Geodesign as Online Teaching Method – Lessons from a Multiple Case Study

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Abstract: This study analyses the geodesign workshop as a method for the online teaching of group work methods in the context of geoinformation systems (GIS) in planning and design. In order to assess the learning outcome, four workshops with international landscape architecture students at master level were conducted over a period of four years (2018-2021) and compared in a qualitative multiple-case study. In times of Covid-19 and the need for remote workshop methods, the geodesign workshops seem well suited for online learning and teaching. The results show that the learning goals were achieved, that new ideas were created and stakeholder expectations reflected and challenged. In individual cases, the lack of on-site knowledge led to mistakes though, and online group work had different group dynamics than in-person negotiations. Vocal and well-organised students seem to engage even more whereas quiet students more easily disengage, as seen in a bimodal distribution of participation grades in the online class. In conclusion, geodesign workshops may be recommended as an online method for teaching GIS and group work methods such as brainstorming, consensus building and stakeholder-role play but a hybrid format or new virtual field trip techniques are preferable when familiarizing students with the case study site. The teaching of group work methods as part of planning and design may be transferred from geodesign to teaching building information models, which is also an information-based digitally facilitated collaboration process.

Keywords: Geodesign, learning and teaching, negotiation, online teaching, collaborative planning

1 Introduction

Geodesign has been included in many university curricula around the world. The International Geodesign Collaboration (IGC) introduced a standardized geodesign process, which has been conducted by hundreds of universities around the world. WARREN-KRETZSCHMAR et al. (2016) already demonstrated the benefits of geodesign as a teaching method in planning and design classes. Building on their insights, this paper further explores whether geodesign is also a suitable method for the teaching of group work methods, and how geodesign classes adapted to online teaching during the Covid-19 pandemic.

In short, STEINITZ (2012) defines geodesign as planning geography through design. In a longer definition, FLAXMAN (2010) defines geodesign as "a design and planning method which tightly couples the creation of a design proposal with impact simulations informed by geographic context and systems thinking normally supported by digital technology." Among other methods, geodesign utilizes the scenario method (BISHOP et al. 2007), which is also part of many university programs.

Hence, a common misconception is that geodesign is only about technology. Although geodesign is characterised by the integrated use of GIS tools and geodata as the basis for an informed design and decision-making process (CAMPAGNA 2014), it is generally a group work process. In this context, several group work methods correspond well with the geodesign process. These are brainstorming, stakeholder role-play, and collaborative negotiation methods.

Journal of Digital Landscape Architecture, 8-2023, pp. 598-607. © Wichmann Verlag, VDE VERLAG GMBH · Berlin · Offenbach. ISBN 978-3-87907-740-3, ISSN 2367-4253, e-ISSN 2511-624X, doi:10.14627/537740063.

Brainstorming is a method for the quick generation of ideas (JONES 1992). In the first step, participants have to write down as many ideas as possible during a limited amount of time. Since this step is about the creation of ideas, no weighting, discussion or filtering takes place yet. In a second step, the ideas are discussed in the group, clustered thematically and redundant or unsuitable ideas are sorted out. DOMINGO et al. (2021) demonstrate how brainstorming can also be applied in remote settings to facilitate collaborative work.

At the same time, geodesign addresses complex multi-stakeholder planning and negotiation processes. PETTIT et al. (2019) suggest collaborative negotiations and consensus-building as part of the geodesign process. Starting with an even number of stakeholder groups, e. g., eight groups with one planning proposal each, these groups meet with the closest other group, e. g., government and business, and negotiate a consensus between their two proposals. Then, the remaining four proposals are narrowed down to two and the two to a final one. Because the process is mediated through digital means, PETTIT et al. (2020) also call it digital negotiations. They conclude that such digital negotiations are an effective planning method.

Such processes embody underlying roles and often hidden agendas and conflicts. LIGTENBERG et al. (2010) used a role-playing approach in which students took on the roles of local citizens, farmers and nature conservationists together with an agent-based model for simulating a multi-actor spatial planning process. In the IGC process, the role-playing approach lends itself to have students represent different stakeholder groups. Common stakeholder groups are local citizens, local businesses, local government, youth organisations or environmental NGOs. Research goals are to assess whether

- learning goals were achieved;
- the quality of the results changes between online and in-person geodesign workshops;
- geodesign workshops as learning and teaching method for group work are transferable to other programs at Master level.

2 Methods: Multiple Case Study Comparison

The research design is based on the multiple case study method (see 2.2.) by YIN (2014). The context for the workshops is kept consistent and comparable by following the recommendations and templates of the International Geodesign Collaboration IGC (see 2.2.): scale, group size, underlying global assumptions, time-frame, and range of scenarios do not change across workshops. The workshops are informed by open data from the EU Copernicus programme, OpenStreetMap and local environmental agencies (2.3.) All workshops use geodesignhub (www.geodesignhub.com) as online platform to facilitate the process (2.4.). In the comparison, quantitative data such as average grades for participation and outcome are compared together with qualitative observations, i. e., data triangulation in the words of YIN (2014).

2.1 International Geodesign Collaboration IGC Template

ORLAND & STEINITZ (2019) describe the International Geodesign Collaboration IGC, a collaborative project of more than 120 universities, research institutions and public / private stakeholders across the world. In order to facilitate research into geodesign, the collaboration organizes annual workshops and provides a template to make the diverse geodesign projects comparable. The IGC template (https://www.igc-geodesign.org/presentation-formats) provides the following:

- Common project boundaries of rectangular shapes and with nested spatial extents of 5, 10 and 20km.
- Common geodesign systems (water, green infrastructure, energy, transport, agriculture, industry and commerce, institutional, residential and two flexible systems) and a common colour palette to easier identify and compare land use patterns and alternative design scenarios.
- Global assumptions and a library of geodesign innovations, such as new renewable energy solutions, transport innovations etc., which IGC participants are encouraged to apply in their individual projects.
- Common scenarios and timeframes at 2035 and 2050, and paths to achieve scenarios for those: "Early Adopters" initiate design interventions in 2020; "Late Adopters" in 2035; and "Non-Adopters" continue with business-as-usual.
- Templates for common reporting formats as presentations and posters.

The geodesign projects compared here dropped the 5km and added a spatial extent at 40km but adhered to the IGC systems, innovations, common timeframes and poster templates.

2.2 Multiple Case Study Design

The basic concept of this multiple case-study is to conduct the workshops as similarly as possible by referring to the IGC standard templates for participating projects. The four workshops (see Tab. 1) were embedded in a GIS module in the second year of an international Master´s degree in landscape architecture. Student backgrounds were very diverse, with students from different Bachelor´s degrees and more than 20 different nationalities. Working language was English. Each workshop had one day of preparation plus individual student homework and three days of the actual workshop. Results were documented on two A2 posters per workshop.

Table 1: Overview of the geodesign workshops (the 2018/19-2021/22 Workshops are documented at https://www.igc-geodesign.org/)

Year	Workshop Title	Methods	Format
2018/19	Munich Parkmiles	Brainstorming, stakeholder role-play, Negotiations	In person
2019/20	Regional Garden Festival Stuttgart	Brainstorming, stakeholder role-play, Negotiations	In person
2020/21	Heidelberg Green Belt	Brainstorming, stakeholder role-play, Negotiations	Online
2021/22	International Building Exhibition Munich Region	Brainstorming, stakeholder role-play, Negotiations	Online

While the first two workshops in 2018/19 and 2019/20 were held in person, the Covid-19 pandemic required the change to an online format in 2020/21 and 2021/22.

2.3 Geodata-Based Process

For each workshop, suitability analyses were run ahead of the workshop in ArcGIS Pro and summarized in so-called evaluation maps. The suitability analyses were mainly based on open geodata from the Urban Atlas, which are derived from Copernicus satellite data (European Union, Copernicus Land Monitoring Service, European Environment Agency (EEA)),

map data from OpenStreetMap and protected areas provided by the Bayerisches Landesamt für Umwelt LfU and the Geoportal Baden-Württemberg.

2.4 Online Platform

All workshops were conducted through the online platform geodesignhub, which uses maps and diagrams to facilitate the negotiation process. FLINT & STEINLAUF-MILLO (2021) describe geodesignhub as "an interactive design method that uses stakeholder input, real-time feedback, geospatial modelling and impact simulations to facilitate the development of an effective management strategy and smart decisions." By presenting two maps with individual diagrams of projects and policies, and adding functions for filtering and visual comparison (Fig. 2), geodesignhub provides the tools to reach an informed consensus.

3 Case Descriptions

All four workshops correspond with local planning topics, i. e., Munich Parkmiles is elaborating the open space concept of the City of Munich; Regional Garden Festival Stuttgart is contributing to the International Building Exhibition Stuttgart, Heidelberg Green Belt responded to the invitation by the City of Heidelberg to develop ideas for a green belt and the last project is contributing to the forthcoming IBA Munich. The four geodesign workshops, presented here, share the same learning goals:

- Addressing a planning question at city to regional scale
- Application of GIS skills and demonstration of geodata capacity
- Developing group work skills

3.1 Case Study 2018/19: Munich Parkmiles

In a competition of ideas, 30 international students drafted the 2035 and 2050 scenarios in parallel working teams. Nevertheless, the results are surprisingly consistent. The common idea is that green infrastructure innovations are concentrated in the „Park Mile" green corridors. Housing is mainly accommodated in mixed-used zoning. For example, the 2050 early adopters' scenario is presented in Figure 1, which extends the high-density mixed-use areas

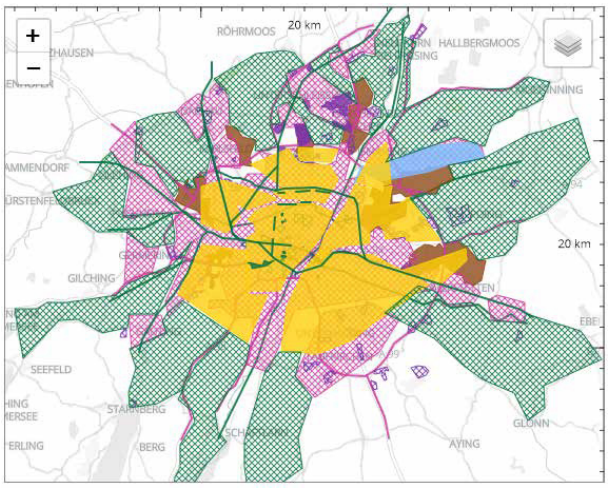
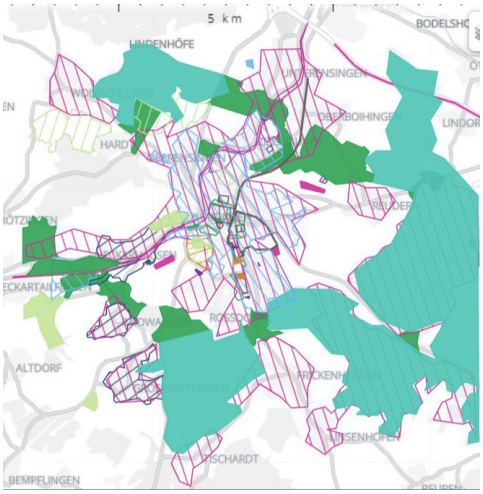


Fig. 1:
Geodesign plan for the early adopters group for 2050 in the Munich park miles case.
Early adopters 2050: Protected green infrastructure near the city and high density and infill housing in the centre. The colours indicate different zoning policies (green: protected agricultural or natural, pink: industrial, yellow: housing).

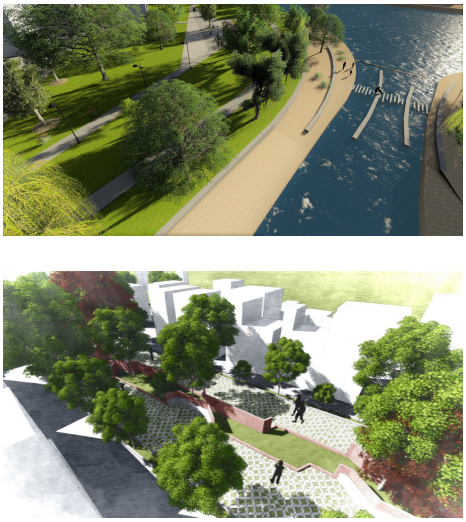
along the major public transport lines towards the city´s edge. In this case, the colours in geodesignhub indicate different types of zoning policies. The green spaces in between, including urban forestry in the south and valuable farm land in the northwest, are put under protection protected from further development. The large inner-city yellow policy zone marks low-density laneway housing in the otherwise high-density neighborhoods.

3.2 Case Study 2019/20: Regional Garden Festival Stuttgart

German garden festivals have become a powerful driver for sustainable urban development. The focus of the student proposals is on a positive impact on the climate. The approach in the 2035 and 2050 scenarios complement each other progressively to implement policies on renewable energy combined with blue and green infrastructure. Land use is planned strategically to mitigate urban sprawl, reduce the urban heat island effect, and increase rainwater collection. Housing is addressed through high-rise developments by converting redundant industrial areas into mixed land use with a focus on bringing in a large "breathing" space in the form of a park that Nürtingen does not currently have (see Fig. 2). Renewable energy projects introduce solar farms, solar surfaces on highways, and policies that require residential and industrial zones to contribute local solar energy.



Early adopters 2050



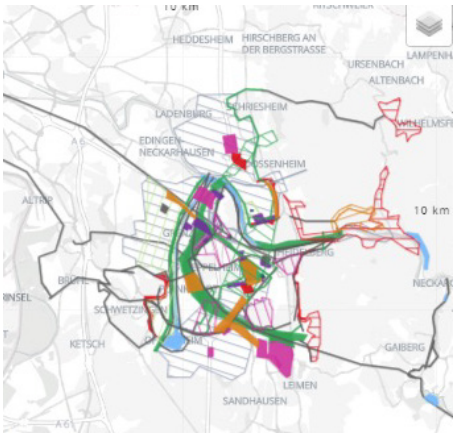
Design for Nürtingen center – integration of blue & green infrastructure with a "city beach" and a park near the City Museum (student work).

Fig. 2: Geodesign plan for the early adopter's group for 2050 in the Nürtingen case and an illustrating 3d visualization generated from the land uses in the plan. The colours indicate different zoning policies (dark green: newly developed green infrastructure "breathing space", turquoise: existing forest and natural areas, pink: existing industrial and housing).

3.3 Case Study 2020/21: Heidelberg Green Belt

The City of Heidelberg and its neighbouring cities, most importantly the City of Mannheim northwest of Heidelberg, have already launched a number of landscape development projects for ecological restoration. At the time of this workshop, the city council had asked the planning department to develop ideas for a multi-functional "green belt" between Heidelberg and Mannheim. Please note that the term "green belt" has been discussed controversially in different contexts. In the context of this project, the "green belt" is supposed to integrate ecological and physical landscape characteristics with multiple land uses (protected natural areas, agriculture, infrastructure, recreation...) in a multifunctional landscape.

Figure 3 is showing the early adopters' scheme for 2050 with green and blue infrastructure corridors visible west of Heidelberg, i. e. along the area adjacent to the Mannheim urban area. In addition to introducing new blue infrastructure, the students suggested links to the strong medical sector in Heidelberg by introducing therapeutic gardens and other forms of restorative landscapes. Interestingly, the seemingly novel idea of creating new blue infrastructure corresponded with a local proposal for an artificial lake.



Early adopters 2050

Illustration of a restorative landscape linked to the medical facilities in Heidelberg (student work)

Fig. 3: Student proposals for the Heidelberg Green Belt with protected areas in the west towards Mannheim and new housing areas in the east. The colours indicate different zoning policies (hatched green: designated green belt, pink: industrial, red: housing).

3.4 Case Study 2021/22: Munich International Building Exhibition

Similar to regional garden shows, the regularly held Internationale Bauausstellung (IBA) is a key driver of national building and planning culture in Germany. It has played an important role in cooperation, innovation, participation, experimentation, and visualization of 10 years of planning and design. Since Munich was awarded the next IBA on the topic of mobility, students were encouraged to envision a regional IBA providing new sustainable approaches to mobility landscapes. The City of Munich IBA team supported the workshop.

The first day mainly focused on learning about the area of Munich and analysing where possible improvements could be made based on suggested systems such as: transport infrastructure, industry and commerce, mixed residential, tourism, blue and green infrastructure, energy infrastructure, climate, and agriculture. One key instrument was the further development of the "park miles", seen in green Figure 4, which had already been addressed in the first workshop by a different group of students.

Government scenario 2050

Photomontage combining the ideas around the green belt, organic farming and park miles (student work)

Fig. 4: Student proposals for mobility landscapes based on green corridors. The colors refer to the blue/green infrastructure (blue and green) and transport corridors (pink lines) linking the urban expansions (yellow and brown for mixed use) and the city centre. In between, areas are designated for the production of renewable energies (hatched purple).

4 Cross-Case Comparison

In all four cases, the students achieved the learning goals. Comparing the four cases, there are commonalities but also differences between the in-person and the online settings:

4.1 Statistical Comparison

The students received grades for 1) participation in the workshops and 2) the quality of the outcome, i. e., the content of the resulting scenarios and their presentation on the posters. Student numbers were supposed to be around 30, but actually varied between 23 and 36 depending on factors out of our control such as visa issues or Covid-19.

A simple descriptive analysis of the average mean grades across the four workshops is presented in Table 2. In general, grades are rather good (with 1.0 the best possible grade). The best participation was recorded during the first in-person workshop in 2018/19, whereas the

second online workshop in 2021/22 had the poorest participation. If you look closer at the grades, participation in the last workshop shows a trend towards a bipolar distribution: quite a few students participated very well in the online workshop, but in contrast, a large number of students participated poorly or dropped out.

Table 2: Overview of average grades achieved in the geodesign workshops (2018-2022) with a grading system from 1.0 (outstanding) to 4.0 (pass) and 5.0 (fail)

Year	Workshop Title	Mode	# students	Av. Grade Participation	Av. Grade Content
2018/19	Munich Parkmiles	In person	33	1.7	1.8
2019/20	Regional Garden Festival Stuttgart	In person	23	2.0	2.0
2020/21	Heidelberg Green Belt	Online	36	1.8	1.8
2021/22	International Building Exhibition Munich Region	Online	29	2.5	2.1

4.2 Cross-Case Observations

In both the in-person and online settings, large numbers of diagrams were created, and both settings led to comparable results in terms of quantity and diversity. With regard to the IGC framework, three scenarios were derived from the diagrams: early adopters, late adopters, and non-adopters. The geodesign process of narrowing down the scenarios to a smaller number of consensus scenarios also succeeded in both settings. For teaching purposes, the scenario process was combined with exercises in negotiation and students "role-played" different stakeholder groups, such as young people, government, business representatives or environmental NGOs. Some students fully embodied their roles and took on a new perspective, leading to interesting discussions, such as proposing affordable housing versus the provision of additional green space.

The online platform geodesignhub facilitated the documentation of the process in both settings, online and in-person. Especially in a teaching environment, it is of great help for the teacher during assessment and grading that all ideas and the scenario building process are archived in geodesignhub.

4.3 Differences between In-person and Online Settings

The online setting can facilitate a broader geographical range of case study topics and locations, although it seemed to come at the costs of sometimes lacking understanding of the site. One group was obviously not aware of local characteristics and depicted high-rises, which were completely out of context.

In terms of organisation, the online workshop made it easier for international students to discuss with local stakeholders than organising such a session in person. Like an in-person setting, the online discussion inspired both groups, students and local stakeholders.

However, the grading showed a lower grade in participation, particularly for the last workshop. From observation, more vocal students tended to engage even more in the online setting, whereas it was much harder than in-person to motivate quiet or disengaged students. Nevertheless, the online setting was a suitable remote learning tool during Covid-19 times, and the geodesign workshop method proved to be well suited for online teaching.

5 Conclusion and Outlook

In conclusion, the learning goals were achieved. Therefore, geodesign workshops are generally recommended for teaching group work methods such as brainstorming, consensus building, and stakeholder-roleplay in GIS-based planning and design. In times of Covid-19 and the need for remote workshop methods, the geodesign workshops were also well-suited for online learning and teaching although participation was slightly lower during the online sessions. These observations are consistent, though, with other classes that were taught online during Covid-19 and could point to a certain online "fatigue".

Regarding the quality of results, the online setting might come at the cost of the students familiarizing themselves with the case study area. It is recommended to further develop hybrid settings, e. g., collaborations with local experts or the development of remote or VR enabled field trip techniques to facilitate a better understanding of the site (HASBROUK & STEPNOSKI 2022).

Findings and group teaching methods from this multiple case study could be transferred to teaching Building Information Modeling BIM. Like geodesign, BIM is a collaborative process rather than a software. In a BIM class, the role-play could simulate the different stakeholders in a BIM process, from surveyor to architect and client, and the BIM model may be used to facilitate negotiations among these stakeholders.

For future geodesign research, it is suggested to focus further on the evaluation of scenarios. Peer review through the students themselves might contribute to the learning and teaching process. In addition, GIS-based or even artificial intelligence (AI) based methods might facilitate new learning and teaching methods by providing real-time quantitative and qualitative feedback. It will have to be seen how the geodesign process is further developing and which role, if any, AI will play in it.

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