesting?</td>
<td>1</td>
<td>4.00</td>
</tr>
<tr>
<td>How applicable to real life has the course content been?</td>
<td>2</td>
<td>3.42</td>
</tr>
<tr>
<td>Did you collaborate with other students?</td>
<td>3</td>
<td>1.83</td>
</tr>
<tr>
<td>Did you collaborate with the instructor?</td>
<td>4</td>
<td>2.83</td>
</tr>
<tr>
<td>Did you find the collaboration with students easy?</td>
<td>5</td>
<td>1.83</td>
</tr>
<tr>
<td>Did you find the collaboration with the instructor easy?</td>
<td>6</td>
<td>3.83</td>
</tr>
<tr>
<td>Did you find yourself to be competent in the subject before joining the course?</td>
<td>7</td>
<td>1.83</td>
</tr>
<tr>
<td>Did you find yourself to be competent in the subject after completing the course?</td>
<td>8</td>
<td>3.16</td>
</tr>
<tr>
<td>Did you find the instructor to be competent in the subject?</td>
<td>9</td>
<td>4.67</td>
</tr>
<tr>
<td>Did you find the course content relevant?</td>
<td>10</td>
<td>4.00</td>
</tr>
<tr>
<td>What would you like to be added or removed from the content?</td>
<td>11</td>
<td>Open quest.</td>
</tr>
<tr>
<td>How would you rate the content delivery as a whole?</td>
<td>12</td>
<td>3.00</td>
</tr>
<tr>
<td>How would you change or improve the content delivery?</td>
<td>13</td>
<td>Open quest.</td>
</tr>
<tr>
<td>The course was organized in a way that helped me learn</td>
<td>14</td>
<td>4.00</td>
</tr>
<tr>
<td>The course provided a mixture of explanation and practice</td>
<td>15</td>
<td>4.50</td>
</tr>
<tr>
<td>The course was effectively organized</td>
<td>16</td>
<td>3.67</td>
</tr>
<tr>
<td>The course assignments and lectures usefully complemented each other</td>
<td>17</td>
<td>4.00</td>
</tr>
<tr>
<td>The course work helped me understand concepts more clearly</td>
<td>18</td>
<td>4.00</td>
</tr>
<tr>
<td>Did you find the course structure logical?</td>
<td>19</td>
<td>4.33</td>
</tr>
<tr>
<td>Did you find the course structure easy to follow?</td>
<td>20</td>
<td>3.67</td>
</tr>
</tbody>
</table>
Did you find the course to be flexible? 21 4.67
Did you find the course to be easy to access? 22 3.83
If you would have changed something, what would you have changed? 23 Open quest.
How motivated you feel when starting the course? 24 4.33
Did your motivation change during the course? 25 3.33
In your opinion, were the examples relatable to real world? 26 3.83
In your opinion, were the assignments relatable to real world? 27 4.17
Did you receive any support from the instructor? 28 3.50
How would rate the received support from the instructor? 29 4.33
Did you receive any support from other students? 30 1.67
How would rate the received support from other students? 31 3.00
Did you receive any support from other sources? 32 3.67
How would rate the received support from other sources? 33 4.40
How would you rate the course material quality? 34 4.00
What overall rating would you give to the course? 35 4.17

The results from the survey look promising. The open questions provide similar results as the small survey does. The course is flexible, reflected real-world situations, increased the students’ competence and students found the course motivating and interesting overall. They had limited collaboration with others and that was to be expected as everything was individual work.

6. Limitations of the research

While the course is only tested in small scale, the testing provided information that supports the framework. Because this course is an original course in LUT, there is no control course to compare against. The framework should be tested in other courses to get results in different courses. Even if the framework works in this case, in a different course it is possible to get different results.

Students are individuals and the materials and course design might work differently with different people. Even if a majority said that some part worked well, there might be times that the course population is comprised of only people representing the minority. Without multiple tests and studies, it is impossible to say with certainty that this framework is perfect or close to it. Another limitation is the fact that the students are adults and might not reflect the usual university population properly. Final limitations are the number of participants in the course and the usage of non-validated surveys. These can limit the reliability of the results.

7. Discussions

In this research, the major research question is “How to create a great independent online course?” This research question led to creating a new practical design framework for online courses.

Online courses have been rising in popularity after MOOCs appeared. In 2016 there were 6850 MOOC courses and over 600 more new course compared to previous year (“By The Numbers,” 2016). MOOCs are slightly different from online courses in a university but similar rise in popularity can be found in universities. This has led to a research on courses and learning environments. Many of these researches focus on
evaluating online courses based on different parameters or guidelines such as the Quality Matters rubric ("Higher Ed Course Design Rubric | Quality Matters,” n.d.). This can limit the reliability because the courses are evaluated by the researchers or instructors but not the actual participants.

The framework designed is constructed around specific attributes that make a course desirable. These attributes work in both offline and online courses. All the attributes are related to each other in some way and most can be mapped beneath general pedagogy. While this framework is meant for online courses, it could also be used for traditional lecture-based courses, blended learning courses and flipped classroom courses.

In LUT, some existing courses such as the Computer Science 1 and object-oriented programming are using recorded lecture videos, quizzes and online assignments. The courses that are already mostly online and already implement many parts of this framework on their own, could be redesigned to use the provided framework and see if the satisfaction increases.

8. Conclusions

This research is conducted in Lappeenranta University of Technology as a study to create an online independent learning course on geographical information systems. For the course, a framework is created to be able to create an effective online learning environment. There are no existing geographical information system courses in Lappeenranta University of Technology, so the whole course has to be created from scratch. Most often geographical information system courses are taught in geography-oriented universities or programs and it is rarer to have such course in a technical university.

This research addresses the gap in design frameworks for designing online courses. There are no practical frameworks for creating online courses. Most of the existing frameworks are either too abstract or list pedagogical attributes, such as motivation, that should be implemented without explaining how to do it. The framework in this thesis tackles the problem of ambiguity and tries to explain how different pedagogical attributes can be implemented in an online environment, what activities an online course should implement and how to connect the different activities within a course together. The results from the survey look promising.

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