Showcase of Existing Active Teaching Practices

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Showcase of Existing Active Teaching Practices

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Short Description:

This report presents showcases of active teaching and learning in spatial data infrastructure education in the SPIDER partner universities. It includes detailed descriptions of the practices that have been implemented, as well as the results of the evaluation of the practices from an active teaching learning perspective.

Keywords:

Spatial Data Infrastructures (SDI), Open SDI, active teaching and learning, education, showcases

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1. Introduction

The intersection point of increased interest in open data initiatives together with national and international directives, such as EU Open Data Directive (Directive (EU) 2019/1024), and the large investment of European public authorities in developing spatial data infrastructures (SDIs) introduces the new concept of Open SDI. Open SDI has the potential to boost reaching SDI general aims and goals on facilitating the exchange and sharing of spatial data to support planning and decision-making, through including public participation and increased openness in all aspects of SDI, including Open SDI Education. The SPIDER project aims to address Open SDI Education by particular emphasis on studying Active Teaching and Learning methods for SDI education.

1.1. Aim

The aim of this report is to present and evaluate examples of active teaching and learning methods for SDI education, which were applied by the project's university partners in their existing courses. The examined practices were selected from existing ones in partner universities and were then further developed to increase their "active teaching and learning" components, based on the literature. Bearing in mind Bloom's taxonomy, the practices were selected in a way to cover higher levels of Bloom's Taxonomy, which are less attended in teaching methods.

1.2. Structure of the document

The document is organized in eight chapters. Beside the introductory and conclusion chapters, the description of practices together with the results of evaluation are presented in individual six chapters. Each evaluation includes the insights of students and teachers. In order to harmonise the evaluation by students, two questionnaire surveys were developed and used for classroom and lab activities (Appendix 1 and Appendix 2). The insights of teachers were collected as free text in order to receive wider professional perspectives on the practices.

The six teaching practices presented in this document cover the following topics:

- Governance of Spatial Data Infrastructures (Chapter 2)
- Interactive Web Mapping (Chapter 3)
- SDI Assessment (Chapter 4)
- Management in Organisations (Chapter 5)
- Assessment of SDI Geoportals (Chapter 6)
- Development and use of SDI services for addressing real-world problems (Chapter7)

2. Governance of Spatial Data Infrastructures

This active teaching practice addresses the topic of SDI Governance. The practice is developed and implemented by KU Leuven in the context of the course 'Geospatial Data Infrastructures' (2 ECTS), which is included in the KU Leuven Master of Bioscience Engineering. The practice is also used in the context of vocational training on the non-technological aspects of SDI implementation, targeted at decision makers and managers. The teaching practice mainly consists of a two-hour teaching session, with some preparatory reading prior to the course and an optional follow-up activity.

2.1. Learning outcomes

After the teaching practice, the students will be able to:

- Explain what SDI governance is and why it is important in the development and implementation of SDIs
- Discuss and analyse the governance structure in place of a particular country
- Explain the different instruments that could be used for SDI governance
- Design an effective governance approach for a national SDI using different governance instruments

2.2. Requirements and teaching material

The following teaching materials are required:

- Presentation on the basics of SDI Governance: this presentation consists of a series of slides on 1) what SDI governance is (definitions and key concepts), 2) why SDI governance is important and 3) how SDI governance can be realized
- Article 'Governance of national spatial data infrastructures in Europe' (Crompvoets, J., Vancauwenberghe, G., Ho, S., Masser, I., & de Vries, W. T. (2018). Governance of national spatial data infrastructures in Europe. International Journal of Spatial Data Infrastructures Research, 13. International Journal of Spatial Data Infrastructures Research, 13.): this article reviews the governance of national SDIs in Europe before, during and after the adoption of the European INSPIRE Directive
- Organizational chart of the SDI governance structures of a particular country or set of countries. For Europe, these charts are often included in the INSPIRE Reports and/or country fiches available at: https://inspire.ec.europa.eu/INSPIRE-in-your-Country
- Illustrations and documentations of governance challenges and approaches in other domains of society, e.g. sports, policy, businesses, etc. An example of these are the national strategies and responses to deal with the COVID-19 pandemic, which contain various aspects of governance, coordination and collaboration. Another example are different approaches and strategies for coordinating the actions of different players in a soccer team.

2.3. Learning activities

The teaching practice consists of the following teaching/learning activities:

- Research on SDI Governance: preparatory reading and 1-minute summary
- Governance in Practice: demonstration and asking questions
- SDI Governance in Practice: demonstration and brainstorm
- Definitions, concepts and lack of SDI governance: short lecture
- Lack of SDI governance: demonstration
- Lack of SDI governance: short lecture
- Implementing SDI governance: breakout discussions
- Implementing SDI governance: short lecture
- Implementing SDI governance: exercise

2.4. Implementation

2.4.1. Research on SDI Governance: preparatory reading and 1-minute summary

Prior to the main teaching session, students are invited to read the 2018 article on SDI Governance by Crompvoets, Vancauwenberghe, Ho, Masser and de Vries. This article reviews the governance of national SDIs in Europe before, during and after the adoption of the European INSPIRE Directive, which aimed to establish an infrastructure for spatial information in the European community. The analysis is based on a governance instruments approach as introduced by public administration researchers to analyse coordination and governance in the public sector. The study provides examples of six sets of governance instruments in the governance of national SDIs in Europe: collective decision-making structures, strategic management, allocation of tasks and responsibilities, creation of markets, inter-organizational culture and knowledge management, and regulation and formalization of the infrastructure.

A set of questions is provided allowing students to test themselves whether they understood the key elements of the paper. Students should be able to summarize the paper in 1 minute:

- What is SDI governance?
- How are European countries dealing with the governance of SDIs?
- What are the key trends in the governance of SDIs in Europe?
- What is the impact of the INSPIRE Directive on the governance of SDIs at the national level?

At the start of the teaching session, students are asked whether they did read the paper and to what extent they were able to provide an answer to the proposed questions. Students are invited to read the paper again and redo the 1-minute summary exercise after the course.

2.4.2. Governance in Practice: example and asking questions

The teaching session itself starts with an example of governance in practice, to illustrate that governance is an issue that is relevant in many areas of society. The selected example should be easy to understand by the students and very close to their interest. The teacher will provide some illustrations and documentations on this example, such as pictures, journal articles, short videos, etc. Students will be asked to explain what the presented pictures, articles, videos, etc. are about.

The current COVID-19 pandemic might be used as an example to demonstrate both the importance of governance and the challenges in implementing governance. Pictures could be shown of the main people involved in the design and implementation of the national policy/strategy, articles could be presented of key governance challenges, etc (Figure 2.1).

Figure 2.1. Examples on the design and implementation of the national policy/strategy.

In addition, soccer (or other sports) teams can be used as an example. As displayed in Figure 2.2, a picture of the team can be shown as an introduction, followed by pictures of the coach of the team, the captain of the team, the goalkeeper etc. Students will be asked who each of these persons are, what is their precise role in the team, etc. In addition, some illustrations can be given of the importance of tactics, training sessions, etc. Each of these elements are dealing with governance.

The focus of these examples will be on showing that governance is an issue in situations with different actors that are (inter)dependent on each other. This applies to different areas of society, also including SDI

2.4.3. SDI Governance in Practice: demonstration and brainstorm

During this teaching activity, a demonstration is provided of what SDI Governance is about. First, students are provided with an overview of the organizational charts of different SDI implementations. Students are asked to briefly describe what they see and also if they are able to recognize the different countries shown.

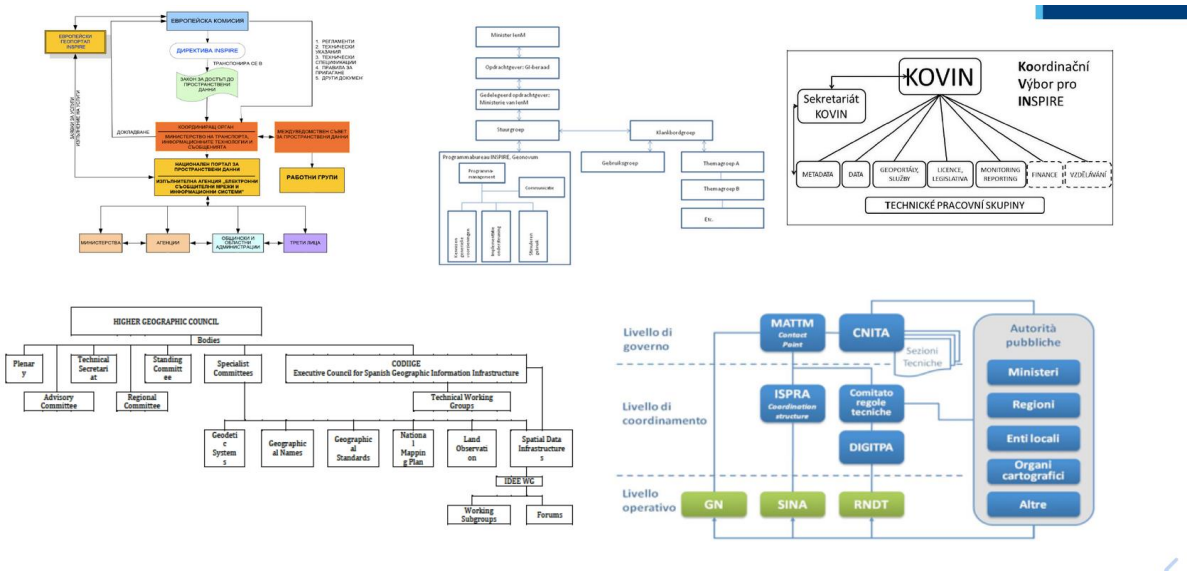

Figure 2.2. Governance in practice by taking soccer team as an example.

After the teacher provides a very short explanation of the key elements of these organizational charts, one more example of an organizational chart is presented. This should be the country/SDI the students are most familiar with (in case there is one single SDI most students know well) or a country/SDI with a well-described and easy to understand organizational chart.

The example below shows the organizational chart of the SDI/INSPIRE implementation in Greece, and can be used for this teaching practice (Figure 2.3). Students will be divided into smaller groups, and have to jointly think and brainstorm on three main questions:

- What do you see in this picture?
- Which elements do you recognize?
- What does the complete picture show?

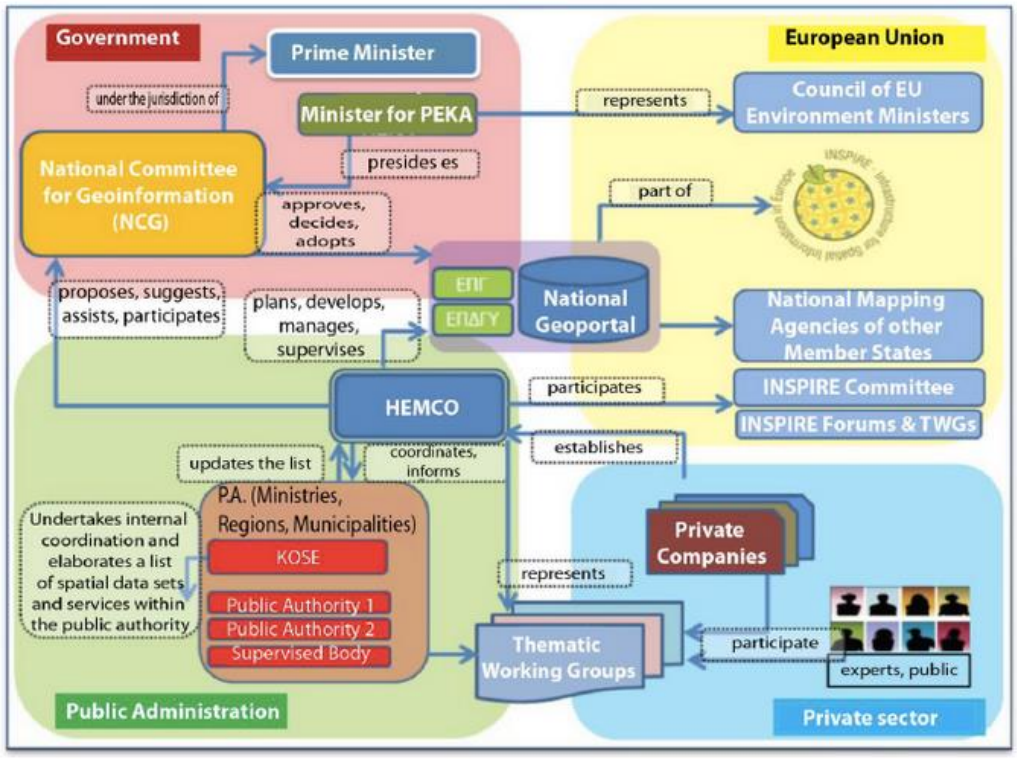

Figure 2.3. The organizational chart of the SDI/INSPIRE implementation in Greece.

After a 5-minute brainstorming session, the groups will be asked to name the different elements/components they were able to discover in the picture. The aim is to develop a long list of elements, based on the elements/components proposed by the different groups. In the following teaching activities, the teacher will refer to this list when particular elements are addressed (e.g. in the short lectures).

2.4.4. Definitions, concepts and lack of SDI: short lecture

The next teaching activity will be a short lecture by the teacher on the definitions and key concepts related to SDI governance but also on the importance of SDI, and what happens in case SDI governance is missing.

In this lecture, some definitions of SDI governance will be presented, emphasizing the key elements of SDI governance: SDI governance is about managing the relationships between different actors and stakeholders, through joint decisions and agreements. It will be shown that agreements are the main output of the governance process, which will determine what should be done, by who, how, when,

etc. In the context of SDI implementation, there are many types of agreements: legislation, policies, standards, data models, guidelines etc.

The second part of the lecture will focus on the different actors involved in SDI implementation, and how these are dependent on each other in many different ways. The evolution towards the stronger evolution of non-government actors will be explained, and the main types of relationships between actors will be discussed.

2.4.5. Lack of SDI governance: demonstration

In this teaching activity, the teacher will demonstrate the importance of SDI governance in a particular setting, and show how a lack of governance could result in different problems. The example used should be well-documented and easy to understand by the students, but should also demonstrate various governance problems.

The example used in the implemented teaching practice is the management of address data in Belgium, as shown in Figure 2.4. The example starts with showing the key actors involved in the creation, management, sharing and use of address data in Belgium.

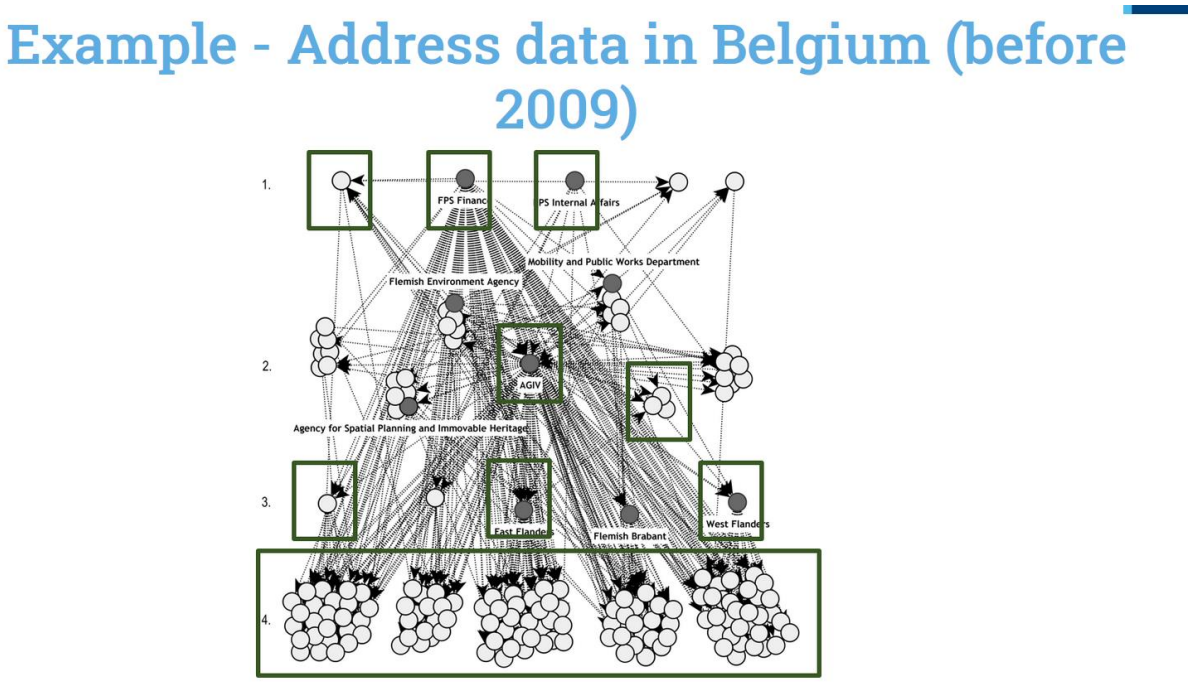

Figure 2.4. Example on the management of address data in Belgium.

The teacher will briefly list the different actors and explain their precise role. A detailed explanation is not required, it's rather about demonstrating that many different actors in different domains and at different levels are involved.

After this introduction, the teacher will explain how a lack of governance resulted in a series of governance problems:

- **Duplications**: huge number of different address data sets (even within organizations)
- **Contradictions**: different formats, different definitions, unofficial addresses
- **Gaps:** no complete and up-to-date address data set (with precise geographic location)
- **Lost opportunities:** i.e. all decisions, services, products that require complete up-to-data address data

Each of these problems will be further explained and illustrated, e.g. showing the different address data sets in place, the different data formats, etc. Optionally, the teacher could also introduce and briefly explain the solution to these governance problems, through the creation of a reference address database.

2.4.6. Implementing SDI governance: breakout discussions

This learning activity consists of discussions in smaller groups on the design of a national SDI governance approach (Figure 2.5). Students are presented a case where the Minister responsible for SDI in a particular country would like to have all the data in their country and their metadata to be compliant with common national standards, in order to avoid the problems introduced in the previous teaching activity. Students are given 10' to discuss in smaller groups on possible actions to achieve this.

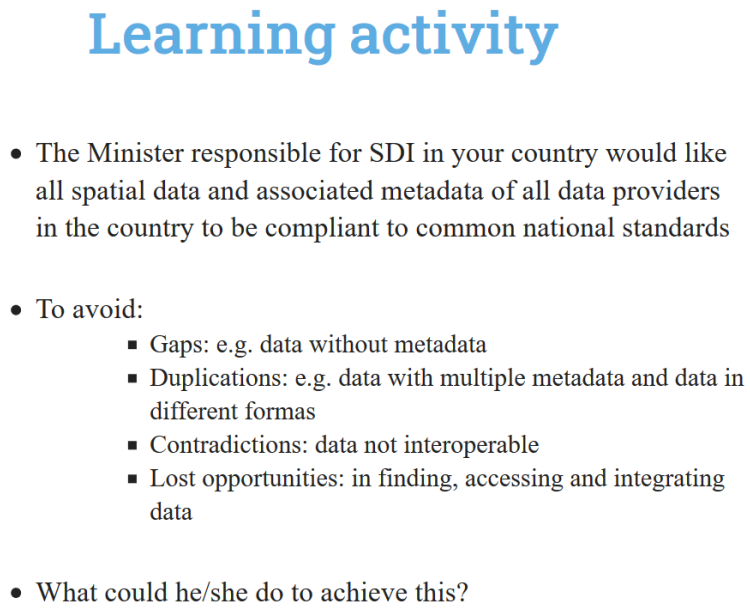

Figure 2.5. Example on learning activity.

After the discussions in smaller groups, each group will be asked to suggest 1 action. Based on the input provided by the different groups, the teacher will create a list of actions. The teacher will structure and present the suggested actions in such a way that they are in line with the six main sets of governance instruments. In case one of these six categories/sets is not mentioned, the teacher will add them.

2.4.7. Implementing SDI governance: short lecture

In this teaching activity, the teacher will introduce and explain the six categories of SDI governance instruments: collective decision making, strategic management, allocation of tasks and responsibilities, creation of markers, interorganizational knowledge and culture sharing and regulating and formalizing the infrastructure. For each category, a short description and explanation will be given, in terms of the main aim, the related instruments and key trends related to the instrument. The six instruments are also central in the journal article used in the first teaching activity. Examples will be provided on how these different instruments have been implemented in different countries. For governance through strategic management, different national SDI strategies could be presented (Figure 2.6).

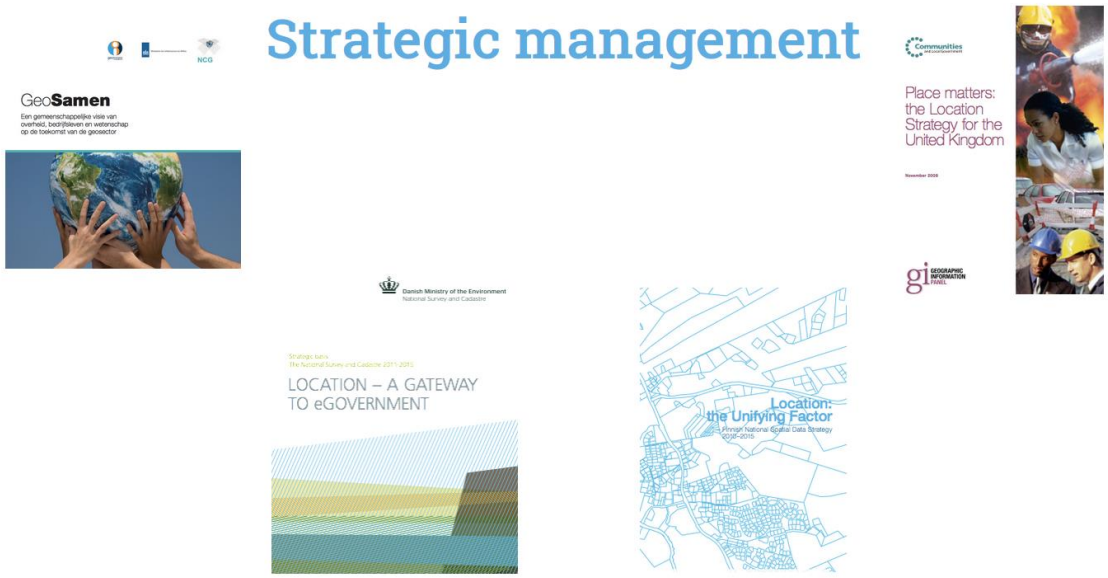

Figure 2.6. Example on strategic management.

2.4.8. Implementing SDI governance: exercise

The final teaching activity consists of an exercise to be executed by the students after the teaching session. In this exercise, students should collect evidence of the different governance instruments for their own country (or for a country assigned to them) and prepare an assessment of the governance model of this country (Figure 2.7).

At the end of the session, the activity will be introduced by the teacher. A simple way to introduce the exercise is by just presenting the key elements to be investigated in one slide. A more advanced manner could be by also preparing and providing a template to be used for collecting the information and reporting.

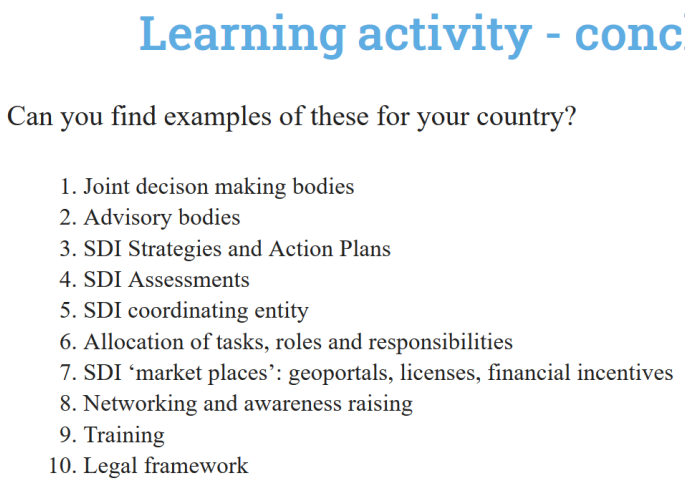

Figure 2.7. Example on learning activity – conclusion.

It should be noticed that this exercise can be implemented in different ways:

- as an individual exercise versus group work
- reporting via a paper/report or via a presentation
- as part of a formative and/or summative assessment
- describing the status versus assessing/evaluating

The overall aim of the exercise is to ensure that students apply their knowledge on SDI governance to describe (and assess) the governance model of a particular country.

2.5. Evaluation

2.5.1. Evaluation by students

Implementation of the teaching action as described in this report will take place in the second half of 2021. Therefore, the action documented in this chapter could not be evaluated yet by the students.

Feedback collected on previous versions of the teaching action was used for preparing this new version. While the previous action consisted of less active teaching activities, it was recommended to better align the teaching activities with the learning outcomes. Another recommendation made was to add more examples of the different aspects covered in the course.

2.5.2. Evaluation by teacher

After the preparation and documentation of the teaching action, and evaluation was made by some of the involved trainers. This evaluation resulted in the identification of a series of potential

weaknesses and challenges that could arise in the actual implementation of the course. In this section, we briefly discuss some of these weaknesses and challenges.

First, there might be some overlap between the preparatory reading as part of the first teaching activity and some of the following activities. Students that read the proposed article thoroughly, will be able to provide answers to some of the questions put forward in the discussions and brainstorm activities afterwards. On one hand, this repetition might help students to better grasp and understand the learning material and meet the learning outcomes. On the other hand, there's a risk that students that did not read the article prior to the course will not actively participate in the other activities.

Second, the short lecture on implementing SDI governance only allows to introduce and discuss the different governance instruments in a rather generic and even superficial manner, without explaining the particularities of and challenges related to each instrument. Students will gain a deeper understanding of the different instruments by 1) reading the article proposed under the first activity and 2) by applying the list of instruments to a real country. Therefore, it is recommended to always combine the short lecture with the exercise on implementing SDI governance. However, the actual implementation of this exercise cannot take place as part of a 2-hour teaching session, but rather should be seen as a separate teaching action.

Third, there is the proposed learning outcome that students will be able to design an effective governance approach for a national SDI using different governance instruments. However, in the different learning activities the effectiveness of governance instruments is not fully addressed. Measuring and assessing the effectiveness of governance however is a complex topic that requires further study. The proposed learning outcome is partly addressed, as students will learn how to screen for and evaluate the presence of different governance mechanisms.

Fourth, it is important to be aware that the different examples and demonstrations included in the different teaching activities should be updated regularly. Even for examples and practices that still are relevant it is required that students are informed about the current status and more recent developments. A key element in preparing the implementation of the teaching action will be reviewing and updating the different examples included in the different activities.

3. Interactive Web Mapping

The active teaching practice 'Interactive Web Mapping' is an exercise (labwork) in the Web GIS course of the Geomatics Master Programme at the Department of Physical Geography and Ecosystem Science, Lund University, Sweden. The exercise targets the "Apply" level of Bloom's Taxonomy and focuses on applying/using OGC WMS and SLD standards and specifications, while developing a Web GIS system using GeoServer (open source software), OpenLayers (open source library) and client-side programming using JavaScript.

3.1. Learning objectives

- To learn Web client programming using JavaScript and OpenLayers
- To learn and use OGC WMS standard
- To learn and use SLD standard for data visualization, in connection to WMS
- To create a Web GIS using OGC standards and JavaScript as well as open source tools (OpenLayers and GeoServer)

3.2. Requirements

Students need to have GeoServer installed on their computer. Geoserver will publish maps based on OGC standards. Setup your computer to work also as a service provider. The instruction is available on GeoServer website. You should also have access to OpenLayers libraries for preparing user interface and interactive web map components.

GeoServer is an open source software written in Java which allows users to share and edit geospatial data. It was designed for interoperability. It uses open standards (by OGC) to publish data from any major data source. Its implementation follows the specification for e.g. Web Map Service and Web Feature Service (http://geoserver.org/).

OpenLayers is an open source JavaScript library for displaying map data in web browsers. It is free software, developed for and by the open source software community. It provides an API (Application Programming Interface) for building rich web-based geographic applications. It implements industry-standard methods for geographic data access, such as WMS and WFS protocols. As a framework, its objective is to separate the map tools from the data (map data), making it possible to use all the tools on all data sources. (http://www.openlayers.org/)

SLD (Styled Layer Descriptor) is a file which describes the way the map should be rendered (e.g. draw lines in a specific color, see https://docs.geoserver.org/stable/en/user/styling/sld/cookbook/, http://www.opengeospatial.org/standards/sld). SLD is a powerful XML-based markup language. Its

open specification (by OGC) was written to be a complement to the WMS specification, by extending it to allow users to specify how they want to visualize the data.

Geospatial data has no built-in visual component; data should be styled in order to be visualized. A style can contain rules for colour, shape, size along with rendering logic for attribute-based rules and zoom-level-based rules. In GeoServer, styling is accomplished using SLD. The SLD files created for GeoServer can be re-used with any WMS that supports SLD. Every layer should be associated with at least one style.

3.3. Technical Material

Students need to read the basic concepts used in GeoServer from the user manual (http://docs.geoserver.org/). More specifically, they have to read the following parts of the documentation carefully:

- Getting started
  - Web administration Interface Quick Start
  - Adding a Shapefile
  - Styling a Map
- Styling
  - Introduction to SLD
- Services
  - Web Map Service

It is recommended that students read the Web Feature Service and Web Coverage Service from the Services section, but this is not required for this exercise.

This exercise contains coding in HTML and programming in JavaScript. To prepare for this tasks, students should read:

- HTML Forms http://www.w3schools.com/html/html_forms.asp
- CSS basic concepts http://www.w3schools.com/css/
- JavaScript basic concepts from http://www.w3schools.com/js/default.asp
  - JS String Object
  - JS Window Object (under JS HTML DOM)
  - JS Form Object (under JS HTML DOM)

Finally, students should read the complete exercise instruction. It will be easier for them to conduct the exercise and learn further, if they understand the whole exercise before they start with the first task.

The data used in this exercise is New York City roads (nyc_roads.zip), which is available at the course page. There are also other files that you should download, from the course page, and use them during the exercise.

3.4. Learning Activities

This exercise consists of five compulsory tasks (1-5). It is highly recommended that students perform them in the suggested order.

The workflow to be followed is:

- Watch a related video lecture
- Publish a layer in GeoServer.
    a. Create workspace
    b. Create store
    c. Create layer
    d. Add SLD to the layer configuration and Edit it.
- Create GetMap request for the layer published in Task 1.
    a. GetCapabilities first
    b. Write GetMap. Modify the page from the exercise "Standardised map services".
- Create a basic viewer using OpenLayers, including
    a. zoom bar & full extent button
    b. zoom & panning functionality
    c. scale bar
    d. View mouse coordinates
- Customize the viewer
    a. Change the layer style (SLD) used to render the layer.

Note to students: Organize your data for this project in a single location; you could create a new folder called 'ExGeoServer' in your home folder or on the C drive. Copy nyc_roads.zip and extract the files to a folder called 'NYC_Roads'. You will see 4 files:

- nyc_roads.shp
- nyc_roads.shx
- nyc_roads.dbf
- nyc_roads.prj

3.5. Implementation

3.5.1. Task 1. Watch video lecture

Watch this video lecture[1], which is about standardized map services. The video lecture starts by introducing the concept of Distributed GI Web Services, heterogeneity issues, and interoperability

[1] http://lumagis3.nateko.lu.se:8080/static/mh_default_org/internal/0cf72522-5e0c-42f7-be15-a02be34d1b7d/216e8a33-4f5f-4123-945c-2fb9cda5894e/Lecture_Standardized_Map_Services__Updated__Excluding_Encodings.mp4

solutions. Then, the lecture focuses on OGC standards and specifications with a special emphasis on OGC WMS.

3.5.2. Task 2. Publish a layer in GeoServer.

The first step of this exercise will guide you to publish a layer in GeoServer. After this task, the layer will be available using WMS or WFS capabilities of the server.

Navigate to the GeoServer admin webpage (e.g. http://localhost:8080/geoserver/; you have set the page, when you were installing GeoSErver of your computer)

Enter username and password (you set it during the installation; e.g.:

User: admin

Password: GeoServer

After login, you should be redirected to the upload page. To the right there is a form where you can choose which file to upload, and to the left you can see a list of the available files in GeoServer, see Figure 3.1 below.

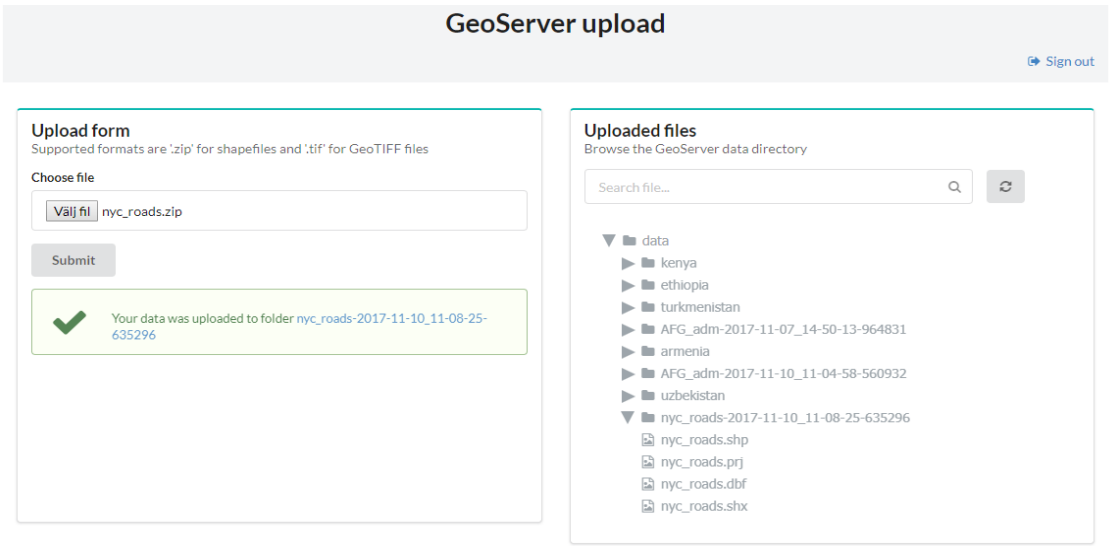

Figure 3.1. GeoServer upload function.

Choose the 'NYC_Roads.zip' file in the exercise folder and use the form to upload it. To avoid naming conflicts in the GeoServer data directory, the upload module will name the uploaded folder according to the pattern 'NAME_YEAR_MONTH_DAY_HOUR_SEC'. Take a note of the name of the folder where your data is located, since you will need to use it later.

The steps we have to follow to publish a layer are: a) create a workspace, b) create a store, and c) add the layer. All these functionalities are found in the data options in the menu, as shown in Figure 3.2.

Figure 3.2. Functionalities in the data options.

Create a new workspace.

The workspace is a container (e.g. folder) used to group similar data together. Using workspaces, it is possible to have identical layers in different workspaces without naming conflicts. Stores, layers and layer groups must have an associated workspace. Individual layers are often referred to by: workspaceName:storeName (e.g. wksLund:cities, wksLund:roads, etc.)

Select from the menu: Data -> Workspaces (Figure 3.3).

Add a new workspace:

- Name: It describes the project. Cannot exceed ten characters or contain a space. Use the name 'wsNYCRoads'.
- Namespace URI: It is typically a URL associated with your project, it may be a different identifier. Use the URL 'http://www.geoserver.org'. The same namespace cannot be used for multiple workspaces.
- Click on the check box 'Default Workspace' to make 'wsNYCRoads' your default workspace.

Click on Submit.

Note: Technically, the name of a workspace is a URI, not the short prefix. A URI is a Uniform Resource Identifier, which is similar to a URL, but does not need to resolve to a web site. In the above example, the full workspace could have been http://www.geoserver.org, in which case the full layer name would be http://www.geoserver.org:layerName GeoServer intelligently replaces the workspace prefix with the full workspace URI, but it can be helpful to know the difference.

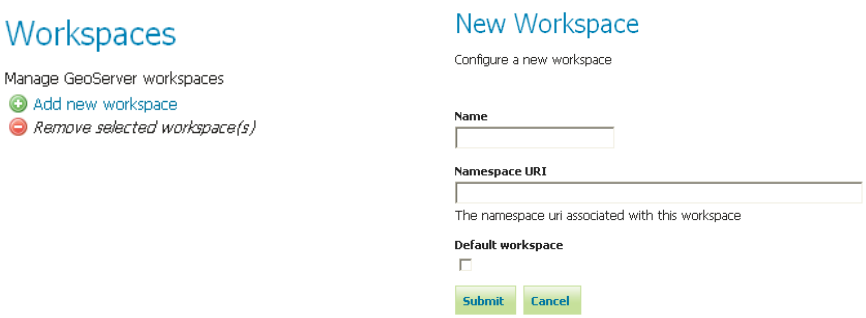

Figure 3.3. Create a new workspace.

Create Store.

A Store connects to a data source that contains geographic data. It refers to a specific data source (e.g. shapefile, database, etc.). It is also sometimes called "datastore" when referring to vector (feature) data, and "coverage store" when referring to raster (coverage) data. A store can contain many layers when connecting to databases, but only one in the case of shapefiles. Each store must be associated with one (and only one) workspace.

From the GeoServer menu: Data ->Stores.

Add a new Store (Figure 3.4):

1. Select from the List of Data types that GeoServer supports the option: Shapefile - ESRI(tm) Shapefiles (*.shp).
2. Select your workspace 'ws_NYCRoads' from the drop-down menu.
3. Write 'NYC Roads' for the Data Source Name and 'Roads in New York City' for Description.
4. In Connection Parameters, you should specify the location of the shapefile: Click on 'Brows' and navigate to nyc_road.shp and select the file. Such a path is displayed in the box: 'file:data/*NYCRoads*/nyc_roads.shp'.
5. Uncheck the options 'Create spatial index' and 'Cache and reuse memory maps'.
6. Click on Save.

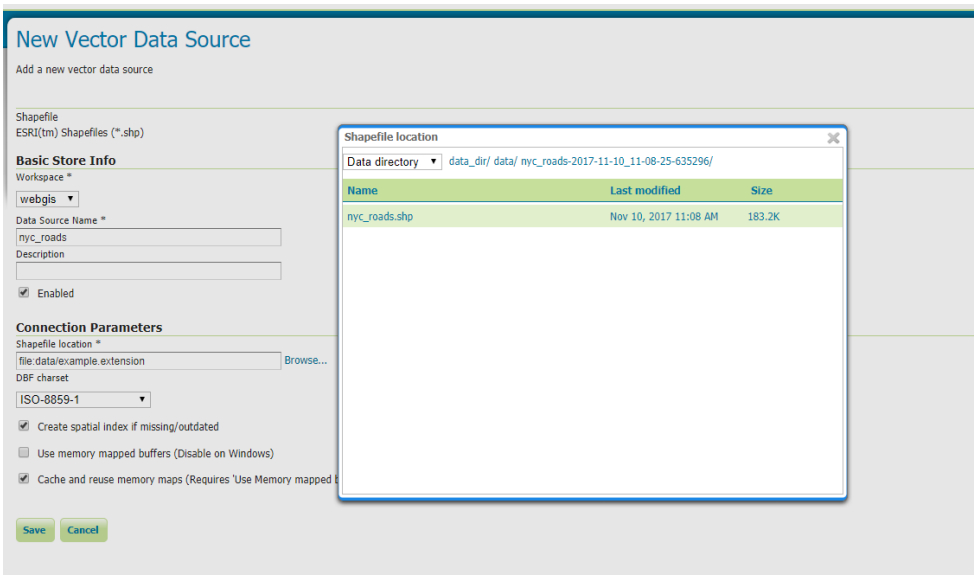

Figure 3.4. Add a new store.

The 'New Layer' page will be shown after you have created the Space (Figure 3.5).

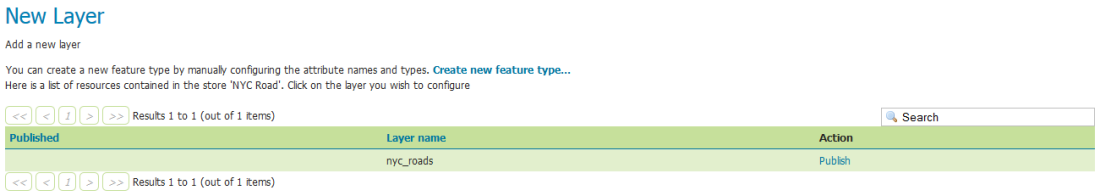

Figure 3.5. New layer page.

Create layer

A layer refers to a raster or vector data that contains geographic features. It usually contains only one type of data (point, line, polygon, raster) and has a single identifiable content (streets, houses, land-use, etc.). Aside from individual features, a layer is the smallest unit of geospatial data. Layer information about projection, bounding box, associated styles and more is stored in this section. All layers have a source of data or store. Each layer must be associated with one (and only one) workspace.

Select from the New Layer page the layer that we will use; to do this click on the 'Publish' link from the row which has the layer name you want to use. The Edit Layer page opens, as shown in Figure 3.6.

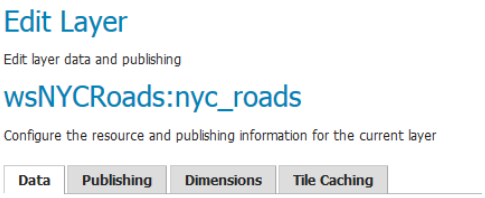

Figure 3.6. Edit layer.

From the Data tab modify the following:

1. Write a small abstract describing the layer.
2. In the Bounding Boxes part click on the links: 'Compute from data' and 'Compute from native bounds' to generate the shapefile's bounds (Figure 3.7).

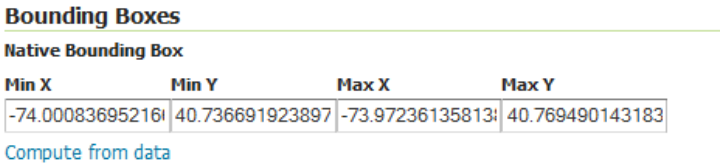

Figure 3.7. Bounding Boxes.

3. The name of the Coordinate reference system appears besides Native SRS box
4. Click on 'Find' and search for 4326 and then select EPSG:4326 from the result list. This is the standard name of the WGS84, which is the reference system of our data (Figure 3.8).

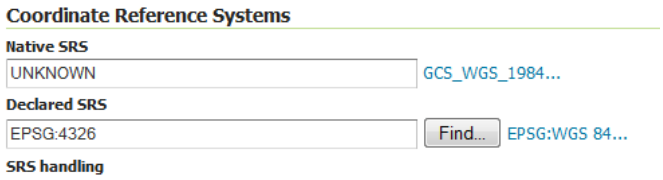

Figure 3.8. Coordinate Reference Systems.

From the Publishing tab: select 'line' from the 'Default Style' dropdown list.

Click Save.

Go to Menu-> Layer Preview.

Verify that you have completed the tasks described above by clicking on the 'OpenLayers' link on the row describing the layer created before (Figure 3.9).

Figure 3.9. Layer preview.

This will open a webpage with a simple viewer (written with OpenLayers) showing the New York City roads shapefile with the default line style (Figure 3.10).

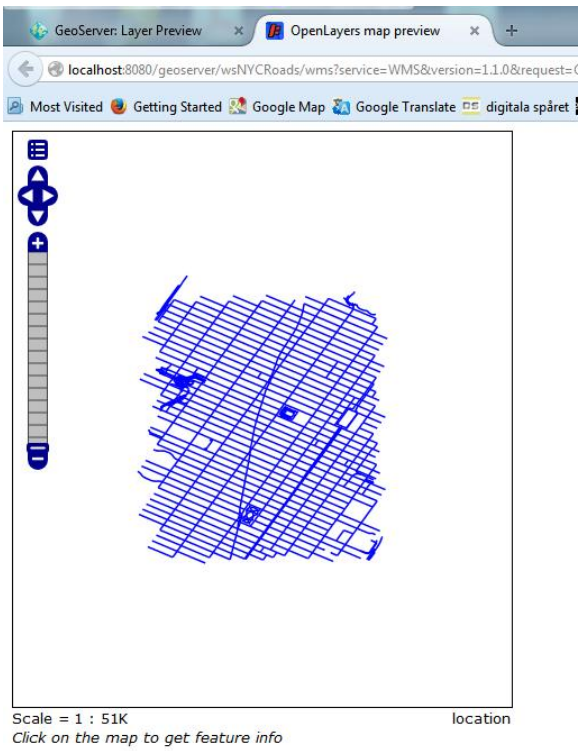

Figure 3.10. A simple viewer showing the New York City roads shapefile.

Create SLD and add it to the layer configuration.

Click on Data -> Styles to open the 'Styles' page (Figure 3.11).

Figure 3.11. Styles page.

1. Click on 'Add a new style'. The 'New Style' page opens.
2. Select a name for your style such as 'NYC Roads Style'.

3. Select ‘wsNYCRoads’ from Workspace drop box.
4. Download ‘Road_SLD’ from the course page and open it in a text editor such as notepad or notepad++, as shown in Figure 3.12.

```
<?xml version="1.0" encoding="UTF-8"?>
<StyledLayerDescriptor version="1.0.0"
  xsi:schemaLocation="http://www.opengis.net/sld StyledLayerDescriptor.xsd"
  xmlns="http://www.opengis.net/sld" xmlns:ogc="http://www.opengis.net/ogc"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<NamedLayer> <Name> area landmarks </Name>
    <UserStyle>
      <FeatureTypeStyle>
        <FeatureTypeName>Feature</FeatureTypeName>
      <Rule>
          <MinScaleDenominator>32000</MinScaleDenominator>
        <LineSymbolizer>   <!-- Style for view in a small scale -->
          <Stroke>
         <CssParameter name="stroke">   <!-- line color: #666666 is gray and #FF0000 is red -->
           <ogc:Literal>#666666</ogc:Literal>
         </CssParameter>
         <CssParameter name="stroke-width">  <!-- line width is set to 2 -->
           <ogc:Literal>2</ogc:Literal>
         </CssParameter>
        </Stroke>
        </LineSymbolizer>
        </Rule>

        <Rule>  <!-- thick line drawn first-->
      <MaxScaleDenominator>32000</MaxScaleDenominator>
      <LineSymbolizer>  <!-- The first Style (Tick line) defined for rendering feature in a larger scale -->
        <Stroke>
          <CssParameter name="stroke">     <!-- road color: #666666 is gray and #FF0000 is red -->
            <ogc:Literal>#666666</ogc:Literal>
          </CssParameter>
```

Figure 3.12. Screenshot on Road_SLD file.

5. Select and copy all the text content and then paste them to the large text box of your ‘New Style’ page (Figure 3.13).

Figure 3.13. New style page.

6. Click ‘Validate’ to validate the SLD. If no error is received, it is OK.
7. Click ‘Submit’
8. ‘NYC Roads Style’ will be listed among the other styles in the ‘Styles’ page. You can click on the style name and edit it within the Style Editor page, later.
9. Click on Data ->Layers.
10. Click on the layer name of your shapefile that you added earlier.
11. Select the ‘Publishing’ tab.
12. From ‘Default Styles’ select the style you have created.
13. Click ‘Save’.
14. Click on Data->Layer Preview. Find your layer and click on ‘OpenLayers’ link in front of it. The road map is displayed with the SLD style.

Two cartographic styles, for two different scale ranges, have been defined for this data layer. We call it StyleS and StyleL. StyleS defines how the roads are displayed in the scales smaller than 1:32K and styleL defines how they are presented in 1:32K scale and larger.

Click on Data->Styles and select ‘wsNYC Roads. Brows the SLD. Lines 11 to 23 define StyleS and lines 25 to 90 defines StyleL.

StyleS is a simple linear presentation of roads in grey (#666666 is hexadecimal code for grey) with the width of 2. You can follow it in the codes.

StyleL is a bit complicated. It consists of 3 parts. A thick line in grey (#666666) with the width of 7 which is rendered first; another thick line in white (#FFFFFF) with the width of 4, which is rendered second; and roads names which are labelled on the roads, third. The font of the labels is set as: Times New Roman, Normal, 14, Bold. The background colour of the labels is set to white with the opacity of 0,85.

Let’s try to change the style values (Figure 3.14).

1. At lines 16 and 30, change #666666 to #FF0000 (red)
2. Click Validate. You should receive No Validate errors.
3. Click Submit.
4. Open the layer using OpenLayers Viewer.

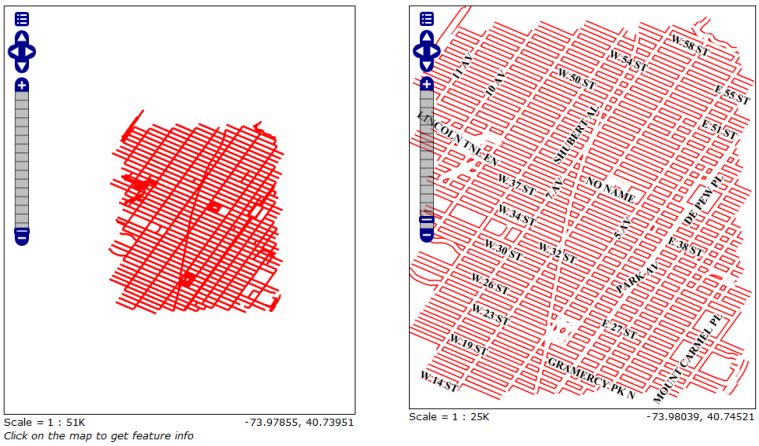

Figure 3.14. View on roads with styles.

3.5.3. Task 3: Create GetMap request for the layer published in Task 1.

In the URL box of your browser type the getCapabilities request for the layer published in Task 1:

http://localhost:8080/geoserver/wms?request=getCapabilities

Save the file and open it in a text editor.

Question 1: With the information obtained from the getCapabilities request, generate the getMap request for the layer 'nyc_roads'. Put correct values for 'xxxx' in the bellow statement.

http://localhost:8080/geoserver/sf/wms?service=WMS&version=1.1.0&request=GetMap&layers=xxxx&styles=xxxx&bbox=xxxx,xxxx,xxxx,xxxx&width=512&height=358&srs=xxxx&format=image/jpeg

3.5.4. Task 4: Create a basic viewer

In this task we intend to create a basic viewer with Open Street Map as background and New York City Road as foreground. The viewer has basic navigation tools (zoom bar, zoom in/out by mouse, zoom to extent of the road data, and pan). It also has a scale bar and shows the coordinates of the mouse. You can also retrieve and show the attribute table of the roads by clicking on them.

Download OL.zip from the course page. The zip file includes the following files:

- lanOpenLayers.htm
- ol.css
- ol.js

Extract the files and save them within one single folder.

Open 'labopenLayers.htm' in a text editor such as Notepad++. This is a template for adding the codes to make the viewer. Find the <body> element. This element has an onload event which is fired, when

the html file is run, and then the init() function is called. We write our JavaScript codes within the init() function. There is also a division called map, which is designed as a place for rendering the maps. Other s have been designed for rendering scale bar (scale-line), mouse coordinates (location), and attribute tables (nodelist).

1. Locate the code:

```
function init(){
        //The bounding box of wsNYCRoads:nyc_roads
        var extent = [a,b,c,d];
```

Write the coordinates of lower-left and upper-right corners of nyc_roads inplace of a,b,c,d.

2. Locate //Initial view and then add the following code, below it to set the view of your map.

```
var view = new ol.View({
    center: ol.proj.transform([-73.99, 40.75], 'EPSG:4326', 'EPSG:3857'),
    zoom: 15
    });
```

The 'view' allows specifying the centre, resolution, and rotation of the map. The simplest way to define a view is to define a centre point and a zoom level. Note that zoom level 0 is zoomed out. Since we are going to use OpenStreetMap as background, our view will have the same coordinate system. You will notice that the '`centre`' specified is in lat/lon coordinates (EPSG:4326), since our road data is in this coordinate system, but it is transferred to EPSG:3857, using ol.proj.transform() function for just the visualization purpose.

3. Locate //The source for wsNYCRoads:nyc_roads and then add the following code, below it to set the source for nyc_roads.

```
var wmsSource = new ol.source.ImageWMS({
    url: 'http://flygbilder.gis.lu.se/geoserver/wsNYCRoads/wms',
    params: {
        'LAYERS': 'wsNYCRoads:nyc_roads'
        },
    serverType: 'geoserver'
    });
```

4. Locate //OpenStreetMap background and wsNYCRoads:nyc_roads in layers and then add the following code, below it to define the layers that you want to be shown in your web map.

```
var layers = [
        new ol.layer.Tile({
                source: new ol.source.OSM()
        }),
        new ol.layer.Image({
                source: wmsSource
                })
        ];
```

5. Locate //Bind the map object to our "map" div and add some extra functionality and then add the following code, below it.

```
var map = new ol.Map({
        layers: layers,
        controls: ol.control.defaults({
        attributionOptions:
                ({
                collapsible: false
        })
}).extend([
        //Extra functionality of the map
        //Control for displaying coordinates
        new ol.control.MousePosition({
                coordinateFormat: ol.coordinate.createStringXY(4),
                projection: 'EPSG:4326',
                className: 'custom-mouse-position',
                target: document.getElementById('location'),
                undefinedHTML: ' '
        }),
//Control for displaying a scale line
new ol.control.ScaleLine({
```

```
            target: document.getElementById('scale-line')
        }),
        //Control for zooming to a defined extent
        new ol.control.ZoomToExtent({
            extent: ol.proj.transform(extent, 'EPSG:4326', 'EPSG:3857')
        })
]),
target: 'map',
view: view
});
```

6. Locate "//Add click event for getting attributes from WMS" and add the following code below it for retrieving attribute data by clicking on road features. This function uses a HTTP GET request to retrieve the information from the WMS. The $ symbol is the used by JQuery, a third party library often used in JavaScript for performing tasks such as HTTP requests. It just defines that we are calling a JQuery function and not a function defined in our own JavaScript. You can read more about JQuery here https://www.w3schools.com/jquery/

```
map.on('singleclick', function (evt) {
    var viewResolution = /** @type {number} */ (view.getResolution());
    var url = wmsSource.getGetFeatureInfoUrl(
      evt.coordinate, viewResolution, 'EPSG:3857',
      { 'INFO_FORMAT': 'application/json' });
// JQuery HTTP GET request
    $.get(url, function (resp) {
        var features = resp.features;
        if (features.length > 0) {
            var properties = features[0].properties;
            fillInfoPanel(properties)
        }
    })
});
```

Question 2: Describe ol.map() , ol.View() , ol.control.MousePosition(), ol.control.Zoom(), ol.layer.Tile(), ol.layer.image(), ol.source.OSM (), and ol.proj.transform() classes in brief.

3.5.5. Task 5: Customize the viewer

Edit SLD of nyc_Roads as below:

1. Roads are presented in Dark Magenta in scales smaller than 1:25K shown in Figure 3.15

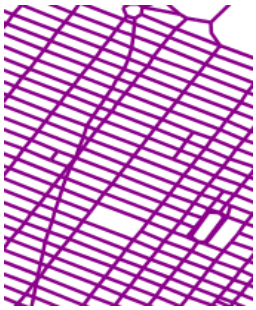

Figure 3.15. Roads are presented in Dark Magenta in scales smaller than 1:25K.

2. Roads are presented in Crimson in edges and Blanched Almond in foreground, in scales larger than 1:25K shown in Figure 3.16

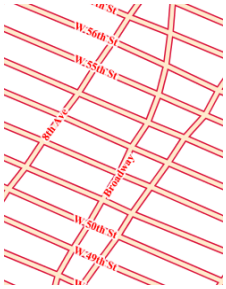

Figure 3.16. Roads are presented in Crimson in edges and Blanched Almond in foreground.

3. Labels are presented in Red in scales larger than 1:40K shown in Figure 3.17

Figure 3.17. Labels are presented in Red in scales.

3.6. Evaluation

3.6.1. Evaluation by students

Twenty students were invited to evaluate the exercise by responding to the questionnaire survey designed for lab works. The survey was open for two weeks, and one reminder was sent to the students at the end of the first week. Fourteen students participated in the survey, out of which seven students had evaluated the whole Web GIS course, instead of the intended exercise. So, those seven students were invited to a meeting to describe the aim of the questionnaire orally and ask them to re-do the evaluation. Six students participated in the meeting and re-did the survey. So altogether thirteen responses were available for this study. Figures 3.18 shows the summary of the response to the survey.

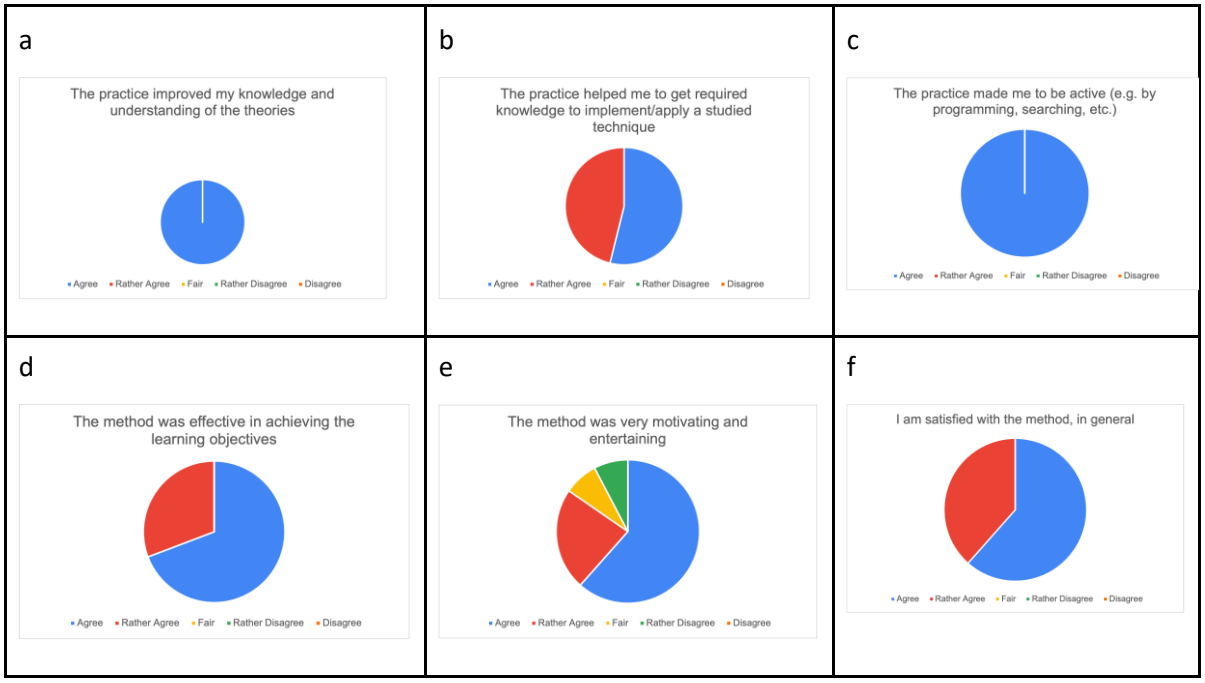

Figure 3.18. Summary of the evaluation of the lab work (exercise) by the students

All students believed that the lab work has improved their knowledge and understanding of the theories (Fig. 3.1 a) by practical implementation of a Web GIS system and the use of OGC WMS and SLD standards for map retrieval and cartographic presentation of the maps.

These statements might be a good summary on expressing how the practice helped students to get required knowledge to implement/apply a study technique (see also 3.1 b):

- *"I did not have any experience with Web GIS and programming. The exercise I took helped me to gain a really good insight on how Web GIS systems work, and what are the extra abilities that programming languages could offer".*
- *"The practice made me understand the background theories of WMS and also get familiar with Javascript and Geoserver."*
- *"Practical methods are very significant for the understanding of SDI."*

Meanwhile some students suggested also include other libraries such as "leaflet" and more standards such as WFS. Although interesting comments, the workload of the exercise exceeds the number of credits considered for that.

As the lab work included programming and system development, the students were active to a high extent (3.1 c). They had to not only do the programming, but also search for and learn e.g. commands and functions in JavaScript and OpenLayers to be able to do the exercise. This made them active when they conducted the exercise; *"During the exercise, I had taken a lot of new knowledge for me. Especially coding and creating interactive maps methods gave me more inspiration. Course was fully interactive and practical."*

The students also believed that the exercise was effective in achieving the learning objectives (3.1 d) and "applying" the theoretical methods in practice. They think:

- *"The practice is very effective and educating".*
- *"I recommend that the number of this kind of active practice should be increased in Master Levels".*
- *"Practical exercises should be always mandatory for SDI."*

A majority of students thought that the exercise was motivating and entertaining (3.1 e). However, *"programming in a short period of time, especially if you are not master in JavaScript and OpenLayers cannot be entertaining",* which makes sense.

All students were satisfied with the method in general (3.1 f). They think that they have learned:

- "JavaScript and OpenLayers programming"
- "Interaction between OpenLayers and GeoServer" (how OpenLayers and Geoserver work together)
- "How interoperability is achieved by OGC standards"
- "How interoperable environment can be created using OGC standards in an SDI"

They have also suggestions for improvement:

- "Add more spatial analysis tools in Web GIS"
- "Add raster analysis in Web GIS"
- "How PostGIS and GeoServer can be setup and used in Web GIS"

- "Consider more time for the exercise"

Although the comments are interesting, but they do not address the learning objectives of the exercise. The latter is partly relevant, which will be considered.

3.6.2. Evaluation by teacher

Three teachers at the Department of Physical Geography and Ecosystem Science, Lund University, who were involved in teaching the lab work (exercise) were asked to provide us with the evaluation feedback. Here are the results:

> *"The exercise has been running for a couple of years. The exercise nicely connects three parts in the course Web GIS: web programming (in JavaScript), web cartography and OGC web services. In the preparation of the exercise it is also stated that the student should prepare these parts as well as read the whole exercise. My experience is that a well-designed preparation part (as this one) is vital for an exercise. The instructions in the exercise are long, almost 20 pages. They are written in a mix of recipe instructions to more independent work for the students. This mix helps the student both to learn the theories and learn by doing (by forcing them to be active), within a reasonable time frame."*
>
> *"The exercise is well-organized and clearly introduces each part, including aim, requirements, preparation, required data and specific tasks. The students can clearly understand the exercise and follow each step from the exercise instruction. From publishing a map service in Geoserver to calling for the service in JavaScript, the coherence and connection of tasks are very close. While visualizing the maps, the map styles are also required to be considered to generate high quality maps. From this exercise, the students can master the theories and skills on interactive web mapping systematically. According to my experience, the workload is fine. Most of the students completed the tasks on time."*
>
> *"Since this is a practical exercise where the students work with technology that is new to them the instructions are quite detailed and easy to follow. There are however, a few pitfalls where the instructions are not very clear and the students might find that the output is not what they expected. Here we rely on the students' knowledge about coordinate systems to identify what the problem is and how to solve it. This exercise gives the students a good understanding of the concepts of- and basic knowledge in using a WMS, setting up a WMS in GeoServer, and SLD, they learn about the structure of SLD-files and XML.*
>
> *I would say that this exercise works very well in introducing the students to the given concepts and technologies. The workload is good, they learn a lot without their exercise being too cumbersome. The students will also use what they have learnt in this exercise in a project later in the course."*

In general, teachers believe that the exercise has been designed properly and helps students to bridge between theory and practice (apply), via pieces of practical tasks that they have to do. Being involved in the exercise including writing codes and developing a Web GIS makes students active within the lab work.

4. Active Online Teaching on SDI Assessment

The active online teaching was applied in the 5 ECTS 'Geo-information organisation and legislation' course, part of the TU Delft MSc. Geomatics for the built environment programme (https://geomatics.tudelft.nl). In this course, students will learn about the organisational and legal aspects relevant for developing a strategy for a geographic information infrastructure. Many organisations, and increasingly also citizens, collect, process and disseminate geo-information (e.g., Google, TomTom, mapping agencies and cadastres). Some information serves a specific purpose, while other information acts as multipurpose or base information, which is the fundament of an information infrastructure. An adequate information infrastructure allows for information to be collected efficiently (collect it once, use it many times) and provides reliable information for effective use in decision-making processes at all levels in government, private sector, academia and among citizens. Legislation is a critical component that needs to be considered to determine whether information can be used for a certain purpose and shared with others.

4.1. Learning outcomes

The active teaching methods in this chapter were applied in the TU Delft MSc. Geomatics course GEO1009 Organisation and Legal Aspects of Geo-Information. The learning objectives of the course are:

- recognize and anticipate relevant legal (especially data protection (EU General Data Protection Regulation), copyright/database rights, access to and reuse of information law (Open Data and Reuse of Public Sector Information Directive), and data sharing legislation (INSPIRE Directive and Regulations), and organisational issues evolving around the acquisition, processing, dissemination and use of (geographic) information
- understand the needs of potential users of geographic information and their requirements within organisations
- apply the concepts, processes and main components of (geographic) information infrastructures (Data, People (human resources), Policies, Access networks and standards) to support geographic information sharing between organisations
- critically assess geographic information management strategies for organisations
- assess the performance of an (geographic) information infrastructure from a user perspective

4.2. Teaching material

The teaching material consists of a variety of literature, video clips and lecture recordings on SDI, SDI assessment, governance, funding, law on promoting access and reuse, and law restricting the access and reuse as well as core concepts of land administration.

The following literature is required:

- Van Loenen, Bastiaan (2006). Developing Geographic Information Infrastructures, chapter 2, dissertation TU Delft.
- Budhathoki, Nama Raj, Bertram (Chip) Bruce, Zorica Nedovic-Budic (2008). Reconceptualizing the role of the user of spatial data infrastructure. GeoJournal (2008) 72:149–160.
- Hennig, Sabine and Mariana Belgiu (2011). User-centric SDI: Addressing Users Requirements in Third-Generation SDI. The Example of Nature-SDIplus. Perspektiv nr. 20, pp. 30-42
- Dalla Corte, L, (2018). Towards Open Data Across the Pond. In: van Loenen, B., Vancauwenberghe, G. & Crompvoets, J. (eds.), Open Data Exposed. The Hague: TMC Asser Press. 290 p. (Information Technology and Laws Series; vol. 30).
- Mulder, A. E., G. Wiersma, B. van Loenen (2020). Status of National Open Spatial Data Infrastructures: a Comparison Across Continents, International Journal of Spatial Data Infrastructures Research, 2020, Vol.15, 56-87.
- Vancauwenberghe, Glenn, Kotryna Valečkaitė, Frederika Welle Donker, Bastiaan van Loenen (2018). Assessing the Openness of Spatial Data Infrastructures (SDI): Towards a Map of Open SDI. International Journal of Spatial Data Infrastructures Research, 2018, Vol.13, 88-100
- Van Loenen, B. (2018). Towards a User-Oriented Open Data Strategy. Chapter 3 in B. van Loenen, G. Vancauwenberghe and J. Crompvoets (eds.), Open Data Exposed. Springer
- Crompvoets, Joep, Glenn Vancauwenberghe, Serene Ho, Ian Masser, Walter Timo de Vries (2018). Governance of national spatial data infrastructures in Europe. International Journal of Spatial Data Infrastructures Research, 2018, Vol.13, 253-285
- Zevenbergen, J.A. (2002). Systems of land registration aspects and effects, Doctoral thesis TU Delft
- Zevenbergen, J.A. & H.D. Ploeger (2019). What would title registration bring to a deeds system with high quality land information? FIG Working Week: Geospatial Information for a Smarter Life and Environmental Resilience - Hanoi, Vietnam
- Welle Donker, F. (2018) 'Open Data Funding', in Van Loenen, B., Vancauwenberghe, G. and Crompvoets, J. (eds.) *Open Data Exposed: Vol. ITLS Vol. 30 Information Technology and Law Series*. The Hague: T.C.M. Asser Press, pp. 55-78
- Dalla Corte, Lorenzo (2020). Safeguarding Data Protection in an Open Data World: On the idea of balancing open data and data protection in the development, PhD thesis Tilburg 2020. Chapter 6: Introduction, 6.1 – 6.4 (p 214-239)
- van Loenen, Bastiaan, Stefan Kulk & Hendrik Ploeger (2016). Data protection legislation: A very hungry caterpillar: The case of mapping data in the European Union, Government Information Quarterly, Volume 33, Issue 2, 2016, Pages 338-345.

A selection of video clips to be studied prior to the lectures:

- 3D Geo-information for sustainable urban development: https://www.youtube.com/watch?v=U8r2ekvo64c
- Data protection and open data: https://www.youtube.com/watch?v=qRh_qW-6NNk
- Funding open data: access policies: https://www.youtube.com/watch?v=XM44WHkOQJ4&feature=youtu.be

- Legal aspects of open government data https://ocw.tudelft.nl/course-lectures/legal-aspects-open-government-data/
- The open data and PSI reuse directive: https://youtu.be/AmSjzuAR6GI
- Implementing Open Government Data: Best Practice (Kingdon): https://www.youtube.com/watch?v=v5cZHPEgK2w&feature=youtu.be
- INSPIRE in a nutshell: https://www.youtube.com/watch?v=xew6qI-6wNk&feature=youtu.be

4.3. Learning activities

Activities needed to reach the objectives are (see Table 4.1):

a. Watch video clips prior to the lecture
b. Read papers/ book chapters prior to the lecture
c. Participate in the online lecture
d. Write a paper on the openness of a National SDI of choice
e. Present the paper to the class
f. Debate on the topic of the paper in a broader context
g. Online open book exam

In this chapter we elaborate on (the practices):

1. Active online lecturing
2. Presentation
3. Debate

Table 4.1. Active learning activities categorized by levels of learning, and as in-classroom and outside classroom activities (in bold and yellow the activities we implemented online in 2021)

Learning level according to Bloom's taxonomy	online teaching session	Example of active learning activity
Remember	demonstrations examples guest speakers **in-class quizzes/polls**	Teacher shows outcomes of previous results as examples Students find a specific dataset / parcel information of a country
Understand	**asking questions** active listening / paraphrasing one-minute paper / one-sentence summary brainstorm / brainwrite jigsaw catch-up four corners / chain notes **in-class quizzes/polls** mind map	Ask the students if they had watched the video clip in advance, and which parts were not clear to them. Class quiz related to whether open data should be treated as a commodity, public good or club good, whereby students have to show an item of a colour corresponding to the colour of the answer option. Students then are asked to motivate their choice.

Apply	**debate** **student presentations** idea line-up four corners / chain notes fishbowl mystery quotation quescussion concept map	Randomly assign groups of students to breakout rooms to look up and discuss which funding regime is applicable to the NMCA of their case study country / state. Report and discuss their findings in class afterwards.
Analyse	muddiest point concept map / mini map active writing **class discussions** cases / simulation think-pair-share group investigation as collaborative learning	Class quiz related to in which category of open data users the national governments should prioritise investing resources (primary users, secondary users, tertiary (re)users or citizens as end-users) to ensure long-term sustainability of open data, whereby students have to show an item of a colour corresponding to the colour of the answer option. Students then are asked to motivate and discuss their choice.
Evaluate	peer instruction **peer review** **peer tutoring** **classroom quizzes** **debate**	Peer review: students had to review the intermediary paper of another group and based on this ask two questions in the presentation of that group. In the final debate students had to prepare a position in favour or against the statement “Open SDI XXXX”.
Create	formulating exam questions mini lectures paper	Writing a paper, with the aim to design a strategy towards more openness in the national SDI of a country.

4.4. Requirements: Preparation for (student and) teacher

Prior to the lecture students were reminded to watch the video clip and/ or study the reading material. We sent a message through the Brightspace platform about the online link to the lecture. A student version of the slides of the lecture were published as well before the start of the lecture. This version did not include slides that provided the answer to questions to be asked/ discussed in the lecture. After the lecture, the full version of the slides is shared with the students through Brightspace, as well as the recordings of the lecture.

We used Zoom for the online lecture as Zoom includes a user-friendly interface for creating breakout rooms on the fly and assigning students to the breakout rooms. Students can be assigned randomly or manually (e.g. by assigning group members already cooperating in another group work). During the lecture, one teacher is presenting. Students can ask questions in the chat box or by raising their virtual hand. Another teacher monitors the chat box/ raised hands to interrupt the teaching colleagues if necessary. Alternatively, we invited one student to perform this moderating task.

All teachers used two screens: one for the presentation and the other for the Zoom overview/ other programs (e.g., Mentimeter for online polling).

4.5. Implementation

4.5.1. Practice 1: Active online lecturing

In the online lecture we applied five active teaching elements:

1. Asking questions to the group, to be answered with coloured items
2. Asking questions directly to individual students
3. Break out rooms for smaller discussions
4. Real-time online polling tools
5. Find X (dataset, parcel of your own house, other)

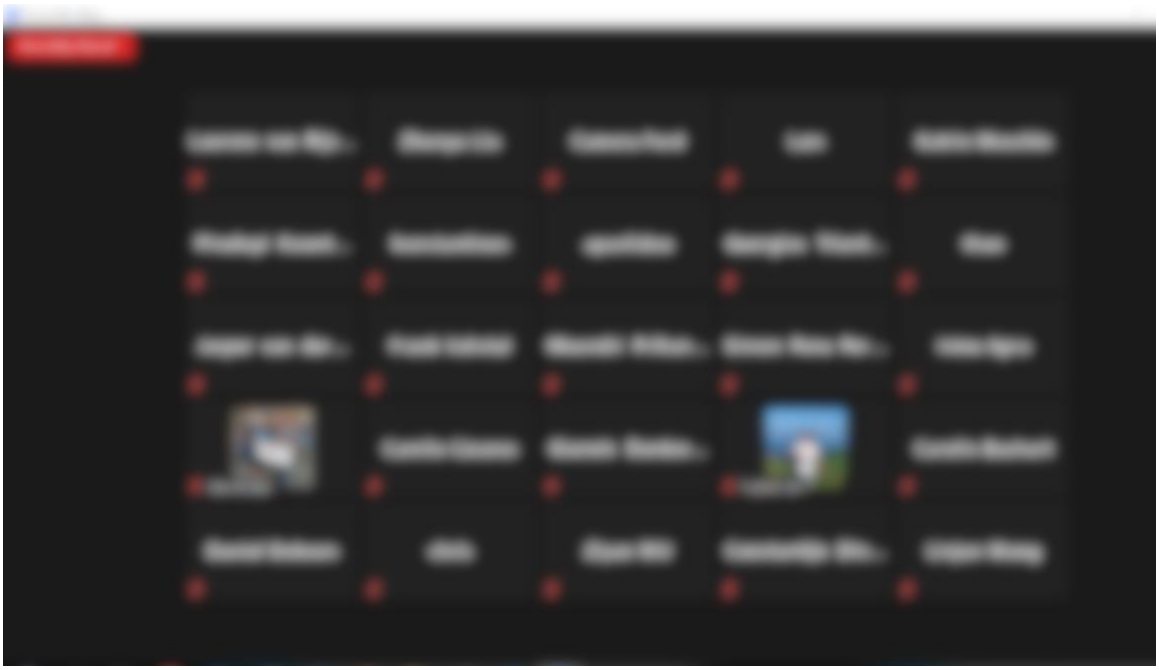

Figure 4.1. start of the meeting: all camera off (The image has been blurred to hide students' names, for privacy reasons)

The start of the lecture

In the online classroom we require the students to turn on their cameras but to mute their microphones. The lecture starts with asking students whether they have a question on the assignment or the videoclip or the literature to be studied.

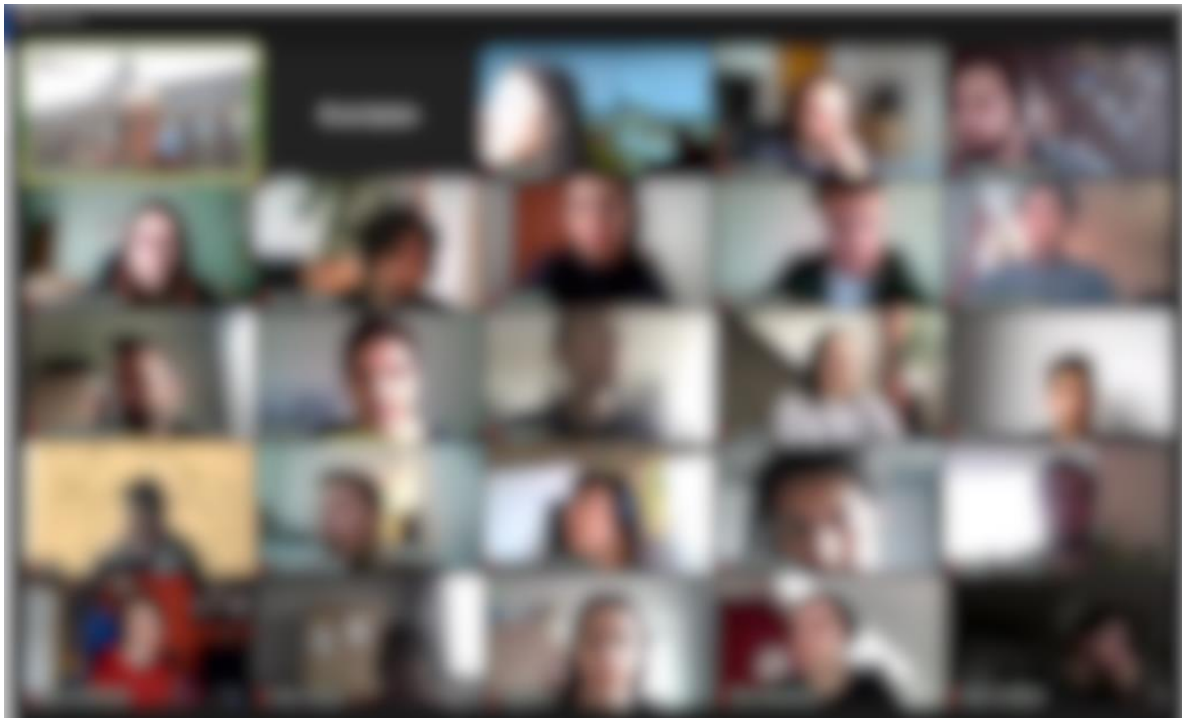

Figure 4.2. lecture begins and cameras are turned on (The image has been blurred to hide students' names, for privacy reasons)

Show the colour: Asking questions to the group, to be answered with coloured items

The next question is who did watch the video clip. Students can answer by showing a green object (yes, I watched) or a red object (no, I did not watch the video clip) (see Figure 4.3). The teacher then may ask the green students to summarise the main message/ take-aways of the clip.

The same method is used during the lecture. A question is presented on the slide with multiple answers. The student should indicate her/ his answer by showing an item in the corresponding colour (see image in Figure 4.3).

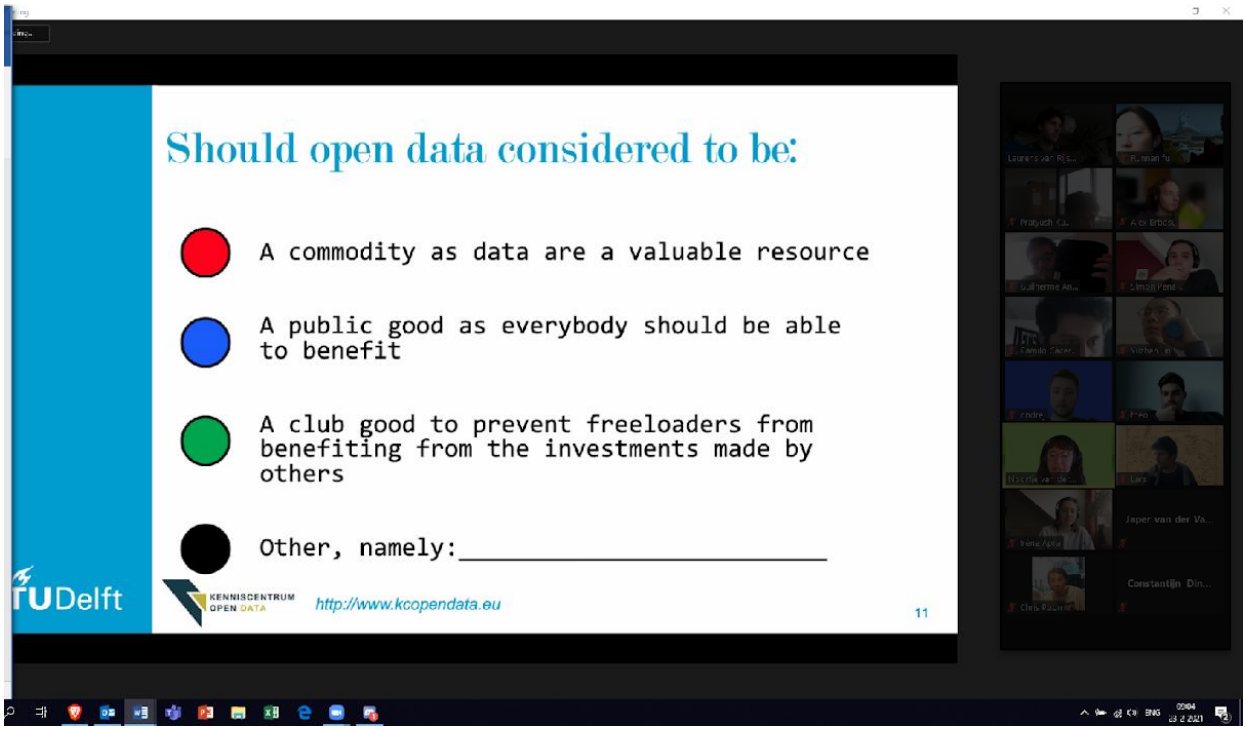

Figure 4.3: example of colour-coded question and students using an item to indicate their response during lecture

Asking questions directly to individual students

The answers of the individuals formed the starting point of a discussion with the students. First, one of the students opting for answer 'Red' was asked to explain her/his choice. Then a student with another answer could explain her/his choice. This would allow for a better understanding of each other's standpoint and ultimately of the theory at hand. The side effect of this method is that students are forced to stand up and search for an item, stimulating them to get away from the screen for some time. It also allows students to use their imagination, demonstrated by the fact that some students used different coloured backgrounds to indicate their chosen option.

Break out rooms for smaller discussions in groups of three to four students

We used the Zoom breakout rooms function to stimulate discussions in smaller groups. The groups were instantly and randomly created by Zoom (see Figure 4.4). Before the groups were created, the question to be discussed was provided and briefly explained. For example, after introducing the role of law in SDI development, students are asked to discuss in groups of three to four the question 'If you had to design a law promoting access and reuse of geoinformation, what would be your recommendations to include?"

The teacher could join and leave a breakout room at any time (see Figure 4.5). This was done to monitor the discussions of the students and their level of engagement, and to interfere if considered to be necessary.

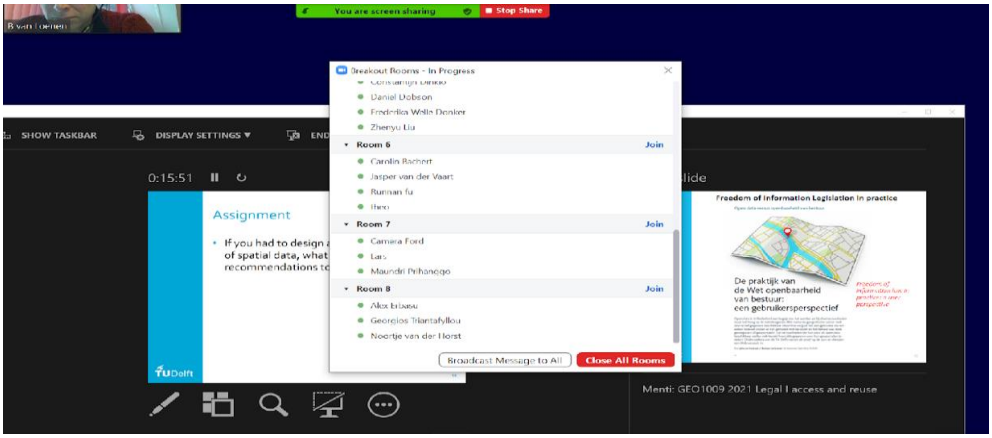

Figure 4.4. In Zoom, breakout rooms are created on the fly and students assigned randomly.

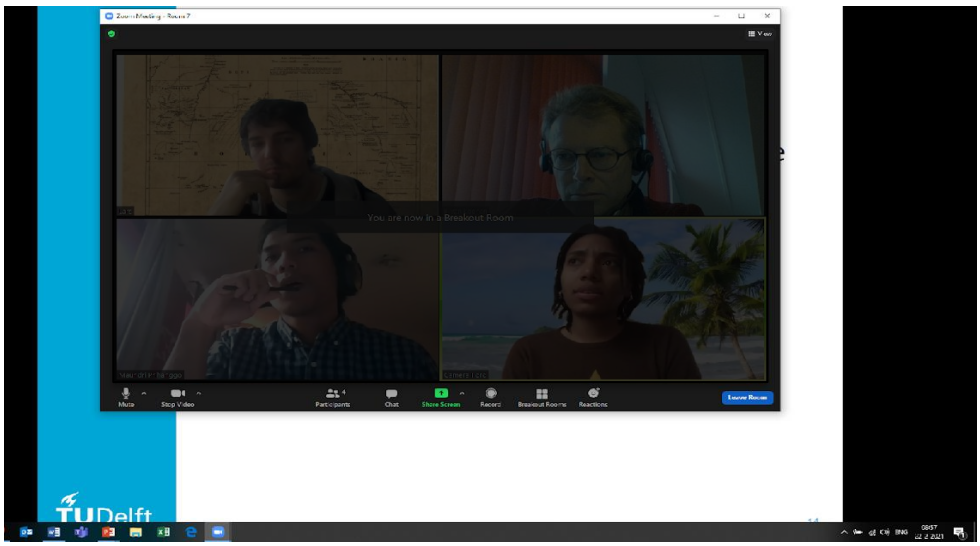

Figure 4.5: teacher joins break out rooms of student (1)

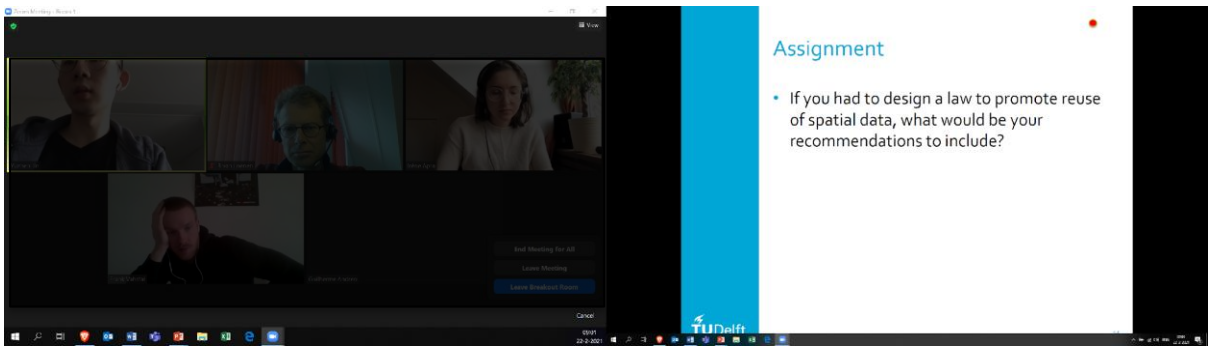

Figure 4.6. teacher joins break out rooms of student (2)

Real-time online polling tools

We also implemented Mentimeter, a real-time online polling tool. The topic was introduced and to link the topic to the student's world, we asked them to answer a question. Using a tool such as Mentimeter, allows for students to respond anonymously, thus lowering the threshold for participating as students are less insecure about failing to give what is perceived to be the 'correct' answer. Their responses were again used to raise an issue or to stimulate discussion on the topic.

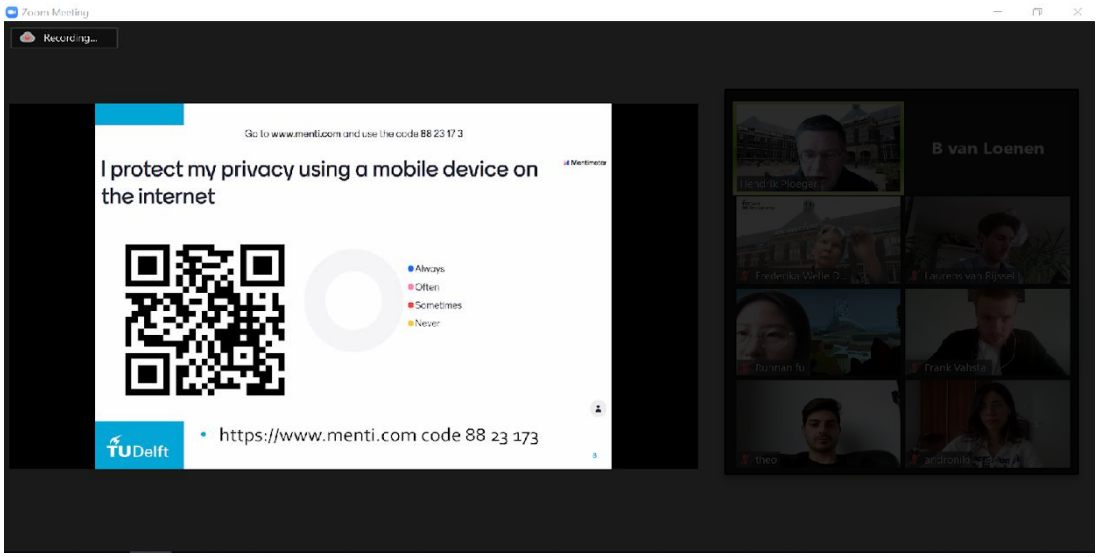

Figure 4.7. online polling tool using QR code

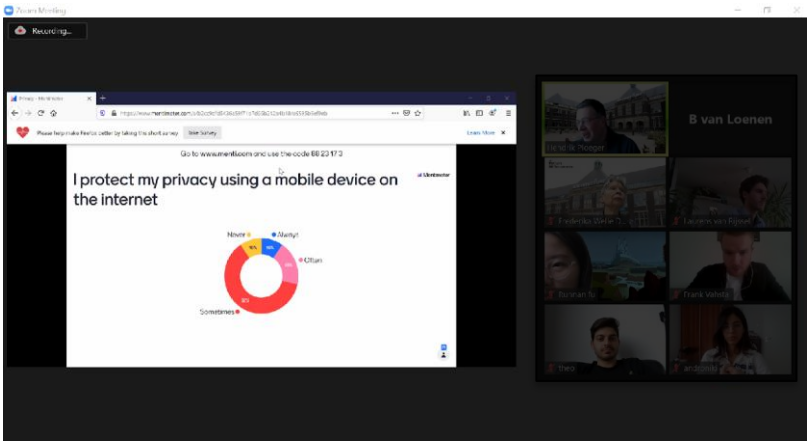

Figure 4.8. the result of the online polling presented

Find X (dataset, parcel of your own house, other)

Finally, to make students aware of the current situation on accessing geo-information, and to have them experience the user friendliness of an SDI, we introduced the exercise find a road network dataset of Germany in the europeandataportal.eu. Most students had significant difficulty with this task since they do not master the German language. Then, the class discussion on INSPIRE and local languages (or lack of a requirement for one common language) started. Interestingly, in the past such a discussion would have been on the price of the dataset, its restrictive licence conditions, or technical qualities not being interoperable. Now, we found that the discussion focussed more on semantics and the need for metadata.

4.6. Students' evaluation of practice 1: active online lecturing

After the lecture series we asked students to review the online teaching methods "show the colour" and the use of "break out rooms" by filling out the survey presented at: https://docs.google.com/forms/d/e/1FAIpQLSftzY4e9e9czakEmNP8Uux3gt6AKSLg4l3FG1-KYL-kHTxrPg/viewform.

Overall, students were quite positive about both the "show the colour" and the use of "break out rooms" (see Table 4.2): most agree (13/18, 72%) or "rather agreed" (5/18, 28%) that the methods stimulate class participation/ activated them to participate.

Table 4.2. student responses on “show the colour” and the use of “break out rooms” methods (total of 18 responses)

Method: colours & break out room	How do you appreciate? [The method stimulated class participation/ activated me to participate]	How do you appreciate? [The method was effective in achieving the learning objectives]	How do you appreciate? [The method was very motivating and entertaining]	How do you appreciate? [I am satisfied with the method, in general]
Agree	13	6	6	8
Rather Agree	5	8	7	6
Fair		4	5	4
Rather disagree				
Disagree				

In their explanations, students confirmed their appreciation for both methods (see Table 4.3):

- “everything is great”,
- “one of the best classes in this master“,
- “it motivates to think”,
- “It gave me the feeling I was back in a classroom (hearing/interacting with classmates”,
- “it is a super nice way to get answers and students involved in thinking about it, and as you just randomly give someone the floor you feel the need to actually have an answer, which motivates me”,
- “the interaction that we have through the course is forcing us to better understand all the concepts and participate more and more”.

Suggestions to improve the online teaching method:

- “The breakout rooms work pretty well, but I sometimes need some time to think for myself first. When the discussion starts right away, I can get a little lost.”
- “Once in a breakout room, it's impossible to see the slide you are supposed to react to.”
- “I don't know much about the topic so don't feel comfortable (/don't see the point) answering without being prepared.”
- “Asking opinions is good and see the stats of answers is interesting! but instead of "showing a colour", it would be better to use a poll where everyone chose independently (you can see the result only when you answered already), and can see the statistics of the answer in the end.”

Improvement for this method would be:

Break out rooms:

- share the question to be discussed prior to the meeting through another platform
- have students first think for themselves before going into the break out room

- do maximum two break out rooms per lecture (one lecture is two times 45 minutes)
- provide the assigned chair of each break out room a clear instruction what is expected regarding the time management
- provide the sheets with the instruction / questions to be discussed on the education platform Brightspace so that the students can look them up, when in the break out room session.

Show the colour:

- have students first think for themselves for a minute before asking them to answer the question
- use polling software instead showing answers anonymously and statistics.

Table 4.3. student explanations on their responses on “show the colour” and the use of “break out rooms” methods

Please explain your answers:	**What would you recommend to keep for next year’s classes?**	**What do you recommend to change for the next year's classes?**
I feel like this is one of the best classes in this masters, including making everyone feel involved and motivated to learn.	everything is great	maybe give the "correct" answer?
It motivates you to think, and allows for discussion.	Yes, the colours.	More things, like live polls are also fun.
Very quick breakout rooms make it easier to communicate with each other and learn quickly about the subject	same style	bigger breakout rooms?
Also good way to activate students, though not as powerful as the colours.	The colours.	Breakout rooms need to be thought out carefully. Polls, like kahoot! very fun. Also colours do well
The multiple choice questions work really good. It still does happen that I get a little lost in the lecture but when I see the multiple choice appear, I try really hard to recover everything I heard.	The showing of a colour in the screen, because it's not an anonymous answer as it is in virtual Classroom	No recommendations
The lecture becomes more engaging and active compared to the traditional passive online lecturing method, which became really dull. Also, it gave me more the feeling I was back in a classroom (hearing/interacting with classmates) and the feeling that I was studying again, which was missing due to working from home/online lectures.	Questions with the coloured answers.	Instead of colours use numbers and have students show number of fingers corresponding to the answers.
The breakout rooms work pretty well, but I sometimes need some time to think for myself first. When the discussion starts right away, I can get a little lost.	The size of the breakout rooms is good.	Maybe a moment to think for myself first.
It's a nice method because you can visually evaluate the opinion throughout the 'classroom'. Also, you really think about the question because anyone can be asked for an opinion through the teacher. I also like it because the teachers really try to engage the students with this and to make it more interactive	In case of online education i would keep this.	Another nice addition could be the extension in zoom to have little quizzes during the call where you have to vote

Often the conversations are lacking motivation from the students.	Nice from time to time. But i would say max. twice per lecture (1 is better)	Maybe have at least 4-5 ppl in a room. Sometimes the given time is also too long and then it gets weird in the breakout room when there is nothing to talk anymore.
Already used same method last year in Q4 WhyFactory studio. I would encourage the use of coloured Zoom virtual backgrounds. Worked very well in there and students don't have to keep a collection of coloured items around.	Keep it	Change to voting by coloured virtual backgrounds instead of physical items.
It definitely increases engagement of students. But breakout rooms as a feature don't work that well. Once in a breakout room, it's impossible to see the slide you are supposed to react to.	Possibly	Maybe there is another platform?
I don't know much about the topic so don't feel comfortable (/don't see the point) answering without being prepared. But, it is interesting to have the information regarding different case studies, and when the answer is not clearly defined but subjective. The videos to watch previously is a good method. Asking opinions is good and see the stats of answers is interesting! but instead of "showing a colour", it would be better to use a poll where everyone chose independently (you can see the result only when you answered already), and can see the statistics of the answer in the end. Also, it allows to still see the question and have an idea of everyone's answer at the same time. (Eg, use google form or Mentimeter?) Regarding breakout rooms: this works well.	see previous answer	see previous answer
teachers asking student is an interactive method to achieve learning's objective	asking student randomly	-
Especially in times of corona, it is a nice method.	interactivity through quizzes	Hopefully, back in the universities.
We usually have a very short time to discuss things, and/or the question is gone upon entering the breakout room, so we must have the screenshot, otherwise it does not work. (sometimes we needed to use a link, and had to type it manually, would be nice if the sheets etc. is already online then so we have the slide and the links.	it is nice for discussion, as this course has a lot of discussion in it, I think it is a good method	regulate better what to do and give sufficient time for the breakout rooms (next to the course, it is also nice to chit chat with other students a bit in this time)
it is a super nice way to get answers and students involved in thinking about it, and as you just randomly give someone the floor you feel the need to actually have an answer, which motivates me.	sometimes give a bit more time, I could not finish reading the text but was already supposed to have an opinion on it.	keep it, just look at how long it takes, or make the answers shorter / simpler
Generally, this method working pretty fine i could say. Although nothing can fully replace the on-site education, the interaction that we have through the course is forcing us to better understand all the concepts and participate more and more.	Everything.	Maybe a bit more interactive questions and open discussion.
Overall, the professors do a good job of keeping us engaged by doing polls, using menti (menti is awesome! use more menti please!) and having breakout rooms for discussion.	The use of physical objects for voting / interacting in class. Dedicating one class per week to case study lecture.	The fact that the teacher always chooses who to call on to answer a question. Sometimes you want to answer but it doesn't feel like you can volunteer. And sometimes you don't know or have a good answer and it is

		unfortunate to be called on when someone else probably has something they would like to say

4.7. Mentors' evaluation of practice 1: active online lecturing

We had a class of 38 students. There were no issues with internet connection experienced, Zoom appeared to be a very stable platform. Creating breakout rooms was very easy. Also, joining and leaving breakout rooms to automatically re-join the main classroom was user-friendly.

One issue that kept coming back was how to use PowerPoint for online lectures. All teachers used the Share Screen option of Zoom to show their presentation in 'Presentation' mode, and used 'Presenter View' mode in their second screen to view their annotations. However, the Zoom overview of participants and the chat box disappear when the share screen mode was chosen. Therefore, we introduced a second teacher in the role of co-host & moderator to monitor the chat and the Zoom classroom. In this way, questions and/or remarks that arose during the presentation could be passed on to the lecturer in a simple and effective way.

It is a tiring activity keeping an eye on both screens, ensuring that the presentation runs smoothly technically, and managing the ongoing administration (creating breakout rooms, responding to interventions (questions), recording the lecture). The presence of a second person/ teaching assistant in the role of moderator and technical back-up is, therefore, necessary, if only to monitor students' non-verbal engagement during classes.

In the online lecture we applied five active teaching elements:

4.7.1. Asking questions to the group, to be answered with coloured items

This was copied from the Dutch TV show "Even tot hier" and worked out well. You will get a nice overview of the variety of answers, students are activated and to use their imagination (have to go look for an item[2]). Not only is it a great starting point for the discussion, it also allows for some humour in the class. It gives the possibility to ask students for an explanation of their choice, or to ask why they did not select one of the given choices ('could not find a green object in a hurry', 'sorry, what do you mean this is purple and not blue?').

[2] Some students prepared well for the second lecture and created coloured backgrounds that could be selected in Zoom, illustrating that Geomatics is a programme of Delft University of ***Technology*** after all.

4.7.2. Asking questions directly to individual students

Based on the answer to the questions on the slide or the quiz, we asked students to explain. Zoom shows the names of the participants of the meeting, which makes it a little more personal than in the classroom ("you with the grey sweater or similar"). In addition, students that turned off their camera will still be asked a question or for their opinion. Some students turn off their camera to save energy or bandwidth. By asking questions to those students, they are still actively engaged in the class.

4.7.3. Breakout rooms for smaller discussions

This was a nice function which was really helpful to create smaller groups. Issue for the teachers was to keep track of the discussions in the smaller groups. The group assignments were between 5-10 minutes which did not give a lot of time to break in and assess the quality of the discussions, students had. In addition, teachers cannot enter a breakout room without being noticed, thus, the online presence of the teacher will always have an effect on the ongoing discussion.

Issues experienced were:

1. how much time should be allowed for an assignment, as you cannot monitor all the groups all of the time.
2. calling attention of the entire group to a certain point raised by one smaller group.
3. when using the breakout rooms that are randomly created by Zoom itself, it is difficult to keep track of which student belonged to which group (with a practical question: which groups have already had their turn in the main meeting).
4. ensure that students sharing one computer are assigned the same breakout room

4.7.4. Real-time online polling tools

Worked out well, but could probably also be achieved with the coloured items.

4.7.5. Find X (dataset, parcel of your own house, other)

Easy to prepare, stimulus for the discussion and allows for students to respond anonymously, thus, lowering the threshold for giving their own opinion. As a teacher, you should allow ample time to the students to respond as there may be time lags due to connectivity issues.

4.8. Practice 2: Student paper and presentation

The task of the students was to write a paper to advise the President of "OpenDatia" on the status of the open SDI and to propose measures to improve the openness. We created 19 groups of 2 students. Each group studied one country of their choice. Pairing students was deliberately chosen because of: 1. As a measure to address the impact of COVID-19 (loneliness of students), 2. To stimulate discussion

on the matter during the writing process, 3. to decrease the time teachers have to spend on paper reviews.

On March 11th (2pm-5pm) students had to present their findings on the openness of the SDI of the country or region assigned to them. They were tasked to prepare a 5-minute presentation addressing the assessment framework applied, the status of the SDI, expected barriers to improve the openness and provide first thoughts on a strategy aimed at the actual implementation of measures to improve the openness.

Due to the size of the group (38 students) and the number of groups (2 students per group), we split them in four sessions: two groups focusing on the European Union SDIs (two groups of five teams for a total of 10 students per session), the other on non-EU SDIs (one group of four teams and one of five teams). Before the meeting, each group had to share their intermediary report with another group. After the presentation of one group, the other group was required to ask two questions on the presentation. Through this form of peer-review, students had to evaluate the SDI situation in another country and the writing style of the other group, thus increasing their knowledge.

After the presentations the groups were distributed over eight groups. In each group a student was assigned as chair and another student as a rapporteur. In separate breakout rooms, the groups discussed the assessment frameworks applied, the open SDI barriers and suggestions for strategies to address the barriers. Their findings were presented plenary by the rapporteur. This was another moment to learn about the open SDI status in other countries, to discuss and compare barriers and possible strategies. In addition, the chair and rapporteur (both randomly assigned) obtained some experience in chairing a group of 5 students and to summarise and report the outcome of the discussion.

4.9. Students' evaluation of practice 2: presentation

In their explanations, students confirmed their appreciation for the presentation method (see Table 4.4). The responses show that the intended active learning objectives were satisfied since for all four categories all students (except one for one category) scores of "Agree" or "Rather Agree" were obtained.

Table 4.4. student responses on “presentation” methods (total of 14 responses)

Method: online presentation and group discussions	How do you appreciate? [The method stimulated class participation/ activated me to participate]	How do you appreciate? [The method was effective in achieving the learning objectives]	How do you appreciate? [The method was very motivating and entertaining]	How do you appreciate? [I am satisfied with the method, in general]
Agree	11	10	8	10
Rather Agree	3	4	5	4
Fair			1	
Rather disagree				
Disagree				

The students appreciated:

- The small group size in both the presentations and the discussions groups
- The strict time limitation for each of the sessions
- The structure of the meeting
- Engagement with other students
- The rapporteur role

Suggestions to improve the online teaching method:

- allow more time for questions, less for presentations. more interaction with teacher
- add a competition element
- start earlier in the day
- provide better guidance to the (student) moderator of the sessions
- better overview of the subgroups made for the presentations and discussions
- not have mandatory online meetings

Table 4.5. detailed student responses on “presentation” methods

Please explain your answers:	What would you recommend to keep for next year’s classes?	What do you recommend to change for the next year's classes?
Smaller class sizes make it better to interact with each other!	Everything!	More time!
To prepare the pre, we also have the opportunity to have a better understand our work. I also learn a lot from Listening others’ pre	Presentation in a small group	I think everything is fine
In general, the course was excellent!	The same evaluation style	More flexible deadlines

Not very entertaining, but that's to be expected. Method does not increase interaction with teacher, but does with students	the entire thing	more time for questions, less for presentations. more interaction with teacher
Had good discussion and had fun.	Strict time limit.	not really.
The presentations were pretty interesting. I had a chance to check the work of others, learn about different countries and share ideas between teams.	Yes	Maybe the timing of this meeting could be different as these 2 weeks are the most intense during this year
This is almost optimal digital learning. So, the same concept in real life would make it 10/10	The structure of the session	Competition element
more involvement, interaction. Gave me the opportunity to work with fellow students during lockdown.	hopefully, next year's class can take place at the faculty, where students can work together in small groups as well. So, yes!	nothing
for the last one: It is definitely a nice addition, but cannot replace a normal lecture. But for the purpose of discussion the results so far I think it was really nice (although a bit long but I guess this is just inherent to it)	I like that the groups were not that big, made it easier to give every person their 'stage'	Start earlier in the day :D
on the faculty it would be hard to have breakout rooms, but the discussion is actually really nice	the small groups. better to get more in depth in fewer countries	perhaps describe better what is expected from a room leader -> time management like 5 min presentation, 5 discussion etc.
The method used allowed us (the students) to engage each other in discussions, which was missing (a lot) with having only online lectures. And specifically for this paper assignment, it gave us more insight in what others were doing, what kind of barriers they encountered and what strategy they came up with, which is helpful with writing our own papers.	Subgroup discussions.	Better overview of the subgroups made for the presentations and discussions.
The Intention for a more active teaching method is very clear. The papers are a very good incentive for us to incorporate and truly digest the given material. However, during the time of the pandemic, active forms of teaching simply do not work in the same way as it would work physically. If you look at forms of successful online education, https://www.skillshare.com/ you see a pattern emerging: on demand: digest at your own pace. Assessment systems clearly make use of the technologies provided by online environments. If you meet, it should be as a sort of help desk, to discuss ideas, and to, let's say debug. Simply digitizing the curriculum is usually not the same as this. Zoom is not the same as a physical classroom, and 'interactive' is not the same physically & digitally. I would therefore suggest to not try interactive forms of educations in this time of the pandemic (Zoom), and instead focus efforts on a streamlined experience for both student & teacher	Papers	Zoom kills the Soul, I highly recommend getting rid of mandatory online meetings
We had to interact with our classmates to understand how they have dealt with the topic at hand. Less number of groups for discussion ensured that I was attentive throughout the presentations and heard everything that people had to say. Discussions after the breakout room were also quite interactive	The meeting rapporteur concept	online mode of education:'(

and we could get to know summary of what other countries were doing instead of listening to each one of them in detail.		
I learnt a lot in the presentation.	The presentation.	The catalogue of course materials is a bit confusing, and it always takes a long time to find the materials I need.

4.10. Mentors' evaluation of practice 2: presentations

Initially we had two groups of nine to ten teams to present. After discussion with the students, we decided to split these groups into two, so four groups creating more time for more discussion. This implied that the two teachers could not attend all presentations, and they had to trust that the students presented to each other without the mentors supervising them. This did really go well. During the presentations, mentors changed between break-out rooms and viewed that in all break out rooms, students were presenting their case study and were asking questions.

In addition, for the discussion in smaller groups, we initially had four groups of ten students. We assessed that this group size as too large, so again, we decided to split the groups into two. The resulting eight groups of five students-sized groups discussed in some depth their findings and most of their reports. The format of only allowed to use 3 PowerPoint slides proved to be right on. We found the presentations were interesting and informative (also for us), and the students (both the presenters as the students asking questions) were really engaged in this activity.

To be improved:

- The role of the moderator was not clearly explained. It should be made clear that the moderator should keep track of the time, ensure that the Q&A runs smoothly and that the rapporteur writes down the conclusions of the group/ have her/him summarise the findings.
- The role of the rapporteur worked very well.
- The discussion in two groups might have been better / in more depth if the first groups were simply split in two groups with all countries of the first group meeting (the presentations) represented in the second round (discussions). Due to a change in the original planning this was now not the case, and as a result some students were assigned a group with new countries. This required a short repetition of the first group meeting before the discussion could really start.

4.11. Practice 3: Debate on open SDI

In the course we taught the concept of open SDI. Students might have understood it as the new way forward in SDI development. Objective of the debate was to have students reflect critically on the concept of open SDI.

The debate centralised around the hypothesis: OpenDatia should go 'all in' for an "OpenSDI4OpenDatia".

The president of OpenDatia asked her four SDI committees for advice: the committee on city member states, the committee on island member states, the committee of federated member states, and the committee on small sized member states. Provided the workload of the course, students did not have to prepare anything for the debate.

We created eight break out rooms for eight groups of four students that were tasked to prepare in 45 minutes a pitch of two minutes either in support of the hypothesis or arguing against it. The remaining students were informed about their role in the debate: as a moderator or rapporteur. The moderator was tasked to strictly manage time, the rapporteur to prepare for the plenary reporting after the debate. After discussion with these students we decided together that both the rapporteur and moderator are also responsible for determining a winner of the debate and to justify their decision.

After the students returned to the main room, they were again assigned a debate break out room where four students in favour and four students against the hypothesis were meeting for an Open SDI battle.

The setup of the battle was as follows:

1. 2 minute pitch of the proponent of Open SDI
2. 2 minute pitch of the opponent of Open SDI
3. 1 minute pitch of another proponent of Open SDI addressing the points raised by the opponent
4. 1 minute pitch of another opponent of Open SDI addressing the points raised by the opponent
5. Open deliberation between moderator and rapporteur on the arguments provided and their preliminary winner.
6. Response by the party not being the preliminary winner.
7. Decision by the moderator and rapporteur.

After the battle all students returned to the main room. Together we welcomed the president of OpenDatia who would have the ultimate say in the future direction of the SDI of OpenDatia. The four rapporteurs reported the outcome of the debate and arguments provided. All groups appeared to be in favour of OpenSDI, and the president followed this advice.

4.12. Students' evaluation of practice 3: Debate on Open SDI

Table 4.6. student responses on "SDI debate" methods (total of 7 responses)

Method: SDI debate online	How do you appreciate? [The method stimulated class participation/ activated me to participate]	How do you appreciate? [The method was effective in achieving the learning objectives]	How do you appreciate? [The method was very motivating and entertaining]	How do you appreciate? [I am satisfied with the method, in general]
Agree	4	2	3	2
Rather Agree	2	4	2	3
Fair		1	2	1
Rather disagree	1			1
Disagree				

Table 4.7. student responses on "SDI debate" methods, detailed responses (total of 7 responses)

Please explain your answers:	What would you recommend to keep for next year's classes?	What do you recommend to change for the next year's classes?
The structure of the debate was in hindsight a bit vague, I was expecting a different format or structure for the actual debate. Also, a short description beforehand would have helped, even though we had some time to prepare, figuring out what to say and that with a different group took quite some time. We could not sum up or come up with all the arguments we would have wanted to.	The setting, by that I mean: debating in small committees, then have rapporteurs reporting to the President and finally the President deciding in favour of or against, was really fun.	Small description of the debate beforehand, or at least with which groups you will be holding this debate would have helped and increase the quality of the debate in my opinion.
Everything was pretty clear and well derived. Although nothing can replace the on-campus lecturing.	Get back to the university for real! Other than that, everything was fine.	Get back to the university for real! Other than that, everything was fine.
the method triggers discussion among students	the debate discussion and everything is cool	nothing

It was very entertaining and probably very much related to the actual procedures. Everyone was participating and we had a fun time.	The structure. Everything was very well arranged, and the whole story with the president and committees was really good and entertaining!	The thing with a debate is that you only have 2 or 3 minutes to speak and there is only one person speaking. Compared to a discussion the participation in that sense might be less.
the use of voting and different class activities and discussion modes (like breakout rooms, in-class exercises) made it interactive and more interesting/livelier than a normal course! Also appreciated the final debate.	the use of physical objects for voting / interacting in class, the fact that one class per week is dedicated to case study lecture	Instead of calling on specific students to answer a question, let people volunteer – sometimes it felt like you could not answer unless called upon

4.13. Mentors' evaluation of practice 3: Debate on Open SDI

The preparation took some proper planning and assessment of how much time is feasible for each step in the implementation of the debate. One teacher prepared the setup, another reviewed.

The debate worked out fine. Students were active in the break out rooms, the debates were running okay, although the focus was merely on open data instead of Open SDI (so open data and open participation). Also, the depth of the discussion was rather limited. But students clearly enjoyed the debate and digested already some of the material that will be reviewed on the final exam.

In a next edition, we may have a similar set up but then with a debate between teachers as the closing session.

5. Blended learning MSc. 'Management in Organisations'

The active teaching practices in this chapter were applied in the MSc. Geo Information Management and Applications (GIMA) course GEO4-GIMA3 'Management in Organisations' (Module 3) (10 ECTS). The GIMA MSc is a blended learning interuniversity course offered by four Dutch universities in cooperation: Delft University of Technology (TUD), Utrecht University (UU), Wageningen University & Research (WUR) and University Twente – ITC (UT-ITC). Utrecht University is the coordinator of the GIMA MSc. The structure of the GIMA blended learning course consists of four contact periods each quarter of two weeks, each at one of the partner universities. During the contact period, two modules are started in three days each, usually with a series of lectures, and two modules are finalised in two days each, e.g. by exams and/or case study presentations. In the following quarter, students study from home or in the GEO Lab provided by UU. BlackBoard is used as a digital education platform. During the covid-19 pandemic, all contact periods were held as online events and students were not allowed to use the Geo Lab at UU as a common study area.

Module 3 'Management in Organisations' is offered by two teachers each of TUD and of WUR. Module 3 kicks off at Wageningen University in the last week of March and is finalised in the last week of June at Delft University. During the quarter, groups of 3-4 students carry out a case study in a real GI-organization to assess and propose improvements to the organization's SDI. Each 2-3 weeks, students have online meetings with their GIMA mentor to discuss their case study progress and to provide feedback. During the covid-19 pandemic, all lectures and teaching activities were held as online events via MS Teams.

5.1. Learning objectives

The intended learning objectives of GIMA Module 3 'Management in Organisations' are formulated as, after this course the student is able to:

- Remember key GI-organizations, their differences, their roles and their scale level of application.
- Understand the principles of management science and management information sciences and apply the organizational resources (Data, Policy, Standards, Technology, Organization/People, Governance) to GI organizations.
- Understand the concepts, processes and main components of spatial data infrastructures and their requirements to support data sharing between GI organizations.
- Apply the main methods and tools for organization (infrastructure) planning, development and management through the application of a SWOT analysis (Strengths, Weaknesses, Opportunities and Threats), and a cost-benefit analysis.
- Evaluate the existing management of GI of an organization.
- Create and present a SDI strategy plan for the management of a GI-organization.

5.2. Preparation for (students and) teacher

Students do not have to study any material prior to the lectures as they also have to prepare for their final exams and/or presentations for two other modules prior to the kick-off of Module 3. During the three contact days, students have to study material made available by the case study organizations, in order to prepare the students for their interview with the case study's contact person, and to prepare for their pitch presentation.

Teachers prepared for the contact days with the following teaching materials / tools:

- Create Case Study folders in Blackboard. These folders contain a Client Assessment sheet, in which each case study organization provides a short description of a problem statement and brief background information. Any other material / web links provided by the case study organisations were also added to these folders.
- Assign all students to a case study group, considering an even distribution of gender and the students' nationalities, whereby an effort is made to assign at least one student per group with a nationality aligned to the case study organization's location.
- Create one main channel and separate channels for each group in the MS Teams platform to allow students to communicate outside the main channel.
- Invite the students to the lectures by sending the links via the MS Teams main channel. This also provides an opportunity to assess whether all students (automatically) enrolled via Blackboard were actually still enrolled in the course.
- Upload presentations of the lectures to Blackboard in advance, so that students can read along if there are technical problems during the lecture.
- Upload a list of recommended literature for the course.

After the lectures, recordings of the online lectures uploaded to Blackboard.

5.3. Learning activities

MS Teams was used as the platform for the online lecture as it is the online teaching platform preferred by Utrecht University. Although Teams has some compatibility issues related to the different versions available per partner university and per role (student, teacher, guest), Teams is integrated with a number of tools that can be used during lectures, such as the use of channels per group or the use of a Whiteboard. Student groups are assigned manually to group channels. Via these channels, students can chat, share documents, etcetera. During the lecture, one teacher is presenting. Students can ask questions in the main chat box or by raising their virtual hand. Another teacher monitors the chat box/ raised hands to interrupt the teaching colleagues if necessary. Alternatively, we invited one student to perform this moderating task.

Activities during the entire course needed to reach the learning objectives are:

1. Participate in the online lecture (during initial contact period)

2. Participate in the online exercises (during initial contact period)
3. Write three essays, in which students have to research and discuss the pros and cons of a given statement in general, and to reflect how their conclusions apply to their case organization (during off-campus period)
4. Carry out an analysis of the current state of the organization's SDI using the SDI components shown in Figure 5.1 into account, and formulate a problem statement (during off-campus period)
5. Carry out a User Needs Analysis to assess the needs of the actual users of an organizational SDI (during off-campus period)
6. Create a change strategy for their case study organization based on the User Needs Analysis to improve the organizational SDI (during off-campus period)
7. Synthesize the analysis of the current state of the organizational SDI, the User Needs Analysis with their proposed change strategy and an extensive Feasibility Study (including a Cost-Benefit Analysis and a SWOT analysis) into a Business Plan (during off-campus period)
8. Present the Business Plan to the class and case study contact persons in an innovative manner without using text-based PowerPoint presentations (during final contact period)

This chapter describes the active teaching activities carried out during the three initial contact days.

5.3.1. Day 1

Introduction to SDIs and their components, using the model in Figure 5.1 as a guide.

1. Online lectures to introduce students the specific components of an SDI, being 'People', 'Standards', 'Access Networks',
2. Exercise European SDIs.

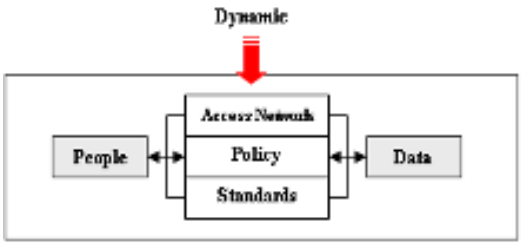

Figure 5.1 SDI components, source: Rajabifard et al. (2002)[3]

[3] Rajabifard, A., Feeney, M.E.F. and Williamson, I.P., 2002. Future Directions for SDI Development, International Journal of Applied Earth Observation and Geoinformation, The Netherlands, ITC, 4(1), pp.11-22.

5.3.2. Day 2

1. Online lectures to introduce students to specific components of the case study methodology, being User Needs Analysis and Change Strategies.
2. Online lecture on SDI Use Case
3. Exercise data dissemination platforms of case study organizations
4. Self-study of student groups to prepare for meeting with case study contact person

5.3.3. Day 3

1. Meeting with the contact person of the case organization to gain a better insight into the problem of the case organization and to draft a preliminary problem statement.
2. Preparation of case study pitch, in which student groups have to pitch the case organization's problem and how the students envisage that this problem can be tackled and on which part of the organization the group will focus. The aim of this pitch is to assess the content and focus of the case rather than to assess the form in which it is presented.
3. Case Study Pitch / Presentations by the student groups. Each pitch is to last no more than five minutes, allowing a ten-minute discussion with all GIMA teachers / mentors to discuss the proposed case content and focus.
4. General discussion of the exercises and the case studies.

5.4. Implementation of activities

5.4.1. Day 1: SDI components

We held seven short lectures of 20 minutes. The first lecture was an introduction to the Module. The next six lectures each described the different components of an SDI (see Figure 5.1), as follows:

a. Introduction to SDIs
b. SDI Policies
c. SDI Standards
d. SDI Access Network
e. SDI Users and organizational structures
f. SDI governance by a guest lecturer

Students did not have to do anything in preparation of these lectures. In the online classroom, we required the students to turn on their cameras but to mute their microphones unless they wanted to ask a question. At the start of the lectures, students were asked whether they had already some experience with SDIs and SDI organizations. The lectures provided the students with an understanding of the six SDI components and how they are applied to organizations. The length of the lectures is a balance between being long enough to disseminate the required knowledge and short enough to retain the attention of the students in an online setting. Although this did not leave much time for active learning activities during the lectures, we implemented a number of activities nonetheless.

To keep the students energized, there was a five-minute break between the lectures, in which students were encouraged to move away from the screen and stretch their legs.

In the online lectures on Day 1, we applied three active teaching elements:

1. Asking questions directly to individual students
2. Online quizzes using Mentimeter
3. Class discussion of presented concepts

Asking questions

Students were encouraged to ask questions during the lectures, preferably directly by switching on their microphone, as the teacher could not see the chat function or raised virtual hands. There was a second teacher present during the lectures to monitor the chat function and raised hands. At the end of each lecture, the teacher would ask if there were any specific questions or which concepts were still unclear. The answers were used as input for class discussions. In addition, students were also asked how they envisaged that the presented concepts could be applied to their specific case study and to bear that in mind in preparation for their meeting with the case study contact person. For instance, consider which access policies are applicable to the case study organization, both from a user's perspective as well as from a supplier's perspective, or which data formats and standards are applicable to this specific organization.

Online quizzes (using Mentimeter)

During the lecture on SDI policies and law, two class quizzes were used, whereby students had to use Mentimeter as a real-time online polling tool. The topic was introduced and posted as an open quiz question. Using an online polling tool allows for students to respond anonymously, thus lowering the threshold for participating as students are less insecure about failing to give what is perceived to be the 'correct' answer. Their responses were again used to raise an issue or to stimulate discussion on the topic. However, due to lack of time and technical hitches, it was not possible to show the students the results of the menti poll. Instead, the teacher read the responses aloud.

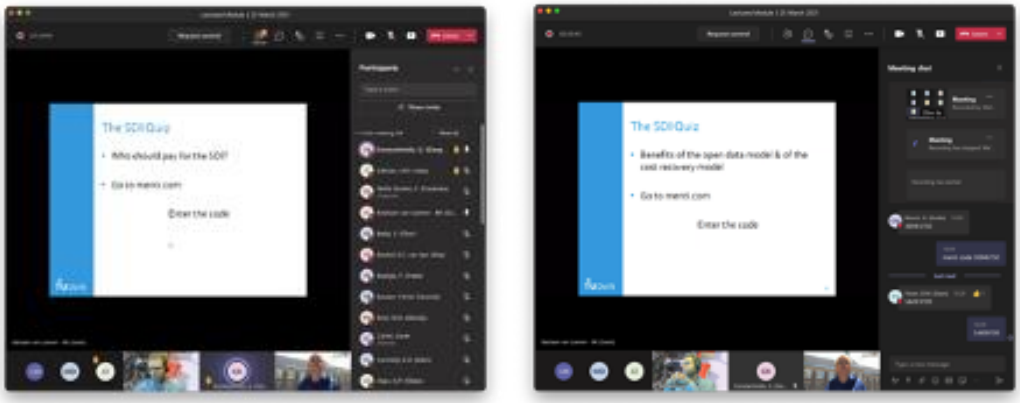

Figure 5.2: Use of Mentimeter for class quizzes.

Class discussion

Each lecture ended with a short summary and questions to the class to stimulate a class discussion on the topic of the lecture.

After the lecture series, we applied two more active teaching elements:

1. Individual exercise: find 1:10,000 topographic dataset in a given European country and answer questions in an online form.
2. Class discussion of the outcomes and challenges faced during the exercise

This was an individual exercise, in which students had one hour to search for 1:10,000 data in a specific European country. Students had to answer questions in an online form. Students were assigned to a country of which they were not expected to master the native language of that country. The aim of this exercise was for students to assess:

- how easy it is to find the dataset (findability) and through which portal / search engine they could find the dataset,
- in which languages the dataset and the metadata were available,
- whether the dataset was accessible and if so, through which type of web services,
- whether the dataset was available for free or subject to fees, and if so, the level of the fees,
- whether there are any restrictions to use restrictions,
- whether the dataset was usable, i.e. which format, machine-processable, adhering to international standards,
- how often the dataset was accessed per year (web statistics of the dataset available?)
- how often the data portal was accessed (web statistics of the portal available?)
- whether there are any studies / reports available to show the socio-benefits of (open) spatial data.

To find the data, students were advised to use the following sources:

1. general search engine: www.startpage.com
2. http://europeandataportal.eu
3. http://inspire-geoportal.ec.europa.eu/
4. http://www.sdiassessment.org/ for national geodata portals
5. directly at the source: e.g., national mapping agency

After one hour, students had to return to the main channel of Teams to share their outcomes and their experiences as an SDI user. Especially the fact that many of the data portals were only available in the native language posed a challenge to the students. The governance structure of a country also caused some confusion, e.g. in federated countries not all national data portals harvest data of the states / provinces.

5.4.2. Day 2: Case Study methodology components

Day two of the contact period focused on specific components of the students' case study. Two online lectures of ca. 75-minutes each were held in the morning focusing on User Needs Analysis and Change Strategies. In addition, a lecture was held presenting Capacity for Copernicus REDD+ and Forest Monitoring Services as an SDI Use Case. In this lecture, technical, organizational and infrastructural elements of the proposed service component were presented and discussed.

In the online lectures on Day 2, we applied six active teaching elements:

1. Asking questions directly to individual students
2. Online group exercise to design a persona as typical SDI user
3. 1-minute summary
4. Class discussion on barriers to change
5. Online polling with Mentimeter
6. Class discussion of presented concepts

Asking questions

Students were encouraged to ask questions during the lectures, preferably directly by switching on their microphone, as the teacher could not see the chat function or raised virtual hands. There was a second teacher present during the lectures to monitor the chat function and raised hands. At the end of each lecture, the teacher would ask if there were any specific questions or which concepts were still unclear. The answers were used as input for class discussions.

Exercise to design a persona as typical SDI user

During the User Needs Analysis lecture, students were asked to design a persona as a typical user of a local government SDI. Students were randomly assigned to breakout rooms to discuss the type of user and reasons for accessing a local government SDI they would consider, as well as some demographic

attributes, e.g. level of education and level of GI-knowledge. After about five minutes, the breakout rooms were closed by the teacher and students returned to the main channel. In the following discussion, it emerged that the students had either already taken their case study organization into account as a persona, or chose to use themselves as a persona.

We used the Teams breakout rooms function to stimulate discussions in smaller groups. As our version of MS Teams did not allow instantly and randomly created groups, we had to allocate students to breakout rooms manually. Before the groups were assigned to breakout rooms the question to be discussed was provided in the chat function of the main channel and briefly explained.

The teachers could join and leave a breakout room at any time to monitor the discussions of the students and their level of engagement, and to intervene if considered to be necessary.

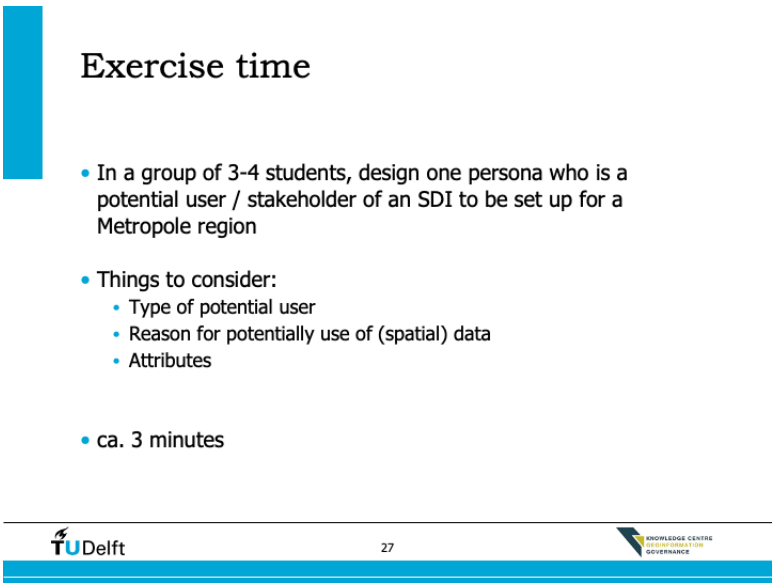

Figure 5.3 Introduction to exercise on design of SDI personas

1-Minute Summary

At the start of the lecture, students were also asked to take notes during the lecture in order to summarize what they considered to be the main message of the lecture. At the end of the lecture, students had to jot down their musings on the Whiteboard function of MS Teams. Using the Whiteboard function makes the 1-minute summary more dynamic than just reading their summaries aloud. The whiteboard formed the basis for a class discussion on the challenges of User Needs Analyses in practice and tips for the students for their User Needs analysis as backbone of their case study.

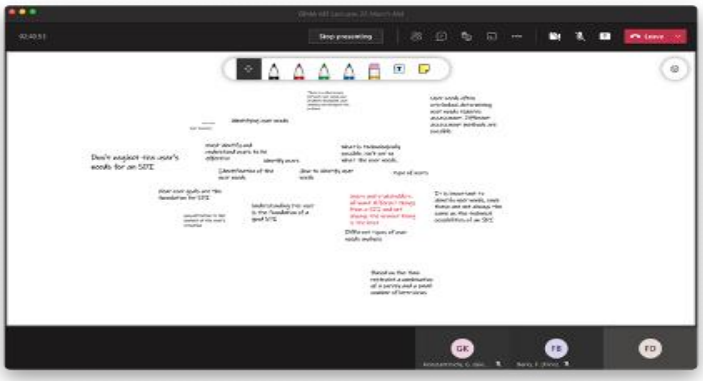

Figure 5.4: Use of Whiteboard function of MS Teams

Class discussion on barriers to changes

During the lecture, students were asked to think and reflect on potential barriers to change. Students were given some hints, such as mentioning misunderstanding or lack of trust. In the following class discussion, not only were reasons to resist changes discussed but also measures that could be taken to counteract such resistance. Again, part of the discussion aimed at how proposed changes could be best communicated within the case study organization to maximise acceptance.

Figure 5.5: Introduction to discussion on barriers to changes

After the lecture series, we applied two more active teaching elements:

1. Group exercise: explore how your case study organization shares its datasets via the national SDI.
2. Class discussion of the outcomes and challenges faced by the students

The student groups were given one hour to explore the website and study the information about their case study organization provided via BlackBoard. Student groups had to find information on how the data from the organization can be obtained. For the Dutch SDI, governmental (meta)datasets are harvested and published via a catalogue service: www.nationaalgeoregister.nl. The case organizations can potentially share their data via this web service. Student groups had to try out different search options to find datasets originating from their case organization. Alternatively, they could use www.pdok.nl (Dutch SDI map viewing and web mapping services) or data.overheid.nl (government open data catalogue service). Students could also try other options to search for any datasets which might be published by their case organization (Google, Organization website, ArcGIS online content, etcetera). The websites of the Dutch SDI web services are in Dutch only. Therefore, when the groups were formed, we ensured that per group, there was at least one Dutch native speaker.

Students had to provide feedback on the following questions:

1. What datasets does your case organization provide?
2. Which datasets from your case organization could you find in the National SDIs?
3. How easy/difficult was it to locate the datasets?
4. What information about access and use restrictions can you find in the metadata?
5. Is it possible to download the datasets?
6. Could you describe the process of data discovery and obtaining in main steps?
7. Which step was the most difficult? Explain the problem.
8. Propose the solution to that problem.

The groups were assigned to breakout rooms and could use their group channel in MS Teams to carry out the exercise. After one hour, the teacher closed the breakout rooms and returned the students to the main channel. Although teachers could join and leave a breakout room at any time to monitor the discussions of the students, in practice there was no need for this as we could monitor the level of engagement via the chat function of the group channels. This allowed the groups to interact more freely.

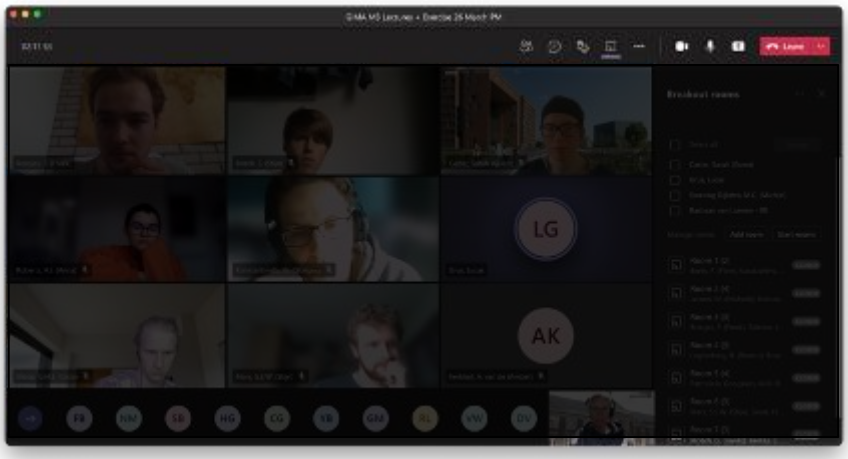

Figure 5.6: In MS Teams, breakout rooms are created on the fly and students assigned manually.

Class discussion of found results

The results of the exercise were discussed in class using the main channel. Based on the results of the exercise, students also had to prepare questions for the meeting with their case study organization's contact person. These questions were prepared during the self-study session at the end of Day 2.

5.4.3. Day 3: Case Study preparation and pitches

All but one group of students used the morning of Day 3 for an online meeting with their case organization's contact person. The group that was assigned to a US-based organization had held their meeting at the end of Day 2 to allow for the time differences. Teachers were not involved in this activity.

The students presented a case study pitch in the afternoon of Day 3. In the pitch, students had to provide a quick and dirty overview of the case organization, the perceived problems with the organization's SDI and the proposed focus of the case study. The pitch should be no longer than five minutes, allowing a ten-minute discussion with all GIMA teachers to discuss the proposed case content and focus, and to provide advice to each specific group. The aim of the pitches was to focus on content rather than on the way it was presented. The session was completed with general tips, including the tip that student groups carrying out similar case studies (either similar organizations or similar problems) should share their work and exchange experiences rather than work as individual groups in isolation.

Figure 5.7: examples of student pitch and ensuing discussion with mentors

5.5. Evaluation

In general, students appreciated the active learning activities as a way to stimulate participation in an online environment. Students were less positive whether the used methods were effective in achieving the learning objectives. Almost half of the students indicated that they found the employed methods motivating and entertaining. In general, more students were satisfied with the employed methods than dissatisfied. None of the students disagreed with the statements. Below, a summary of the students' evaluation is presented.

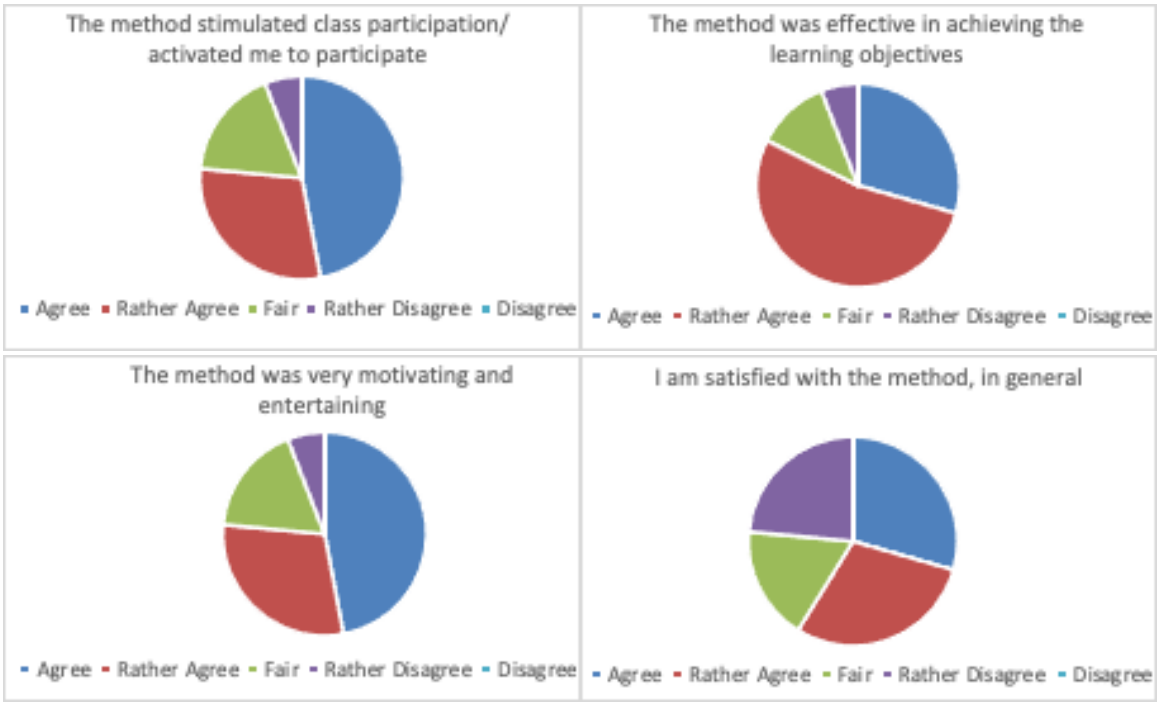

Figure 5.8: Summary of students' evaluation of Module 3 active learning activities

5.5.1. Students' evaluation of activity 1: online lectures using Mentimeter

After the lecture series we asked students to review the online teaching methods "online sprint lectures using Mentimeter", the use of "break out rooms" and the use of the "whiteboard" by filling out the survey presented at: https://docs.google.com/forms/d/e/1FAIpQLSftzY4e9e9czakEmNP8Uux3gt6AKSLg4l3FG1-KYL-kHTxrPg/viewform.

Only 6 out of 26 students filled in the survey for the first activity. Overall, students were fairly positive about both using Mentimeter as a form of interaction between students and the teacher. In their feedback, students confirmed their apprehension of the method of sprint lecture sessions by mentioning the lack of interactivity during lectures, and the fact that the results of the Mentimeter polling was not shown on-screen. In addition, the students indicated that seven lectures in such a brief time was probably too tiring. Especially as due to the closing class discussions, some of the lectures were longer than the intended 20 minutes.

Some of the comments provided by the students:

> *"I think using Mentimeter can contribute but it is always difficult to really start discussing a topic. It might be good to provide more structure (say you want to discuss the answers we give afterwards) so people can already think about the topic. Also, the more difficult the questions*

the more time it takes people to respond. I think it is very important to make students feel like their ideas and opinions are welcome, and there is no 'wrong'."

"I liked the menti, I think it's a good interaction method. Would've liked to see the actual results though, instead of listening to the teacher mentioning it."

Suggestions to improve the online teaching method were to keep the structure of the lecture simple with more interactivity, such as the use of online polling tools. In addition, students preferred to see more practical examples during the lectures. Students suggest that other forms of interactive extensions within Teams could be explored. In general though, students admit that in the current setting of blended learning with limited face-to-face time, it is difficult to actively engage students in an online environment.

"I think the menti is a good beginning to make classes interactive but it's not quite there yet. I think a more game or quizlike approach would be more successful"

"try to find a more 'simple' format, maybe something that is an extension of Teams or share one link at the start of the lecture."

5.5.2. Students' evaluation of activity 2: use of breakout rooms during lectures

For this activity, more responses were received: 11 out of 27 filled in the questionnaire. Students were more positive about the use of breakout rooms as an active learning tool. They appreciated the fact that they could work on exercises in a group and interact with other students. The group exercises as part of the lectures are seen as a positive way to practice what had just been explained.

"I think the breakout rooms are pretty great, especially because you get moved to those rooms automatically and back automatically as well. It is great to interact with your peers, as we don't get to do it that much with online lectures in general."

"I think it was good that you needed to implement what you just heard in the lecture"

Suggestions to improve the use of breakout rooms during lectures it was indicated that the sessions should probably be longer than the planned 5 minutes. In addition, students indicated that they preferred more group exercises using breakout rooms, provided the tasks at hand are clearly explained.

"It was a nice method to use and really stimulates interaction. I am not really sure if it met the learning objectives in my case. The assignment was rather vague and it only lasted 5 minutes."

"Make sure that the assignment is clear and requires input from all students in the breakout room. Also make sure that the assignment really feels like you're doing something relevant. The assignment in my case did not feel really necessary."

5.5.3. Students' evaluation of activity 3: Use of Whiteboard

Many of the students who filled in the survey used one entry to evaluate both the use of breakout rooms as well as the use of Whiteboard as an interactive tool. Again, as with the breakout rooms, students were more positive about the use of Whiteboard as an interactive learning tool. They appreciated the fact that the Whiteboard could be used as a tool to brainstorm ideas. Even though not all students felt motivated to participate, they enjoyed watching other students going with the flow. One student really appreciated that we used a MS Teams extension rather than an external tool, as the time between switching screens is much shorter. Use of the whiteboard was seen as a positive way to stimulate a class discussion.

"It was a nice addition to the lecture and something different from what we always do. It is a good method to use sometimes, since online lectures can be hard to follow for students as they cannot focus as good as when you are really in class. However, i personally did not feel very motivated to participate, but i liked seeing the other students interact with the teacher."

"I like the idea, for a brainstorm session for example. But it is not useful if there is no time to see all the input of students and to get an overview of the whiteboard."

There were no real suggestions from the students to improve the use of whiteboard during lectures. For many students, it was one of the first times they used this tool. Some students indicated that the whiteboard sessions should probably be longer in future and students should get more instructions to obtain the complete overview.

"It is nice to use the whiteboard just a few times, but be aware not to overuse it as students will lose interest in it and probably will not participate."

"For the use of class brainstorm sessions, but more time to look at the results and to speak about it."

5.5.4. Teachers' evaluation of activity 1: online lectures

We had a class of 27 students. There were no issues with internet connection experienced, MS Teams appeared to be a very stable platform. Creating breakout rooms was very easy for the host of the meeting, but we could not automatically assign students to breakout rooms, only manually. For the teachers, it was one of the first times they used the breakout rooms function in Teams. Once students were assigned, it was easy to have the students joining and leaving breakout rooms to automatically re-join the main classroom.

One issue that kept coming back was how to use PowerPoint for online lectures. All teachers used the 'Share Screen' option of Teams to show their presentation in 'Presentation' mode, and used 'Presenter View' mode in their second screen to view their annotations. However, the Teams overview of participants and the chat box disappear when the share screen mode was chosen. This means that the teacher cannot monitor students' raised hands or non-verbal engagement. Therefore, we had a second teacher present during the sessions in the role of moderator to monitor the chat and raised hands in the Teams classroom. In this way, questions and/or remarks that arose during the presentation could be passed on to the teacher in a simple and effective way.

Another issue with Teams is that the participating universities – we were with two teachers from TU Delft and three from Wageningen University – have different licences for Teams and different in-built functionality. As all students have email addresses ending in @students.uu.nl, it is easier for teachers to use their staff @uu.nl account to create the Teams meeting, invite the students to the meetings and add them to the group channel rather than using their institutional email account. However, this implies that other teachers either must have an @uu.nl account to enter the meeting as otherwise they can only enter the meeting as 'guest', even though their role is upgraded by the host. Where in Zoom, co-hosts can take over the meeting, in Teams only the original host can manage the meeting. It was, for instance, not possible for the teachers from Wageningen University to create breakout rooms or initiate the Whiteboard function. This may partially be caused by a lack of experience with using Teams, as TU Delft uses Zoom for their own courses. The breakout rooms and the whiteboard functionality had only recently been added to the Teams version used by TU Delft. However, not all built-in apps of Teams are available or accessible by all teachers depending on their institute's Teams licence or whether they had entered the meeting using their institutional email address or their UU email address. For instance, sharing documents via the built-in OneDrive app was not possible. This meant that any documents used during the teaching activities had to be shared via BlackBoard.

In the online lecture, we applied five active teaching elements, as below.

Asking questions directly to individual students

Based on the answer to the questions on the slide or the quiz, we asked students to explain. During MS Teams sessions, the names of the participants are visible, which makes it a little more personal than in the classroom ("you with the grey sweater or similar"). In addition, students that turned off their camera were still asked a question or for their opinion. Some students turn off their camera to save energy or bandwidth. By asking questions to those students, they are still actively engaged in the class.

Breakout rooms for smaller exercises (create a persona as SDI user) and discussions

This was a nice function which was really helpful to create smaller groups. An issue for the teachers was to keep track of the discussions in the smaller groups. The group exercises were between 5-10 minutes which did not give a lot of time to break in and assess the quality of the discussions students had and whether all students participate equally. In addition, teachers cannot enter a breakout room without being noticed, thus, the online presence of the teacher will always have an effect on the ongoing discussion. Monitoring the chat conversations in the chat function of the group channels was a nice proxy. Issues experienced were:

1. how much time should be allowed for an exercise, as you cannot monitor all the groups all of the time.
2. how to call attention of the entire group to a certain point raised by one smaller group.
3. ensure that students sharing one computer are assigned the same breakout room

1-minute summary using Whiteboard

This was a new way of allowing students to present their short summary of the main message of the lecture. For the teacher it proved to be more effective than using Mentimeter, as the response time for students is much shorter (no lag) and students have an opportunity to add a second post on the Whiteboard. Not only was this a new functionality for the teachers but also students were not very familiar with this function. When both teachers and students become more experienced, the whiteboard can be used as a very efficient and effective tool for brainstorming and as an input for class discussions. It may be advisable to already insert some samples to kick-start the session. Participants need clear instructions how to move the around on the whiteboard to get a better overview.

Student pitches of case study organization

This is the first step towards the problem-based learning activity that will be the main focus of the course. For the teachers it is an evaluation moment to see if the students are able to formulate a problem statement for their case study. Although we stress that students have to present their pitch quick & dirty, taking no longer than 5 minutes at most, most student groups actually take longer. This means that teachers have less time for feedback. A way to solve this, is to assign a timekeeper, either one of the students of another group or one of the teachers. The timekeeper keeps track of the remaining time, gives a one-minute warning and students have to stop after exactly five minutes.

Real-time online polling tools

Worked out well, but could probably also be achieved using a built-in functionality of Teams, e.g. Forms. It takes time to stop sharing the presentation, share the Mentimeter results, then stop sharing

Mentimeter and re-share original presentation. Another disadvantage of using external tools is that there is a lag between the answers submitted by the students. Especially when students have a weaker internet connection, their answers may only become visible when the discussion is almost over.

Longer exercises using breakout rooms: Find X (1:10,000 topographic dataset, data of case organization)

Easy to prepare, stimulus for the discussion and allows for students to spend more time on applying theory into practice. Using an online survey for their answers means that students respond anonymously, thus, lowering the threshold for giving their own opinion. As a teacher, you should ensure that the instructions are clear. In addition, the teacher should post the instructions in a central (external) platform, so that students can refer to these during the exercise while they are in a breakout room. Alternatively, you can ask students to make a screenshot of the instructions, and copy these to their own channel.

6. Assessment of an existing SDI geoportals

This active teaching practice addresses the assessment of an existing SDI. The practice is developed and implemented by the University of Zagreb in the context of the course 'Geoinformation Infrastructure' (5 ECTS), which is included in the University of Zagreb's Master of Science in Geodesy and Geoinformatics degree. The teaching activity consists of a preparatory reading prior to group discussion and optional follow-up activity. The optional activities involve group work on SDI geoportals assessment, peer review of chosen indicators and final evaluation.

6.1. Learning outcomes

After the teaching practice, the students will be able to:

- Understand concepts of an SDI Geoportal
- Learn about INSPIRE themes, search and use data available via Geoportals
- Learn and apply SMART assessment indicators
- Analyse datasets, assess specific SDI element

6.2. Requirements and teaching materials

The following requirements and teaching materials are required:

- Students need to have QGIS installed on your computer. QGIS is a free and open-source geographic information system, it can be downloaded from this link: http://qgis.org. QGIS will be used to model and assess the geospatial datasets available via OGC web services. The QGIS manual can be found on the website.
- Students need to read about a few local, national and regional geoportals (see Table 6.1) prior to the class. Try out their functionalities, check the data sources and Institutions:

Table 6.1: national and regional geoportals

Country/Region	Geoportal website
European Open Data Portal	https://www.europeandataportal.eu/
Croatian Open Data Portal	https://data.gov.hr/
EU INSPIRE	https://inspire-geoportal.ec.europa.eu
Croatia	https://geoportal.nipp.hr/
Albania	https://geoportal.asig.gov.al/
Austria	https://www.inspire.gv.at/

Belgium	https://geo.be/
Bulgaria	http://bsdi.asde-bg.org/
Cyprus	http://www.geoportal.gov.cy
Montenegro	https://www.geoportal.co.me/
Czech Republic	https://geoportal.gov.cz
Denmark	https://geodata-info.dk
Estonia	https://inspire.maaamet.ee
Finland	kartta.paikkatietoikkuna.fi
France	https://www.geoportail.gouv.fr/
Greece	http://geodata.gov.gr/en
Ireland	https://inspire.gehive.ie
Iceland	https://gatt.lmi.is
Italy	http://www.pcn.minambiente.it/
Latvia	https://geolatvija.lv/
Liechtenstein	http://geodaten.llv.li/
Lithuania	https://www.geoportal.lt/geoportal/
Luxembourg	www.geoportail.lu
Hungary	https://inspire.gov.hu/
Malta	https://msdi.data.gov.mt/
Netherlands	https://www.pdok.nl/
Norway	https://www.geonorge.no/
Germany	http://www.geoportal.de/
Poland	https://www.geoportal.gov.pl
Portugal	https://snig.dgterritorio.pt
The Republic of North Macedonia	http://www.katastar.gov.mk/
Romania	http://geoportal.gov.ro/Geoportal_INIS/
Slovakia	https://www.geoportal.sk/en/inspire/
Slovenia	http://www.geoportal.gov.si/eng/

Serbia	https://www.geosrbija.rs/
Spain	http://www.idee.es
Sweden	http://www.geodata.se
Switzerland	https://www.geo.admin.ch/
United Kingdom	https://www.gov.uk/defra/
Australia & New Zealand	https://www.anzlic.gov.au/
Canada	https://www.nrcan.gc.ca/earth-sciences/geomatics/canadas-spatial-data-infrastructure/10783
USA	https://www.fgdc.gov/

- Students need to read about INSPIRE (https://inspire.ec.europa.eu/about-inspire/563), INSPIRE themes and datasets (https://inspire.ec.europa.eu/Themes/Data-Specifications/2892).
- Students needs to install QGIS and try to load a few OGC web service datasets – WMS, WFS (https://docs.qgis.org/3.16/en/docs/). You can use a list of Croatian NSDI services from SGA Geoportal: https://geoportal.nipp.hr/geonetwork/srv/hrv/catalog.search#/search?resultType=details&sortBy=relevance&from=1&to=20
- The data used in this exercise is accessible via OGC web services. All other materials needed are located on the course's Moodle webpage.
- It is compulsory to write and upload to the course Moodle page a written report. It is enough that only one member of the group uploads the report.

6.3. Learning activities

The teaching practice consists of the following learning activities:

1. **Class discussion** on why exactly SDI portals should be assessed
2. **Group assignment**: students are divided into smaller groups and asked to study INSPIRE themes and NSDI portal's datasets. Students are asked to decide on themes for which they will make an assessment taking into consideration different aspects (high-value datasets, etc.)
3. **Group work**: following SMART criteria, students should come up with a few indicators which will give insight into what they want to know about the relevant dataset (e.g. completeness, overall quality, maintenance, metadata ,…).
4. **Peer review**: before presenting their indicators to other colleagues, each group must develop grading scale for each assessment indicator
5. **Evaluation**: based on previous steps, students are asked to perform the assessment and make conclusions on the results

6.4. Implementation

This exercise consists of five main activities. It is highly recommended that these activities are implemented in the suggested order.

The workflow is as follows:

1. Class discussion on the purpose of the geoportal assessment. Prior to discussion, students must read about INSPIRE directive and themes and visit a few national, local and regional geoportal websites (steps 1 and 2, Chapter Requirements).
2. Students must choose a group by using Moodle Group choice activity to divide them into smaller groups (3-4 students). Each group decides on themes and assessment taking into consideration different aspects (high-value datasets, etc.).
3. Group work:
    a. Choose which geoportal level will be analysed – global, regional, national or local
    b. Choose the assessment perspective: user (professional, citizen, …), cost, …
    c. Find applicable framework and adapt it to your needs
    d. Develop the grading scale.
4. Students present the chosen framework, indicators and grading to other colleagues.
5. Students perform the assessment and evaluate the results.

6.4.1. Class discussion on the purpose of geoportal assessment

Discussion on the purpose of the geoportal assessment. The discussion is preceded by a short introductory lecture on the topics which students had to read prior to discussion. Students are asked to decide on themes for which they will make an assessment taking into consideration different aspects (high-value datasets, etc.).

Note: Chosen themes are common to all groups.

6.4.2. Forming a student groups

Students must choose a group using Moodle Group choice activity to divide them into smaller groups (3-4 students). Each group decides on themes and assessment taking into consideration different aspects (high-value datasets, etc.). The groups that agreed on the same level of geoportal assessment, must choose the same regions, countries and cities which geoportals need to be analysed.

Note: Choose 5 or 6 geoportals to be assessed. Agree with other groups to the same extent to get comparable results.

6.4.3. Group work - studying and choosing an indicators

Within each group, students independently assign tasks. Considering the chosen level and perspective, determine the appropriate assessment framework. Study the existing indicators, and use or adapt the assessment indicators.

Write a detailed report: explain selection of level and perspective. Explain the choice of assessment framework and valuation ranges. Choose a few indicators which will give insight in what they want to know about the relevant dataset (e.g. completeness, overall quality, maintenance, metadata ,…) and develop grading scale.

Note: Here you can find some SDI assessment framework and key performance indicators related articles (from different perspectives and levels):

- van Loenen, B., Crompvoets, J., Poplin, A.: Assessing geoportals from a user perspective
- Zwirowicz-Rutkowska, A.: A multi-criteria method for assessment of spatial data infrastructure effectiveness
- Medolińska, K., Gołębiowska, I., Karsznia, I.: Local GIS: development and assessment of the geoportal for local governments and local communities. Case study of a small town in Poland
- Badawya, M., El-Aziz, A. A., Idress, A. M., Hefny, H, Hossam, S.: A survey on exploring key performance indicators

6.4.4. Peer review: presentation of indicators and the grading scale

Each group presents their indicators and grading scale. The presentation is reviewed by other students.

6.4.5. Assessment

Based on previous steps, students are asked to perform the assessment and make conclusions on the results. Upload the final report to the course page, one per group.

6.5. Evaluation

6.5.1. Evaluation by students

Sixteen students were invited to evaluate the exercise by responding to the questionnaire survey designed for the lab works. The survey was open for ten days and one reminder to participate was sent at the end of the first week. Fourteen students participated in the survey and evaluated the lab work. The following charts show a summary of the survey responses.

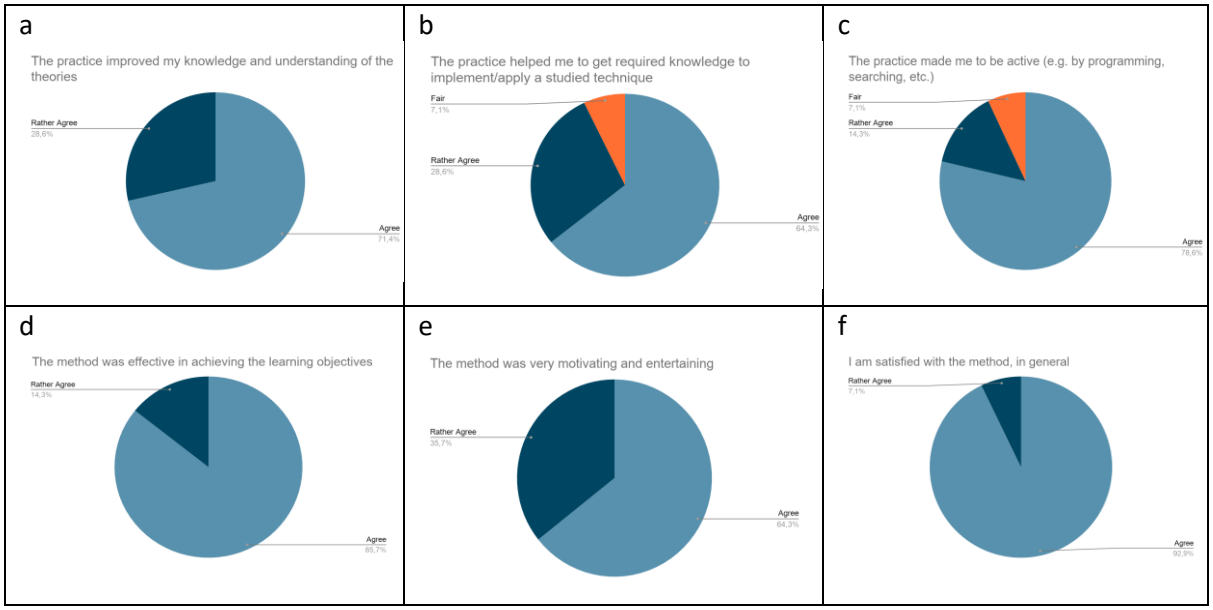

Figure 6.1.Summary of the evaluation of the lab work by students

Almost all students are satisfied with the method (Figure 6.1.f) and most of them believe that the lab work has improved their knowledge and understanding of the theories (Figure 6.1.a). Majority of students agree that the practice made them active and that it was effective in achieving learning objectives.

Students appreciated the team work and think it made them more active:

> *"I really enjoyed working with all of my colleagues, learned to appreciate other people's opinions and the importance of teamwork. We had small assignments every week and it wasn't tiring."*

> *"The practice gave us another view on sites we usually visit and don't actually appreciate. We were supposed to do the research on our own, which surely made us more interested in the practice and that made the method more effective. Also, each group presented their results and that way we all heard about what others have learned. Since we were working in groups, I learned more than I would have just by working on my own. Also, I was in a group of 4, so all of us had to put effort in order to do the practice right. It was very entertaining, it made us more invested in what we would have otherwise learnt studying from books. Overall, I am very satisfied."*

> *"First of all, I am glad that we were able to form groups on our own and work with colleagues with whom we get along well. With well-organized group work, we researched and evaluated various geoportals of other countries that we would probably never even look at. I find this way of learning very fun, interesting and useful."*

The students' recommendations for which part of activity to be kept in the future were focused on motivation and entertainment level:

> *"I would recommend more practice in general and more entertaining methods."*
>
> *"Motivation, entertainment level"*
>
> *"Freedom of group formation and a research approach."*
>
> *"To keep up with this kind of method."*

In general, students were satisfied with the activity. Majority of them did not recommend any changes while some had suggestions for the improvements: they indicated problems related to overlapping of topics with topics of similar courses at our master programme. Others noticed some lacking in the structure of the activity (the activity was held online and there were some slight changes due to that):

> *"Nothing, everything is great."*
>
> *"While the Lab activities are great, they are lacking in structure, probably as it is a new method. A bit more organization won't hurt it in the long run."*
>
> *"I don't think anything needs to be changed."*
>
> *"I think everything is very well prepared and organised. There is no need for change. "*
>
> *"Maybe a little better explanation about the process at the beginning would help, or maybe it would be useful to see some previous works on similar subjects. It would be helpful for making a higher quality project."*

6.5.2. Evaluation by teachers

The evaluation by teachers was made by teachers involved and after the activity was performed and questionnaire responses collected. In this section, the potential weaknesses and challenges that arose while implementing the practice were discussed.

Some of the identified challenges arise from the fact that some of the students did not read the proposed articles (the requirement for the first task) and were not able to participate actively in the discussion. It is necessary to do introductory lectures before the assignment and instruct students in details to make sure they will go through all the prerequisites and be able to participate actively in all parts of the activity.

From the provided questionnaire responses, we believe that the exercise was designed properly and helped students to gain insight into the geoportals content and tools available as well as the possibilities of their evaluation using various frameworks. The application of various valuation frameworks at different levels made it possible to compare the differences between different approaches. We can assume that the students found the activity interesting and useful. Only a few

students have suggested that the activity should improve the overall entertainment level, but it can be assumed that this issue is more related to the topic than to the active performance of the activity.

7. Problem-Based Learning of SDI Practice

This active teaching practice addresses the hands-on development and use of SDI services in the context of a concrete real-world problem. The practice has been developed and carried at Aalborg University Copenhagen (AAU CPH), where SPIDER team member Carsten Keßler has taught this course for 5 years before joining Bochum University of Applied Sciences. Moreover, AAU CPH is also represented by Prof. Henning Sten Hansen on the Advisory Board. As such, the team has decided to include this practice in the report as it adds to the breadth of the presented spectrum. Problem-Based Learning is a core principle across all educations at AAU and made the university internationally recognized for this strong focus. UNESCO has placed its only Professorial Chair in PBL at AAU.

The practice is based on a 20 ECTS workload and designed to be taken together with two other 5 ECTS courses to form a full semester of teaching during the first semester of a Master's education.

7.1. Learning Outcomes

The focus of the project module can be either on Surveying, Geoinformatics or Land Management – one of the three specialisations of the corresponding study program. In any case, the projects all involve SDIs at some degree, with the largest focus in projects in the Geoinformatics specialisation. The remainder of this chapter will focus on projects from that specialisation; however, the following learning outcomes from the semester description are phrased in a generic fashion to suit all three specialisations, and to give the students a large degree of freedom when it comes to choosing their project theme.

Students who complete the project module must:

Knowledge:

- be knowledgeable about technologies and theories/methods relevant within Surveying, Geoinformatics or Land Management
- be knowledgeable about the fundamental principles of Problem Based Learning (PBL) as implemented in the Aalborg PBL model (*)

Skills:

- master theories/methods related to Surveying, Geoinformatics or Land Management.
- be able to evaluate theories/methods related to Surveying, Geoinformatics or Land Management.
- be able to identify problems related to Surveying, Geoinformatics or Land Management.

- be able to assess/analyse problems related to Surveying, Geoinformatics or Land Management.
- be able to suggest solutions to problems related to Surveying, Geoinformatics or Land Management.
- be able to assess the quality of the suggested solutions
- be able to communicate/discuss problems related to Surveying, Geoinformatics or Land Management with both peers and non- specialists
- be able to structure project management activities based on a well formulated problem formulation (*)[4]

Competencies:

- be able to master relevant data and technologies
- be able to master general skills required to solve typical tasks
- be able to give advice regarding problems related to Surveying, Geoinformatics or Land Management
- must be able to structure and combine theoretical discussions

  with practical challengers throughout the project work and its result (the project report)
- be able to reflect on, plan and manage a study project in a PBL learning environment (*)

7.2. Requirements

The project module is designed to run over the course of a semester; however, the work load is kept low at the beginning of the semester (project formation phase) to allow students to complete the two other 5 ECTS courses in the first few weeks of the semester (see Figure 7.1)

[4] To obtain the knowledge, skills and competence marked with (*) it is presupposed that students follow the course in Problem Based Learning and Project Management that the school offers all new students in the beginning of 1st semester.

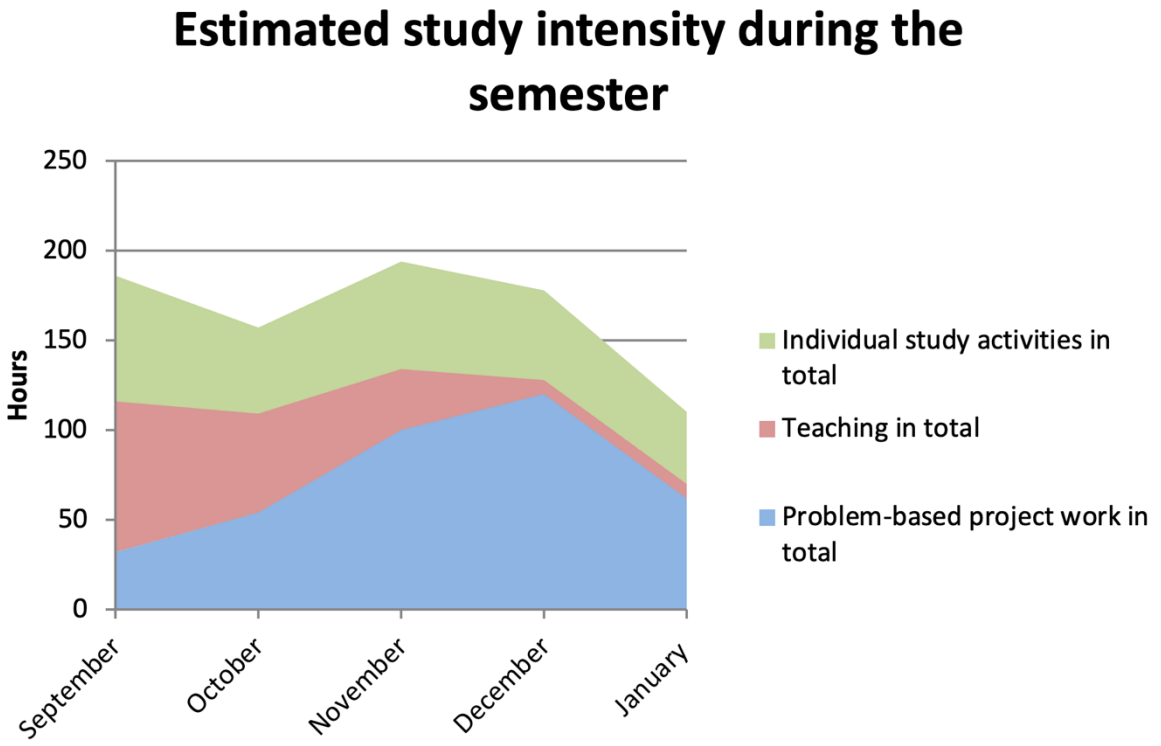

Figure 7.1: Distribution between course work (red) and project work (blue) over the course of a semester.

The **Geospatial Information Technology** module aims to provide the knowledge and skills to understand the different processes in systems development – and not at least how to develop information systems, where geographic information plays a key role. Thus, this course gives the student a sound basis for carrying out the self-defined project, which typically focuses on building a web-GIS application, although other ideas related to technology or society are welcome. The module consists of the following 10 sessions:

- Lecture 1: Fundamentals of geospatial analysis: Raster and vector
- Lecture 2: Cartography and maps as communication means
- Lectures 3–6: Python programming
- Lecture 6: Basic Spatial Database Technology
- Lecture 7: Advanced Spatial Database Technology
- Lecture 8: Web Mapping with OpenLayers 3
- Lecture 9: Web mapping with Leaflet and Google Maps
- Lecture 10: Workshop for setting up Web-GIS applications

The module on **Modern Data Acquisition Methods** aims to provide the knowledge and skills to understand how geographic information is being collected, processed, managed, and distributed. Starting from the role of geographic information in governmental processes, the module provides the student with a broad overview of the principles of the underlying technologies. The module consists of the following 8 sessions:

- Lecture 1**:** SDI and INSPIRE
- Lecture 2: Geospatial data handling: data models and data quality
- Lecture 3**:** Distributed systems and Geographical services
- Lecture 4**:** Principles of remote sensing
- Lecture 5**:** Remote sensing and earth observation applications
- Lecture 6**:** Laser scanning and UAV technologies
- Lecture 7**:** Big Data, Internet of Things, Semantic Web, Linked Data
- Lecture 8: Applications: state of the art of the 1st semester projects

7.3. Teaching Materials

Due to the project nature of the project module, the concrete materials are very much dependent upon the chosen project theme. Students – and often also educators – are therefore required to get a quick overview of the main literature in a new subject area in a relatively short time. Example project topics from the past years include placement of new charging stations for electric vehicles, a spatial decision support system for wind farm locations, an emergency notification and evacuation system, and an online system to find ideal locations to live in the city of Copenhagen based on various constraints. These require the whole team (of usually 3-4 students) and their faculty supervisor to get into this topic, while the role of the supervisor is also to make sure that (a) the project goal remains at a realistic, yet ambitious enough level, and (b) that the students also get access to technical literature and online materials for aspects that have not been covered in the two course modules at the beginning of the semester.

7.4. Learning Activities

Despite the diverse nature of the different projects, the semester is structured by common learning activities that are shared across all projects:

1. **Group formation**. Ca. 4 weeks into the semester, we arrange a first common meeting on project work within Geoinformatics, where we present the exact scope and some examples of previous first semester student projects. Another 1-2 weeks later, we arrange the second common meeting on project activities where students present their own ideas for project work, and discuss the different ideas in common and within the groups. Based on these ideas and students interests, groups are formed and a supervisor is assigned to each group.

2. **Literature review**. Each group works with their supervisor to get an overview of the state of the art in the field of their respective project, with a particular focus on the use of geodata and the involvement of SDI in the solutions. Each group presents the state of the art to the whole semester.
3. **Problem formulation**. Each group phrases a problem statement, along with 3–4 research questions that forms the basis for the project work for the rest of the semester.
4. **System implementation**. The projects have to include a practical component, where the students implement a prototype solution involving SDI components and usually also a mobile and/or desktop web mapping interface.
5. **Supervision meetings**. Throughout the project, the groups hold regular meetings with the supervisor to discuss the progress, solve problems, and make sure the group stays on track. These are held as needed, but once a week is a common model.
6. **Status seminar**. After about two thirds of the semester, a common seminar is held where all groups present the status of their project. That entails showing a first version of the prototype implementation and an exchange about challenges that are often shared between groups even when they are working on very different topics.
7. **Peer review**. The status seminar is also used to give feedback to the other groups. For this purpose, the current status of the project in the form of a draft report is shared with another group, which gives feedback and asks questions.
8. **Group exchange**. Semesters at AAU are assigned study areas, where group commonly uses one table in a larger open space. This model allows for plenty of interaction across the different groups during the main project phase.
9. **Project report**. Each group has to hand in an extensive report on their project at the end of the semester; as a rule of thumb, 40 pages per group plus 25 per project member are expected.
10. **Oral exam**. The project report is handed in 2 weeks before the oral exam, and the group members are given individual grades based on the report and exam combined. The exam starts with a presentation by the project group, followed by an extensive discussion with the supervisor and a censor, who is a qualified person (i.e., with a relevant degree, usually in geoinformatics) either from the university or an outside organisation, and has not been involved in the project. This guarantees an unbiased grading. The exam duration is 45 minutes per group member – i.e. 3 hours for a group of 4 (including presentation, grading, etc.) – so that there is plenty of time for in-depth discussion of the project and to carefully consider the individual group members' contributions and understanding of the project.

7.5. Implementation

The following subsections outline examples of projects that have been conducted in this module over the last few years.

7.5.1. Web GIS for Wind Turbine establishment

The project uses a multicriteria analysis in a WebGIS solution for identifying potential establishment areas for wind turbines. The analysis can be used throughout Denmark, but the project focuses on the Syddjurs Municipality.

The project is initiated with a study of the basis for the establishment of wind turbines in the countryside. Here, the different aspects are examined in order to identify the variables. Furthermore, the project examines the theory of constructing a spatial decision support system (SDSS) and the use of a multi-criteria analysis.

The analysis and design of a WebGIS system is initiated with verification and analysis of the data. The data is methodically classified as factors and valued by the pairwise comparison method. These are then used with the standardized area weights and the decision-makers' weights in a linear combination equation.

The analysis results are the combined weights, that are distributed in hexagons. The hexagons are assigned values, where the most suitable areas will have the highest values. Decision-makers will be able to change a number of values and the analysis will therefore be dynamic, thereby, decision-makers can have an impact on the results.

The project is completed by an evaluation of the WebGIS solution for its application and quality.

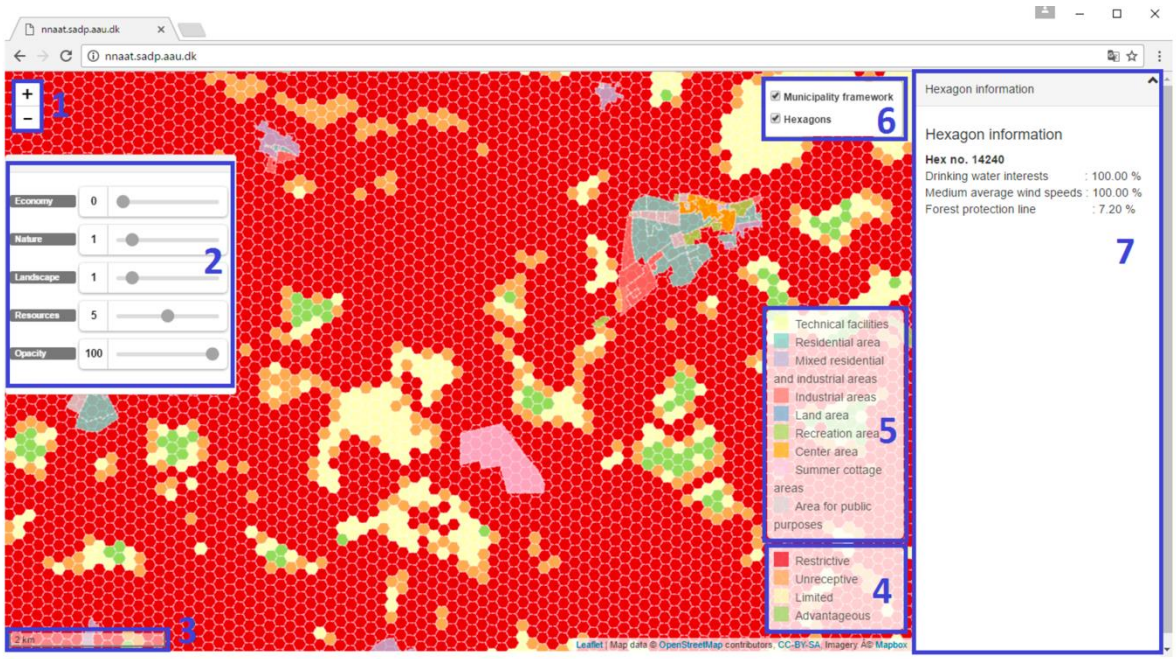

Figure 7.2: Final Web GIS interface

7.5.2. *COMMUTrKOMPUTr!*

This research paper takes an approach on available commuting services that provide users with tools to assist in decision-making skills closely related to relocation of home or work addresses. The creation of this web-based application aims to reduce time in determining best transit type, best route and monthly expenditure related to commute costs. Another goal of COMMUTrKOMPUTr! is to provide additional information to users who experience struggles in deciding between predetermined locations that they are interested to purchase or rent property in. Our tool will also serve users who are unsure where to relocate to by returning a comparison of kommunes within a certain distance and displaying average accommodation pricing, incomes and other anticipated living expenses.

Previously conducted literature research and examination of pre-existing applications, commuting theories and tools will be analyzed in depth in order to determine what is currently lacking among existing tools that would benefit the user in timely decision-making. The study of commuting on both a social and behavioral science level will provide us with additional knowledge in how best to craft an accessible online tool that is intuitive and displays relevant information to the user.

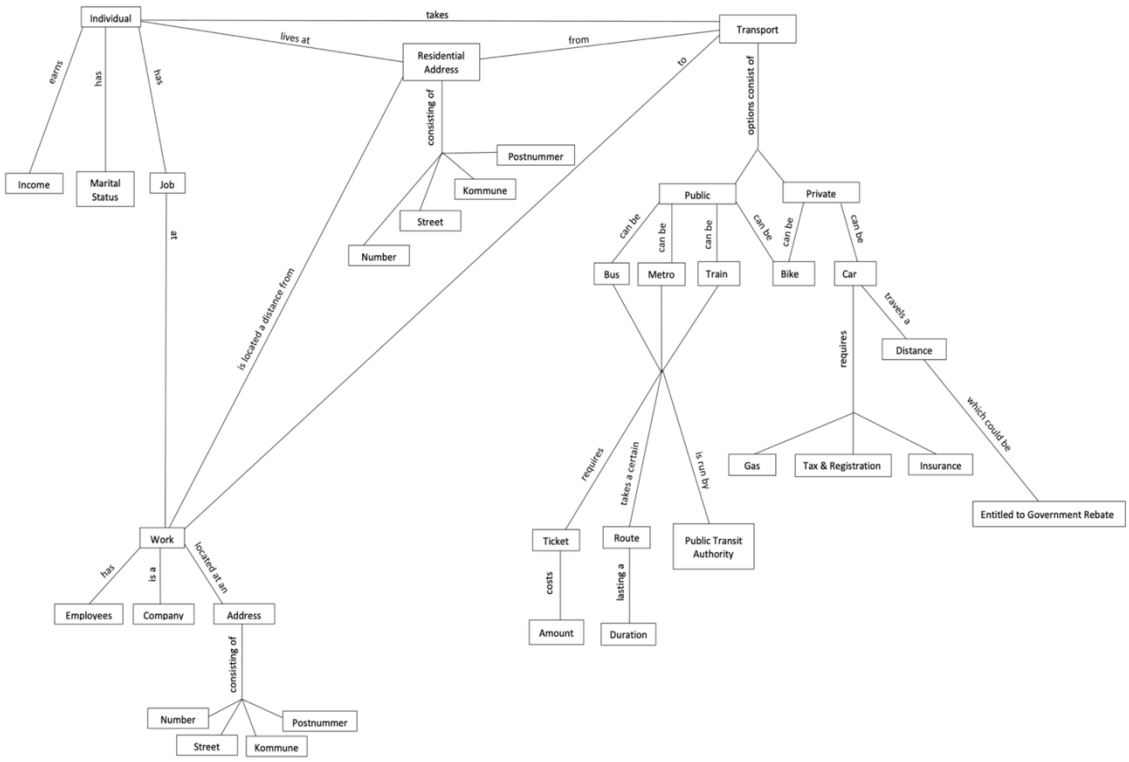

Figure 7.3 Concept map underlying the project

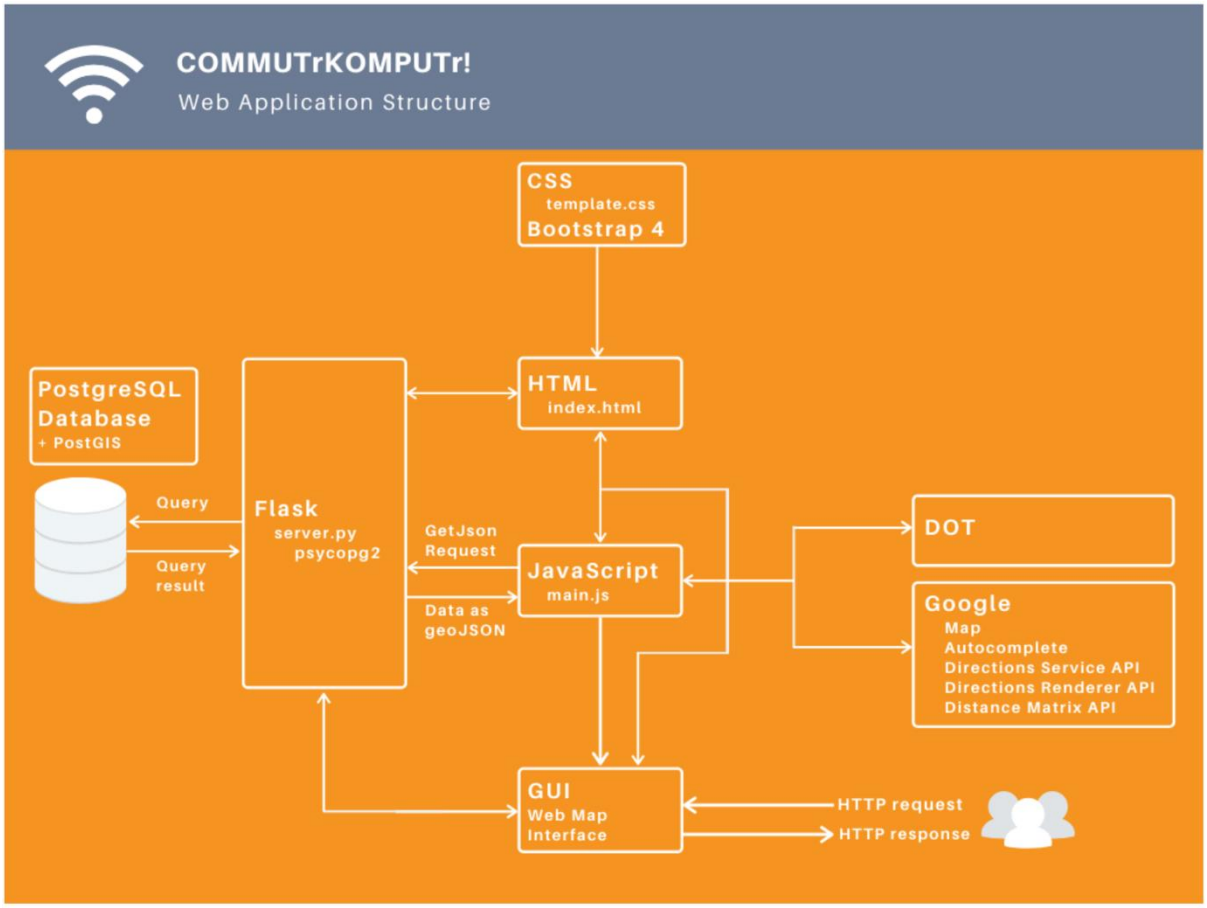

Figure 7.4 We app components

7.5.3. Gone with the Wind

This project examines how routes for bicyclists can be created in a WebGIS based application, while taking wind into account. The project is focused around Copenhagen. The selection of parameters, including the direction of the wind, is based on a literature review and a market analysis of the existing applications. This gives an idea of which parameters are important for bicyclists and therefore, which are relevant to include in the application. Furthermore, it gives an idea of which functionalities the existing applications have. Among the most important parameters is the weather conditions. As no currently existing applications plan a route based on the wind direction, this parameter will be the main focus of this project. The created application finds a destination based on the direction of the wind and the distance, among other parameters. From there, it will find the nearest station, and this is the actual destination of the created route. This gives the opportunity of taking train back to the origin of the route and avoid headwind. If wanted, the user can select parks as waypoints to go by before heading to the destination.

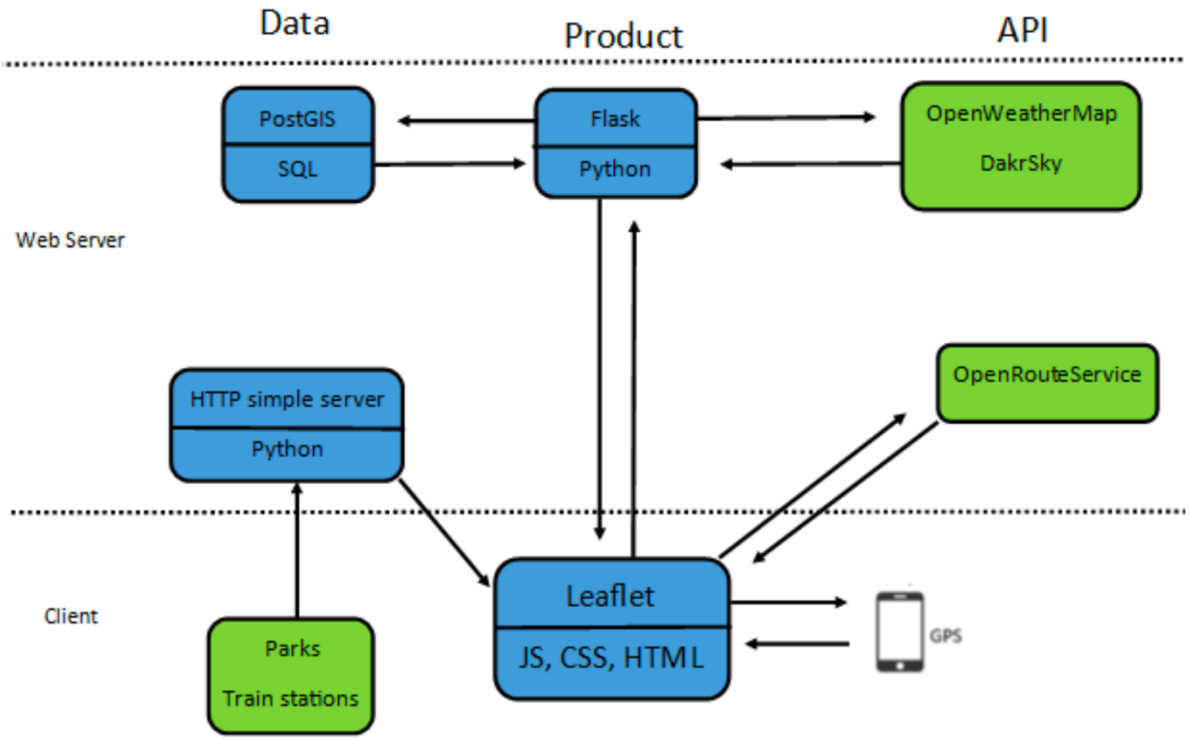

Figure 7.5 Application architecture with external data sources shown in green.

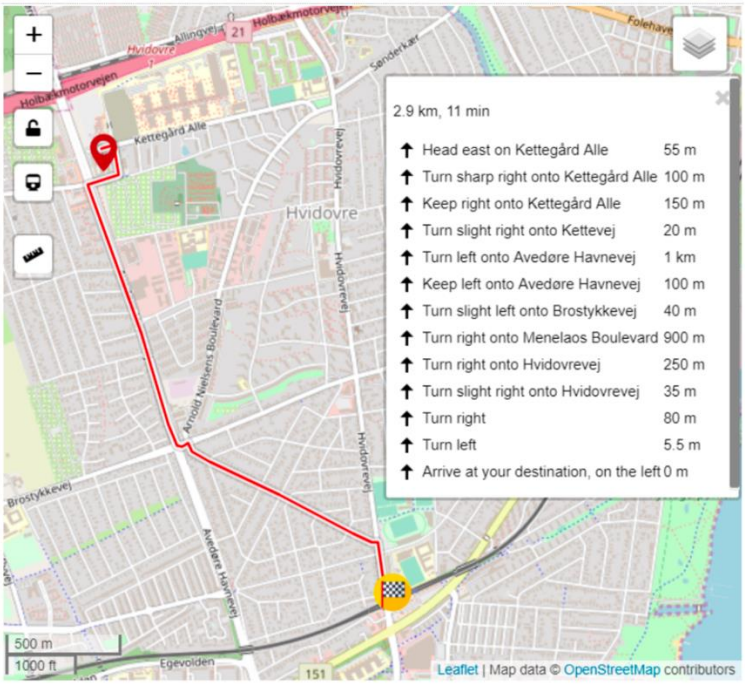

Figure 7.6 Biking application UI.

7.5.4. EVACUATR

The ability of authorities to respond to an emergency, making best use of spatial informa- tion and novel geoinformatics technology (GI) solutions, has become paramount as means of saving lives and resources and coordinating efforts, in modern society. While several applications offer solutions for authorities to make best use of spatial analysis to coordi- nate their response, few efforts have aimed at addressing the communication gap between authorities and citizens affected by an emergency. While authorities and emergency per- sonnel have access to spatial data which may be of significant value to the people affected by an incident, this information rarely trickles down to “user” level, and if so, it is usually mediated by mainstream medias.

In this project, we aim to address this technology gap, by building an application which can be used by disaster management agencies to disseminate evacuation instructions, directly to the people affected by an emergency, using their mobile phones as a medium.

Ultimately, the design of a web-GIS application, entitled “EVACUATR”, is detailed in this re- port. With a spatial database, including a grid point dataset covering the case study area around central Copenhagen, as its backbone, the prototype application is built using a mix- ture of various programming languages and libraries. The front end webmap is designed using leaflet, and the user interface and data visualizations is powered using a combination of HTML, CSS and JavaScript.

Connected by a XAMPP stack with an Apache webserver, PHP is used to connect to, and manipulate the PostgreSQL database.

The final application is tested and validated, meeting the minimum requirements as set out in the problem statement, using a dummy dataset, stored in the database and created using a Python module.

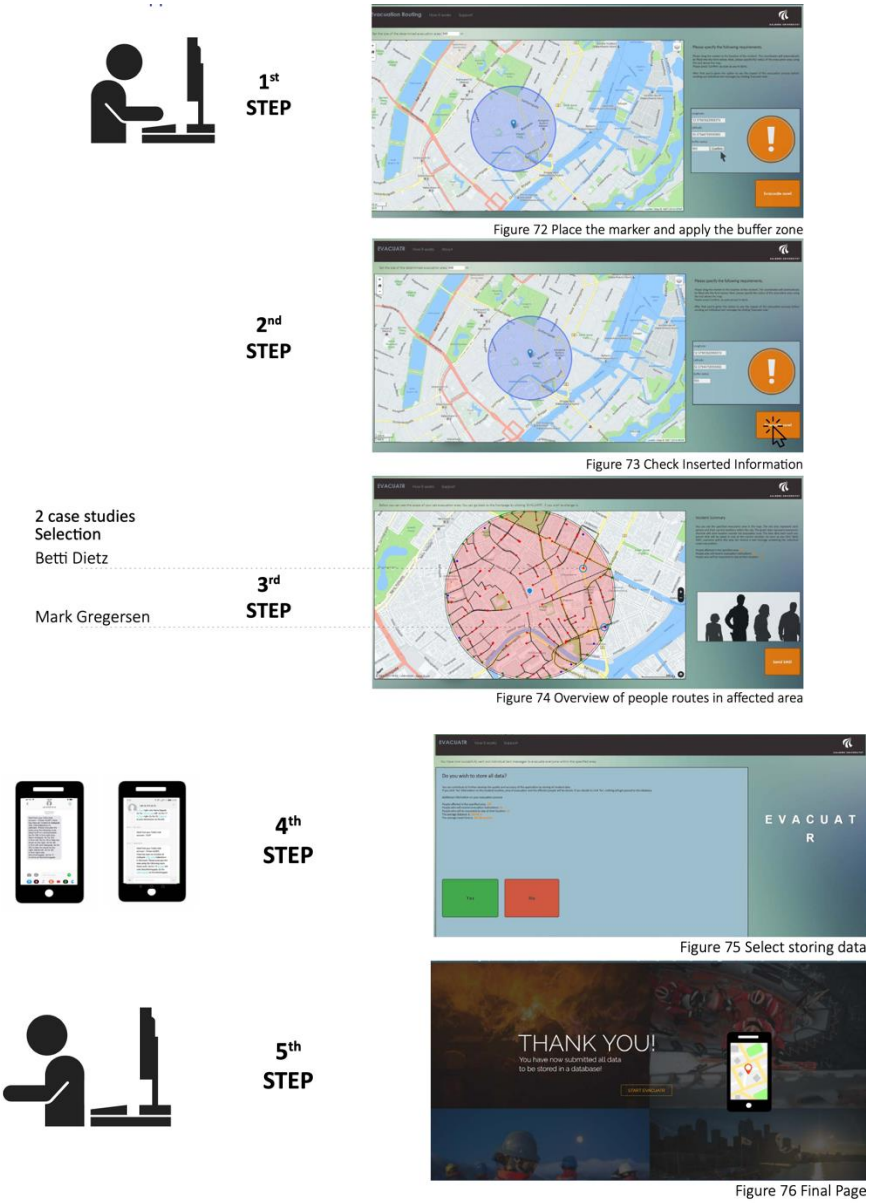

Figure 7.7 Evacuatr workflow

7.6. Evaluation

7.6.1. Evaluation by Students

Students are generally quite satisfied with this comprehensive and hands-on teaching activity, as shown in the excerpt from a semester evaluation in Figure 7.8. The positive comments particularly focus on the active aspects of PBL, where the students really have to get deep into a practical problem and build an SDI-related solution to address it. Students stress how much more practical knowledge they get out of this process compared to prepared, "canned" exercises where everything simply works. Negative comments usually concern the work load, which is quite substantial for this module and can easily cause stress towards the end of the semester if students are not putting in the required hours from the beginning of the semester. Moreover, the students who are new to PBL (usually those who join the Master's program with a Bachelor degree not from AAU) can have problems to adjust to this kind of learning, which is much less structured than most other forms of education at this level.

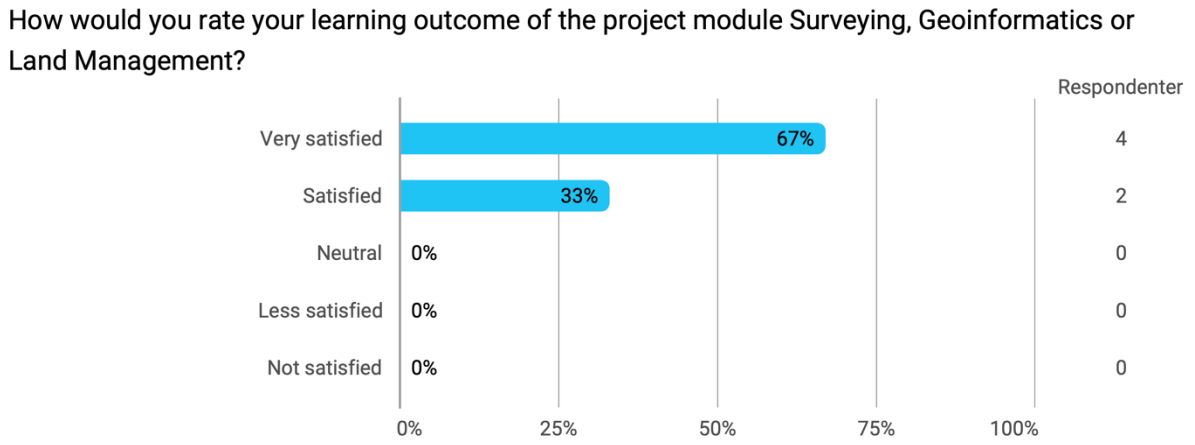

Figure 7.8 Example course evaluation

7.6.2. Evaluation by Teachers

From a teacher's perspective, every project is new and always demands getting into the literature of a potentially new field of work. This requires some extra effort on the teacher's side, but at the same time it also keeps the module exciting, because it is – unlike many other "classical" teaching activities – very different in every iteration. Concerning its effectiveness, the teachers in this module share the perspective that this is a highly effective method to teach hands-on skills – a fact that is reflected in employers' high demand for graduates from AAU.

8. Conclusions

In this report several active teaching practices on SDI and related topics are presented and described into detail. The practices are all based on existing SDI teaching activities implemented by the project partners.

These practices rely on a variety of active teaching methods, including *1-minute paper/summaries, Asking questions, Demonstrations, Brain storming, Short lecture, Students presentations, Breakout discussions, In-class quizzes/polls, Class discussions, Debates, Peer reviews, Peer tutoring, Implementations with instructions and Reviews and assessment.* The methods were applied during practices (classroom activities and lab works) that are related to both technical and none-technical aspects of SDI. The practices were evaluated by students, who had passed the practice, as well as teachers.

The overall results of the assessments by the students show that the adopted methods have stimulated the participation of students, actively in the class, and hence have been effective in achieving the learning objectives. A majority of the students believe that the methods have increased the interaction between the students and teachers. For the lab works, active teaching and learning methods have helped students to get a better knowledge and understanding of theories and helped the to get required skills for applying studied techniques. In general, students are satisfied with using active teaching and learning methods and they prefer it over traditional passive teaching methods.

Appendix I:

Evaluating Active Teaching and Learning in Open SDI Education (Classroom Activities)

Please answer these questions in accordance to learning objectives of the activity, provided to you by your teacher, together with the link to this questionnaire.

* Required

Please select your university *

Choose

Please specify the course name and the activity *

Your answer

How do you appreciate? *

	Agree	Rather Agree	Fair	Rather Disagree	Disagree
The method stimulated class participation/ activated me to participate	○	○	○	○	○
The method was effective in achieving the learning objectives	○	○	○	○	○
The method was very motivating and entertaining	○	○	○	○	○
The method increases interaction between students and with the teacher	○	○	○	○	○
I am satisfied with the method, in general	○	○	○	○	○
I prefer this method against traditional passive lecturing methods	○	○	○	○	○

Please explain your answers: *

Your answer

What would you recommend to keep for next year's classes? *

Your answer

What do you recommend to change for the next year's classes? *

Your answer

Submit

Never submit passwords through Google Forms.

Appendix II:

Evaluating Active Teaching and Learning in Open SDI Education (Lab Activities)

Please answer these questions in accordance to learning objectives of the activity, provided to you by your teacher, together with the link to this questionnaire.

* Required

Please select your university *

Choose

Please specify the course name and the activity *

Your answer

How do you appreciate? *

	Agree	Rather Agree	Fair	Rather Disagree	Disagree
The practice improved my knowledge and understanding of the theories	○	○	○	○	○
The practice helped me to get required knowledge to implement/apply a studied technique	○	○	○	○	○
The practice made me to be active (e.g. by programming, searching, etc.)	○	○	○	○	○
The method was effective in achieving the learning objectives	○	○	○	○	○
The method was very motivating and entertaining	○	○	○	○	○
I am satisfied with the method, in general	○	○	○	○	○

Please explain your answers to the above questions: *

Your answer

What would you recommend to keep for future? *

Your answer

What do you recommend to change? *

Your answer

Submit

Never submit passwords through Google Forms.