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Piloting a collaborative data library of fine-grained data to support knowledge facilitation in architectural courses

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Abstract. This study discusses the establishment and pilot of a collaborative data library (CDL) for educational purposes, based on a transdisciplinary collaboration between the architecture departments at Chalmers University of Technology in Gothenburg, Sweden, and University of Pretoria, South Africa. The CDL was tested Hammarkullen in Gothenburg in a joint exercise during which students from both institutions collected qualitative and quantitative data through site analysis using analogue and digital tools such as KoboToolbox and Maptionnaire. The collected data were uploaded in guided sessions to the web-based platform GeoNode to be stored in a systematic way for re-use of the data later in the course. Results show that the tools and CDL were relatively easy to use. For the students the most interesting aspects were the contextual information gained by using the data collecting tools, and, by that, make communities' needs heard. Thus, the students appreciated the participatory features of the data collection tools. The CDL will be further developed and tested in the South African design studio in the Mamelodi township of Pretoria early in 2020. The development of the CDL in a transdisciplinary and global context will allow for up-scaling and potentially also applications outside educational environments. The project contributes to the United Nations' Sustainable Development Goals 4 and 11.

1. Introduction

The transition to an inclusive and sustainable urbanization with capacity for participatory, integrated and sustainable human settlement planning as formulated in the United Nations' Sustainable Development Goal (SDG) 11.3, needs actions not only in practice but also in education to provide learners with knowledge and skills needed to promote and implement sustainable development globally in local contexts (SDG 4). This study explores the establishment of a collaborative data library (CDL) for educational purposes, based on a transdisciplinary collaboration between Chalmers University of Technology (CTH) in Gothenburg, Sweden, and University of Pretoria (UP), South Africa. Architectural students at both universities routinely collect fine-grained visual and qualitative spatial data while working on their design projects, e.g., through transect walks, participatory action



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research, community mapping and participatory GIS methodologies. Each year the students gather a remarkable amount of data. However, this data is collected on an ad hoc basis in many formats and is not adequately stored, therefore cannot be re-used for other purposes or by students working in the same area in subsequent years. To overcome this lack of systematization, a methodological framework for knowledge facilitation and support of data re-use in architectural courses has been developed. The aim of the study is to test this framework for managing and cataloguing data through a CDL in the context of an architectural Master's course on social inclusion. This paper discusses the lessons we have learnt from using the framework regarding a) students' feedback and b) teachers' perception. The focus has been on data collection and storage but not sharing and using the data for specific design tasks. This will be subject for the further investigation of the CDL development.

2. Data collection – analogue vs digital

Current trends towards digitalization [1] pose the question of the actual contribution of the more traditional analogue representations of data to the contemporary learning/teaching approaches. In fact, the “myth of a paperless” [2] working environment can be refuted by highlighting the different “affordances” [3-4] provided both by analogue and digital methods (Table 1). By acknowledging benefits from both, a combination of digital and paper documents becomes desirable [4-5].

Table 1. Affordances of analogue and digital records. Source: [4:4].

Affordances of paper maps, guides	Affordances of electronic devices
Flick through several pages (guide)	Access larger amount of information
Read across several documents at once	Access and display multimedia content
Make annotations on the document	Modify documents and create new ones
Get an overview of an area of interest (map)	Get additional information linked to a document
Grasp, fold the map	Use computational resources for services like navigation, route guiding
Work collaboratively on the document	Remote communication with other users
Source of static information	Access dynamic information
Independent, easily accessible	Dependent on battery power, network connection, familiarity of the user with the technology

Once such combination is taken into account, the next step is the management and organization of the different data inputs, which is related to the concept of “physical hypermedia” [6], aimed at bridging the gap between the physical and the digital in data collection. This concept stems from acknowledging the existence of a gradient of possibilities between the digital and the physical such as “physical-only”, “physical-with-digital-id”, “physical-with-low-resolution-digital representation”, “physical-generated-from-digital” and “digital-only” [6:14].

3. Method

The methodological framework has been pilot-tested in the *Design and Planning for Social Inclusion (Social Inclusion)* [7] course from CTHs' Master's Programme in *Architecture and Planning Beyond Sustainability*. The course runs every year from the end of September to the beginning of January and is open for postgraduate students with a background in architecture, urban design and planning, landscape architecture, interior architecture, environmental engineering, human geography, and conservation of the built environment. CTHs' Department of Architecture and Civil Engineering has been running the course in the Swedish suburb of Hammarkullen in Gothenburg for about 10 years. In the first week of the course, in September 2019, 18 students registered at CTH (13 different

nationalities) and 3 students from UP were involved in a series of assignments focusing on data gathering, cataloguing and storage. During the week the students mainly collected qualitative data through site analysis (observations, sketches, photographs, short interviews). They used both analogue methods such as sketches and notes and different digital tools such as the smartphone app KoboToolbox (to register coordinates, photographs, voices, notes) and the map-based survey tool Maptionnaire. All data, both analogue and digital, have been transferred by the students, with guidance from the teachers, to the newly developed platform, the CDL, implemented in GeoNode. GeoNode is a web-based application and platform for developing geospatial information systems (GIS) and spatial data infrastructures (SDI).

The assignments were guided by four teachers from CTH with a diverse background (architecture, planning, geography and design) and three teachers from UP, one with an architecture background and two with a background in geoinformatics. In the development of the methodological framework two more researchers were involved, one with a background in architecture, the other in geoinformatics. The teachers first introduced the general challenge of the research project, and the different types of data produced in architectural courses, followed by a description of data collection and mapping challenges and a presentation of different mapping tools suitable for different purposes. The mapping exercises were alternated with data cataloguing exercises to become familiar with the functionalities of GeoNode. The details of the exercises and tools used are further described in section 6.

The mapping was carried out in several rounds (first impression/thematic social sustainability/role play) and in four groups, with 4-5 students in each, investigating a different area of Hammarkullen. Two of the teachers followed the groups to observe how the mapping and tools worked for the students outside. In the cataloguing sessions, two teachers guided both the students and the other five teachers to learn GeoNode. In a final workshop at the end of the week, the students discussed the most interesting and most challenging aspects of using different data collection tools, their potential applicability in design projects in general and in social-inclusion projects in particular, along with suggestions for improvements. The students presented their reflections orally in a feedback session for the whole class in three-minute slots per group. Written notes from each group were handed in. The teachers took notes during the whole week and had a feedback session after the week. Thus, the researcher team members took on different roles; they acted as educators, learners, and/or observers.

4. The collaborative data library

A library is a curated collection of sources of information and similar resources, selected by experts and made accessible to a defined community for reference or borrowing [8]. Our library is a collaborative data library, i.e. a curated collection of geospatial datasets and related information (e.g. photos, videos, etc.), gathered and selected by students, researchers and lecturers and made accessible to a defined community of students, researchers and lecturers for reference or use in research and education projects.

As architectural projects involve various methods of data collection (i.e. analogue and digital) and generate both geographical and non-geographical data, the CDL has to accept various types of data inputs. This allows users, in our case architects and urban planning (students), the flexibility to use data collection tools that do not compromise their design process, while at the same time allowing data to be catalogued for proper management and preserved for future use. For the first iteration of the CDL developed for testing in Hammarkullen, the CDL was implemented using GeoNode. GeoNode is an open source geospatial content management system. GeoNode allows users to load data directly into the application and not just provide links to the data. Users can also create interactive maps with GeoNode that can be shared with the rest of the world. To test the CDL, we used the data collection tools, both analogue and digital, described in subsequent paragraphs.

KoBoToolbox and *Maptionnaire* are both data collection tools, however, they each have a very different focus. *KoBoToolbox* is an open source survey tool that can be used to collect geospatial locations (i.e. points, lines or polygons) of observations with the associated descriptive information. This information can be in the form of text, lists, photos, videos and audio, to name a few.

KoBoToolbox can be used for online and offline data collection on all mobile platforms. Similarly, Maptionnaire is a proprietary map-based survey tool that focuses on public participation, but it can also be used in direct dialogue with different people. Users can either work with a mobile platform or desktop solution and data are collected online. With Maptionnaire users can develop own questionnaire surveys and ask participants to indicate places, for example, the route they take daily, without actually walking the route, unlike with KoBoToolbox where locations have to be captured in the field using a smartphone's GPS. Both KoBoToolbox and Maptionnaire allow users to do basic visualisations (e.g. symbol, proportional symbols and heatmaps) of the data collected.

FieldPapers (<http://fieldpapers.org/>) is an open source web application for creating a printable map of a specified area from OpenStreetMap (OSM, www.openstreetmap.org/), a free and editable map of the world. The printed map can then be used in the field to manually annotate changes and add notes. After completion of the fieldwork, the map is scanned and added as a backdrop to Java OpenStreetMap Editor (JOSM, <https://josm.openstreetmap.de>) where the user can digitise the annotations. *FieldPapers* is very easy to use and requires little to no technical expertise.

QGIS (<https://www.qgis.org/en/site/>) is an open source desktop GIS application (allowing vector and raster analysis) that can easily be extended with plugins. QGIS is generally user-friendly, it has a large user base and documentation is freely available on the Web. QGIS was used to manipulate the data and perform basic spatial analysis on the data available in the GeoNode using web services. The functionalities were demonstrated to the students but was not key in testing the CDL.

5. Community mapping activities

During the first week of the Master's course, students had to establish a personal relationship to Hammarkullen as a physical place and to learn about the local settings and the people living and working there, using different methods. The following mapping activities were conducted: a) mental map and first impressions, b) mapping with analogue methods and c) using digital tools (see Fig 1 for details). The results of these activities were then loaded into the library (i.e. GeoNode) and explored using QGIS.

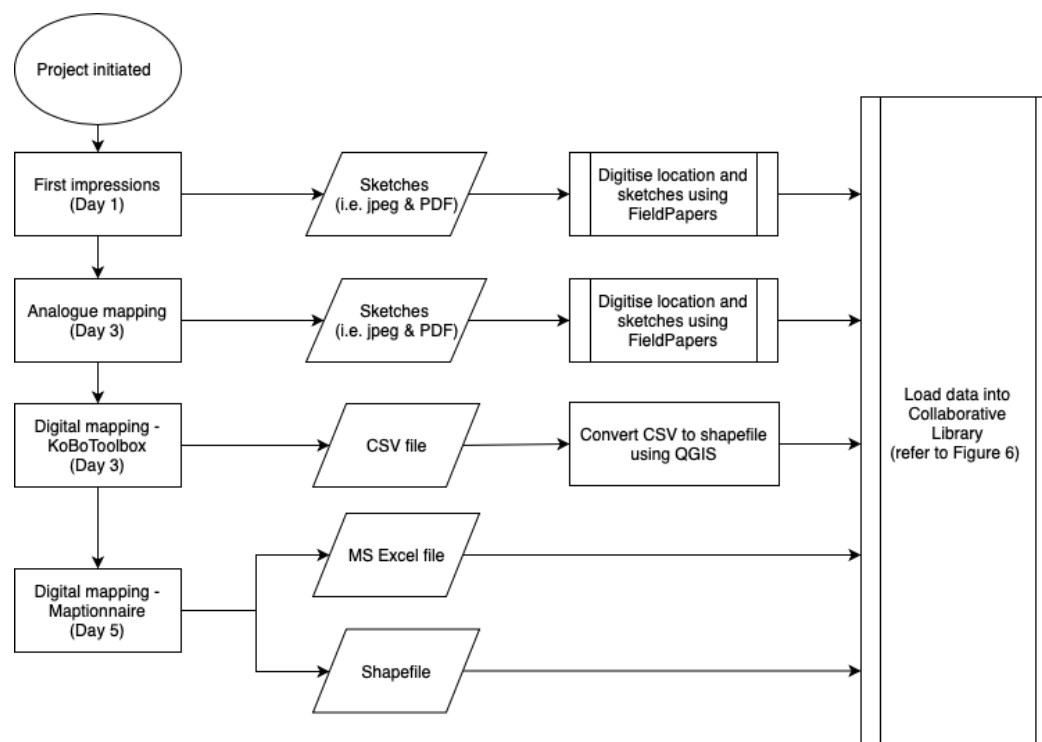


Figure 1. Flow diagram illustrating the activities that took place during the week.

5.1. Mapping first impressions without any digital devices

For the first immersion (on the first day), the students walked around in the community of Hammarkullen and mapped their first impressions using handmade sketches. The students were not allowed to take any digital devices with them, only a pen and paper to do their sketches.

When the students returned, they were asked to indicate the location of the sketches on a large map, consisting of a number of map sheets created with FieldPapers. Each student wrote a unique identifier on their sketches and placed a sticker with a corresponding unique identifier on the map. This activity can be challenging if a student struggled to create a complete mental map of the area. Afterwards, the map sheets were scanned and georeferenced using the FieldPapers web application as GeoTIFFs. The GeoTIFFs were then loaded into QGIS and each sticker was digitised as a point. The resulting dataset was then loaded into GeoNode by the instructors. Each sketch was also scanned and renamed to match the unique identifier. Figure 2 provides an overview of how the students interacted with FieldPapers during the first immersion.

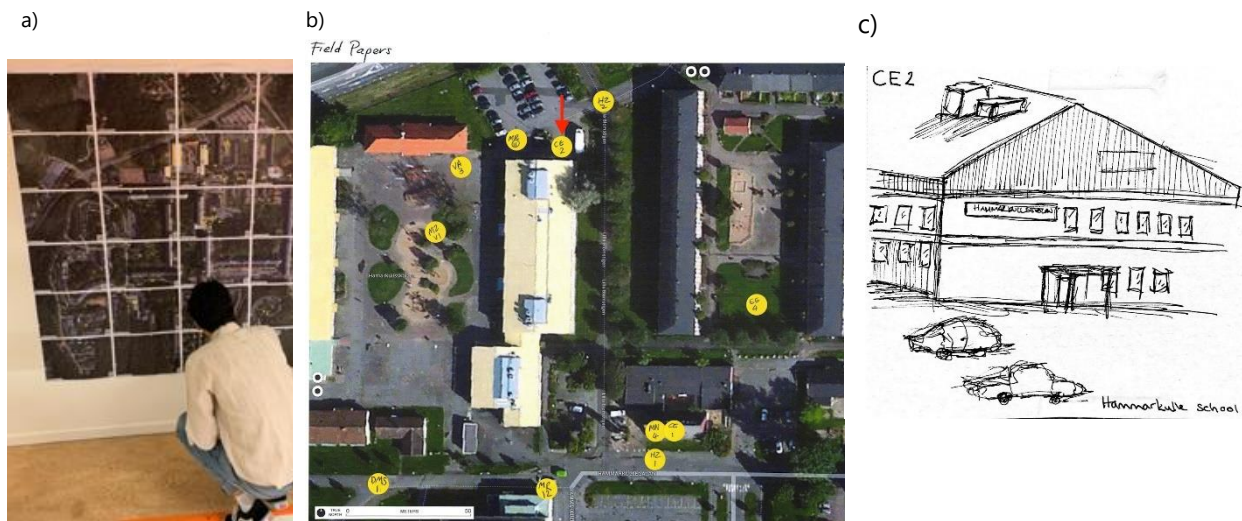


Figure 2. Example of how students interacted with FieldPapers. a) Student marking the location of a sketch on FieldPapers. b) The map segment with various stickers indicating the location of maps. CE2 is indicated with a red arrow. c) The sketch linked to location CE2.

5.2. Analogue mapping

For the second iteration of mapping (morning of the third day), the students were divided into groups and each assigned a specific area. They mapped specific features or activities in the area related to the theme of social sustainability. This iteration was also an analogue activity, but more focused than the first immersion. To map and load the sketches, the same process was followed with FieldPapers and QGIS as with the first immersion. The process went smoother for the students as they were now familiar with the process and better oriented in the area after spending two days in Hammarkullen.

5.3. Digital mapping

The digital mapping was done using KoBoToolbox and Maptionnaire. For both KoBoToolbox and Maptionnaire, the architecture teachers designed a form that the students could use to collect data.

During the third iteration of mapping (on the afternoon of the third day), the students used KoBoToolBox to map the area. The questions defined in the KoBoToolBox form maps places used for engaging, learning, living, moving, playing and working. Such categories of activities stem from an adaptation of the Vancouver framework for social sustainability [9]. Each place was then defined further, again adopting the guiding principles of the Vancouver framework, by using one or a

combination of the following descriptors: equitable, inclusive, adaptable, secure, and happy. Some students struggled with the tool at first, as this was their first exposure to such an application. During the 90-minute session, the students collected 106 points.

The fourth iteration of mapping (on the fifth day) was focused on participatory mapping using Maptionnaire. Rain interrupted the plans to interact with the community and roleplaying was used as an alternative. The students found Maptionnaire fairly easy to use, which could be due either to its user-friendly interface or to the knowledge they had gained on the previous days. During the 90-minute session, the students mapped 70 places.

5.4. Cataloguing and documenting the collected data using the CDL

After completing the third iteration, students had a guided hands-on session with the CDL. The aim of the session was to evaluate the CDL, to see if it fits the initial requirements set out. A similar hands-on session was carried out after the fourth iteration. Depending on the data collection tool, the data format differed: KoBoToolbox exports data as a Comma Separated Value (CSV) file and Maptionnaire exports data either as a Microsoft Excel file or as a Shapefile. These are common data formats and the students knew how to deal with these formats.

The pilot CDL was implemented with GeoNode. Unfortunately, GeoNode does not support CSV as a geospatial format, thus QGIS was first used to convert the CSV file into a shapefile. Next, the students were guided through the process of uploading a shapefile into GeoNode and adding the associated metadata to the layer (e.g. title, abstract, category, restrictions, region and the purpose). The raw data collected (Microsoft Excel file) were also uploaded as a document into GeoNode and an association was created between the geospatial layer (shapefile) and the document. An overview of the process is shown in figure 3.

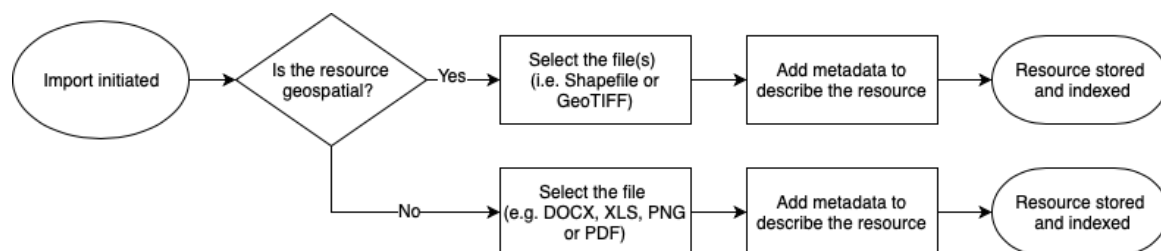


Figure 3. Overview of process followed to upload a layer or document to GeoNode.

The students were then shown other functionalities of GeoNode, for example searching and filtering layers and documents, creating and sharing web maps, and exporting maps. Advanced functions, such as editing the data using a web feature service (WFS) and creating custom styles in QGIS were also covered. These aspects are not part of the CDL but were shown to the students in order to enable them to use geospatial data and the library to its fullest.

5.5. Feedback on using the collaborative library

Overall the feedback from the students on the CDL was positive. From our own observations, the students at first struggled to start using the CDL but with each test scenario, the students became more familiar with the library and their confidence in using it also grew. Many of the students do not have a technical background but were able to pick up quickly what needed to be done in order to successfully use the library. The students did enjoy seeing their sketches and the data they collected being given a geographical context, meaning they were able to see a precise location linked to each drawing. This gave each drawing a new dimension. One theme that kept recurring throughout the student feedback was the user-friendliness of the library. The students indicated that the multistep process for uploading resources benefited them as the uploading process was broken into smaller, easier to manage sections.

When asking the students about the learnings and usability of the tools and the CDL, they mentioned that the most interesting aspects were the contextual information gained by using the data collecting tools and the possibility to collect different types of data, thereby making it possible to make the real needs of communities heard. Thus, the students appreciated the participatory features of the data collection tools. They also appreciated the possibility to gather other kinds of data, for example to include notes on body language, and they enjoyed working with different information layers with geographical references. Other aspects the students highlighted were the direct translation from data to infographics making things clearer and easier to understand, and the overlaying of information layers with the potential to make patterns visible. The students also appreciated that the CDL allows collaboration, provides easy access to data from different sources, supports data sharing all over the world, and that it can be used to create a visual historical time-line. At the same time, the students perceived it as challenging to learn the GeoNode platform and how to transfer the data collected with the different tools they have tested in the course. Potentially it would be better to focus on only one data collection tool. Challenging was also to learn how to digitize the data collected with analogue methods (sketches) and to make sure to capture the analogue information through digital tools.

From the teachers' perspective, using the tools and the CDL were seen as advantageous as they offer a way to systematize the mapping task. Not only the data collecting and archiving functions are of interest here, but also the provision of a systematic way for analysis of the collected data. The course Social Inclusion is about co-creation, from co-initiation to co-evaluation of a project. So far, the mapping of the area has not been done collaboratively. Thus, establishing the CDL added a new value to the course. Regarding the data collection tools, KoBoToolBox does not necessarily require involvement of other people compared to Maptionnaire which requires interaction with other people. The teacher also appreciated that the tools are limited to analysis and do not offer solutions, something which is difficult to separate in participation processes.

From the teachers' perspective the guidance of the data collection tools as well as the CDL was perceived as clear from the beginning: being a pedagogical tool with the purpose for students to learn tools for analysis. When it comes to the use of the gathered data and information, it was clear how they inform the design process but not how they contribute to the participatory approach of the course.

6. Lessons learnt - discussion and conclusion

This paper has presented the development and implementation of a pilot of a CDL for cataloguing, storing and sharing fine-grained data gathered in an architectural Master's course. The pilot is a first step to overcome the prevailing lack of systematization and to support data re-use and knowledge facilitation in education and for a locally adapted and sustainable development of neighborhoods.

We see the potential of the CDL in developing a qualitative understanding of complex urban patterns, especially those that are in transition or are experiencing socio-economic tensions and marginalisation. By leveraging on the micro-data being collected, stored and used in the field in this way, urban planning and architectural intervention may be more responsive to local contexts.

Due to the ease of use and the smartphone application, the data collection and storing process carried out with the students does not compromise the methods usually underpinning the course, such as transect walks and participatory mapping, in which intuitive immersion and observation are required. Further, it contributes to a more consequent structure of the collaborative design process.

The CDL has been developed in an educational context using an open source geospatial content management system. All the gathered data are accessible for the students participating in the course. However, only parts of the data will be available as open access (OA). In an up-scaled situation with potential use of the data outside university for, for example, local municipality administrations or urban planners, OA questions need to be discussed further.

The data have been organized and stored in a systematic way for re-use later in the specific course the CDL has been piloted. The CDL will be further developed and tested in a South African architectural course in the Mamelodi township of Pretoria early in 2020.

The development of the CDL in a transdisciplinary environment and global context and the use of open source tools will allow for up-scaling in different global geographical contexts and potentially also applications outside educational environments. In a broader perspective, this research illustrates how digitalization might contribute to the design of more resilient and locally adapted urban neighborhoods and thus to sustainable cities and communities.

The ad hoc data collected by architecture and planning students represent an enormously valuable resource. By capturing it in a collaborative data library this data is not only available for future research, but can then also be augmented by micro-data captured by students in other disciplines such as anthropology, economics, sociology and medicine to build a rich description of a particular neighbourhood and its needs and opportunities for development and improvement.

The project contributes firstly to the United Nations' Sustainable Development Goal (UN SDG) 4: Quality education, providing learners with knowledge and skills needed to promote and implement sustainable development globally in local contexts. Further, such digitized information may serve not only to understand historic trends, but also support the development of smart and participatory planning platforms such as Digital Twins in order to anticipate rapid change in normally under-represented geographical areas. The project therefore also supports the UN SDG 11.3: "By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries" (/sustainabledevelopment.un.org/sdg11).

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