



Delft University of Technology

Active online learning in the geomatics domain

The experiences of five European universities

van Loenen, B.; Welle Donker, F.M.; Mansourian, Ali; Schulze Althoff, Jan; Pitz, Nathalie;
Vancauwenberghe, Glenn; Tomić, Hrvoje

Publication date

2025

Document Version

Final published version

Published in

Teaching Architecture

Citation (APA)

van Loenen, B., Welle Donker, F. M., Mansourian, A., Schulze Althoff, J., Pitz, N., Vancauwenberghe, G., & Tomić, H. (2025). Active online learning in the geomatics domain: The experiences of five European universities. In R. Rooij, R. Cavallo, & F. van der Hoeven (Eds.), *Teaching Architecture: Insights from TU Delft – Research on Education Innovation in Architecture & the Built Environment* (pp. 177-185). BookRxiv.

Important note

To cite this publication, please use the final published version (if applicable).
Please check the document version above.

Copyright

Other than for strictly personal use, it is not permitted to download, forward or distribute the text or part of it, without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license such as Creative Commons.

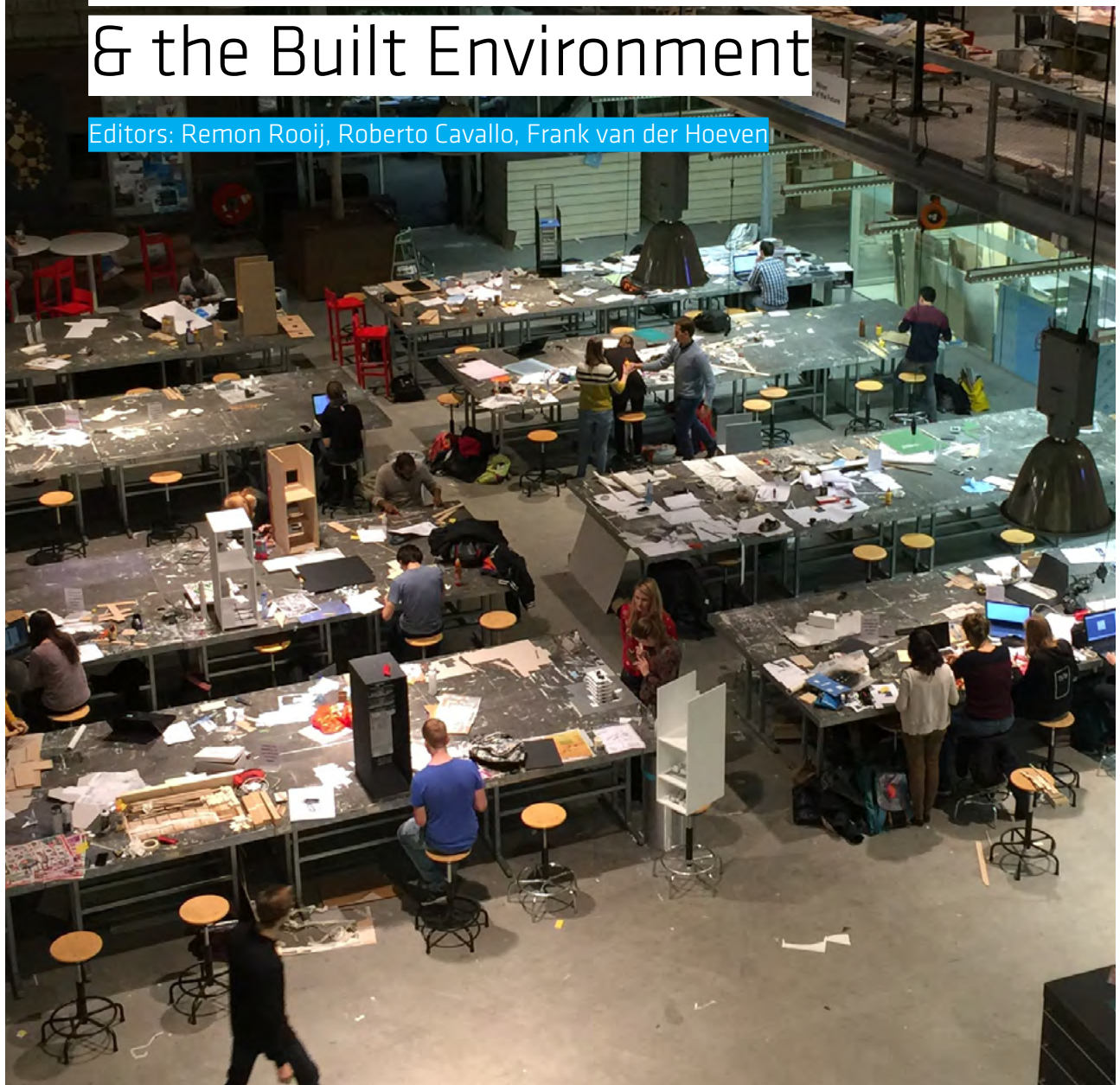
Takedown policy

Please contact us and provide details if you believe this document breaches copyrights.
We will remove access to the work immediately and investigate your claim.

Teaching Architecture

Insights from TU Delft – Research on Education Innovation in Architecture & the Built Environment

Editors: Remon Rooij, Roberto Cavallo, Frank van der Hoeven



Active online learning in the geomatics domain

The experiences of five European universities

Bastiaan van Loenen [1], **Frederika Welle Donker** [1], **Ali Mansourian** [2],
Jan Schulze Althoff [3], **Nathalie Pitz** [3], **Glenn Vancauwenberghe** [4],
and **Hrvoje Tomić** [5]

[1] *TU Delft, Faculty of Architecture and the Built Environment, Department of Urbanism*

[2] *Lund University, Department of Physical Geography and Ecosystem Science*

[3] *Bochum University of Applied Sciences*

[4] *KU Leuven, Spatial Applications Division Leuven (SADL)*

[5] *University of Zagreb, Faculty of Geodesy*

Abstract

Geomatics is a domain that has gained relevance and importance within the field of Architecture and the Built Environment. Typically, Geomatics education in Delft, Lund, Bochum, Leuven, and Zagreb was best characterised as lecture-based: traditional and relatively passive. This has changed fundamentally after March 2020. In this article, we analyse the development towards more active learning and teaching in five university degree programmes regarding geomatics. This study found two types of active online education: digitisation of on-campus education and implementation of new online active learning and teaching methods, including clips, quizzes, forums, in-depth Q&A, and debates. Despite the use of active learning methods, universities are struggling to maintain the attention of students during lectures and with the design of online assessments.

Keywords

Geomatics, geographical information, active online education, teaching

COVER FIGURE Photo by authors

1 Introduction

Modern teaching requires innovative methods to meet today's requirements. Educational institutions can no longer rely solely on face-to-face events but must adapt to the digital world. The increasing number of distance learning courses, the desire to combine family and studies, and the trend towards self-study and self-regulated learning have shifted focus towards digital offerings. This adjustment poses great challenges for many educational institutions but pays off in special situations, such as the Covid-19 pandemic, where face-to-face events are impossible. Digital teaching offers new possibilities for educational exchange around the globe. The location factor of the students is no longer decisive, further promoting the exchange of knowledge.

Online teaching and learning come in many shapes and sizes. In this chapter, we have compared the practices and experiences and discussed the lessons learned from the active online teaching methods that are currently applied in educational programmes on geographical information at five European universities: Delft University of Technology (TU Delft), Lund University, Bochum University of Applied Science, KU Leuven, and the University of Zagreb. These five universities cooperated in the open SPatial data Infrastructure eDucation nEtwoRk (SPIDER) programme to develop an education platform to facilitate the sharing of and access to innovative teaching practices on the topic of geomatics. Via this platform, the SPIDER partners shared their innovative active teaching practices and newly developed teaching practices on topics that were not implemented in geomatics education. Via the platform, teachers, trainers, and students can easily discover innovative teaching practices and learning materials on a wide set of topics within the geomatics domain. This chapter uses texts from and builds on our SPIDER project report (Vancauwenberghe et al., 2023).

In Section 2, we will explain what active teaching and learning is about. In Section 3, we briefly review the geo-information domain, and in Section 4, we describe the online teaching practices of the five universities active in this domain. Section 5 presents the main findings from the comparisons between the five universities, and Section 6 concludes this chapter.

2 Active teaching and learning methods

In a constantly changing society, it is necessary to rethink teaching methods on a regular basis. The technical changes that have taken place in recent decades have changed our everyday lives to such an extent that our thinking has evolved, and we approach problems differently today. Therefore, existing teaching methods must be reconsidered and adapted to societal developments. Face-to-face teaching with active lecturers and passive students no longer seems appropriate, and numerous studies have already questioned its effectiveness (see, for example, Bonwell & Eison, 1991; Michel et al., 2009).

2.1 Active teaching and learning

Active teaching and learning strategies can be described as ‘anything that involves students in doing things and thinking about the things they are doing’ (Bonwell & Eison, 1991, p. 19; cf. Drake, 2012). It is not the traditional one-way direction of teachers or a textbook providing the knowledge to the students. In active teaching, students discuss and reflect on a topic or are challenged to develop solutions themselves (see also McManus, 2001). Fink translates this into three components that are key in active learning strategies (see Fink, 2003, 2005; see also Table 1):

- 1 Receiving information and ideas (e.g. reading a textbook, classroom lecture)
- 2 Experiencing the information and ideas (e.g. case study, roleplay, direct observations)
- 3 Reflecting on the information and ideas (e.g. reflective dialogue with oneself or peers)

	OBTAINING INFORMATION AND IDEAS	EXPERIENCE		REFLECTIVE DIALOGUE WITH	
		‘DOING’	‘OBSERVING’	SELF	OTHERS
Direct	- primary data and sources	- ‘real doing’ in authentic settings	- direct observation of phenomena	- reflective thinking - journaling	- dialogue (in or out of class)
Indirect, vicarious	- secondary data and sources - lectures, textbooks	- case studies - gaming/simulations - roleplay	- stories (can be accessed via film, oral history, literature)		

TABLE 1 Learning activities for holistic, active learning (Source: Fink, 2005, p. 5)

Active teaching focuses on the communication between students and teachers. Interactive teaching methods constantly integrate students into the teaching process, whereby they often subconsciously guide the lessons. The different methods for actively involving students are broadly diversified and include the use of modern media, games, group works, presentations, open discussions, or even roleplays. A well-known example of active learning is the so-called flip-the-classroom concept: before the lecture, students prepare the lecture material (papers, presentations, etc.), and in the classroom, the topics are further explored and discussed, allowing for a better and deeper understanding of the topic at hand (see Abeysekera et al., 2015).

2.2 Active teaching and learning online

Online education may come in many forms and, accordingly, has many definitions. Here, we define online education as:

Education being delivered in an online environment through the use of the internet for teaching and learning. This includes online learning on the part of the students that is not dependent on their physical or virtual co-location. The teaching content is delivered online and the instructors develop teaching modules that enhance learning and interactivity in the synchronous or asynchronous environment. (Singh & Thurman, 2019, p. 302)

In addition to a synchronous or asynchronous environment, online education may be organised as an entirely virtual course with all materials and supervision or tutoring online. The course may also use digital tools connected to internet access to complement traditional classroom lectures (Neri-Vega et al., 2019; see also Lopez, 2004). In Table 2, we applied the active learning and teaching framework of Fink (2005) to active online education.

	OBTAINING INFORMATION AND IDEAS	EXPERIENCE		REFLECTIVE DIALOGUE WITH	
		'DOING'	'OBSERVING'	SELF	OTHERS
Direct	- primary data and sources	- 'real doing' in authentic settings	- direct observation of phenomena	- reflective thinking - journaling	- dialogue (in or out of class)
Indirect, vicarious	- secondary data and sources - lectures, textbooks	- case studies - gaming/simulations - roleplay	- stories (can be accessed via film, oral history, literature)	- reflective thinking - journaling	- dialogue (in or out of class)
Online	- watching recorded lectures - watching videos/clips - reading recommended literature in advance - online lectures and shared screens	- pose a question before the video - review learning material and post the take-homes to the forum - virtual labs/assignments - quizzes testing the understanding of the material - interactive textbooks - group work on a case study - gaming/simulations - roleplay	- online exercises	- reflective writing and peer review - discussion with the teacher - debate with roleplay (e.g. court case)	- group discussions in break-out rooms - group discussions with externals - group discussion through the outcome of online (open-ended) polls - online discussion forum

TABLE 2 Learning activities for holistic, active learning (adapted from Fink, 2005)

3 Geomatics education

Geomatics is the science and art of collecting, managing, analysing, and visualising geographical information, defined as information that is linked to the surface of the earth. Geographical data, or the geomatics domain, is well-known for its technological advances and wide applications, such as Google Maps and TomTom.

Geomatics technologies, skills, and competencies are increasingly relevant in the domain of Architecture and the Built Environment. In spatial planning, for example, knowledge about existing structures above and below the surface (e.g. utility networks, tunnels) and their location has always been key. In addition to planning, GIS is also important in analysing and understanding spatio-temporal dynamics in urban areas. The 3D models and visualisations allow for more accurate analyses and, therefore, better-informed decision-making in the built environment. In landscape architecture, GIS plays a prominent role in the historical analysis of landscapes, visibility analyses of landscapes, and landscape design. Introducing the 3D models of the urban environment into architectural practice and design approaches provides new opportunities to visualise and build new structures or to develop digital twins of cities.

Until March 2020, teaching methods in geomatics education at our five institutions were mostly limited to traditional, relatively passive teaching approaches in the classroom, such as lecturing and reading articles from a prescribed literature list. We barely used online tooling or methods. Since the Covid-19 pandemic, however, the SPIDER universities have been implementing active learning methods through labs and project education. In addition, in some lectures, the responses to online quizzes have triggered additional student discussions, some courses have organised debates or roleplays (e.g. court cases), and in a few instances, classrooms have been flipped.

Until SPIDER, there was limited international exchange of educational material and approaches among universities with geomatics programmes. An overview and detailed analysis of existing geomatics education was unavailable, and an international platform facilitating geomatics education was lacking.

4 Active online education in geomatics at five European universities

The 2024 status of active online education in the geomatics programmes of five organisations involved in the SPIDER project is listed in Table 3.

ONLINE ACTIVE LEARNING AT	OBTAINING INFORMATION AND IDEAS	EXPERIENCE		REFLECTIVE DIALOGUE WITH	
		'DOING'	'OBSERVING'	SELF	OTHERS
Bochum University	- online lecture (live and recorded) with chat - reading selected literature (mainly original standards and papers)	- quizzes and online tests - assignments on data interoperability, data literacy, and data mapping - bigger homework: definition of a complete data provision workflow	- demonstration of the model-driven approach using special software products	- individual review and reflection with the teacher	- group discussions - break-out rooms
Delft University of Technology	- online lecture (live and recorded) with active chat - watching videos/clips - forum - reading recommended literature	- virtual online labs/ assignments - quizzes/polls - case study of NSDI (writing a paper)		- debate with roleplay - individual review and reflection with the teacher - reflection section in a paper	- group discussions during classes in break-out rooms - online open-ended poll to start discussions - peer review - discussions outside classes using Discord
KU Leuven	- online lecture (live and recorded) with chat - reading selected literature	- understanding data licences - searching for and accessing data sets (e.g. via data portals) - understanding (open) data assessments and evaluations		- individual review and reflection with the teacher	- group discussions
Lund University	- online lecture (live and recorded) - watching videos/clips - reading selected literature - group discussions	- assignments - quizzes/polls - case study of NSDI and geoportals		- reflection on issues/ proposing innovative ideas for spatially enabled e-government - individual review and reflections	- designing (being approved by the teacher) and implementing a project
Zagreb University	- online lecture (live and recorded) - reading selected literature	- assignments: using OGC web services to analyse spatial datasets		- individual review and reflection with the teacher	- group discussions

TABLE 3 Summary of active online teaching in SPIDER partners

When it comes to teaching practices, approaches differ between and within universities. Two approaches can be distinguished: (1) online active teaching and (2) digitisation of the traditional classroom (i.e. lectures; see Vancauwenberghe et al., 2023). For example, TU Delft introduced a combined teaching approach whereby some lecturers use the flip-the-classroom method, whereas other lecturers choose to digitise traditional classroom lectures. In the latter case, lectures were given online and recorded for students to watch at any time. A similar practice was used at KU Leuven, with the difference that students from KU Leuven used classic learning materials instead of videos.

The strength of this teaching method is that it allows students to focus more on discussions and understanding the topic. In contrast, the other partner universities used traditional teaching methods but in an online environment. For instance, Bochum University of Applied Sciences transferred most lectures to online mode with PowerPoint slides presented in an online session. As for online tutorials (for projects), students followed the steps the tutor demonstrated on screen in real-time. The University of Zagreb used the same technique, as did some teachers from Lund University.

5 Discussion

Although the very first step in the development of online material is to lecture online, record the lecture, and allow for questions through the chat, this format remains rather passive. Adding intermediate quizzes to test the understanding of the students or to stimulate discussion is an appreciated next step towards truly active online education: students are provided 5 to 10-minute clips or instruction videos, which they have to watch before the lecture. During the lecture, the teacher discusses the clip with the students, or the students can ask questions about the video and work on the assignment. There is a forum where students can discuss any course-related topic with readily response times from either students or teachers. If applicable, students cooperate in break-out rooms and present their work in non-traditional ways to their peers and supervisors. Course evaluations by the students and the teachers showed that the flip-the-classroom method is highly appreciated by students. In addition, the assessments showed that the teachers also enjoy creating a flipped classroom (see Mansourian et al., 2022).

In our experience, the remaining issues include:

- 1 Silent students in the break-out rooms. Unlike in classroom group discussions, where a teacher can walk around to quietly observe levels of participation, in break-out rooms, it is not possible to enter without being noticed.
- 2 Single active students in a discussion, especially if video or audio are switched off.
- 3 It is difficult to know how much time groups need in break-out rooms or if they need help.
- 4 Not all students can easily participate in synchronous activities (unreliable internet access, no quiet space, not in the same time zone).
- 5 Difficult to assess the exact needs and questions of students as there is no eye contact.
- 6 Maintaining the attention of students.
- 7 Ensuring that all students are involved.
- 8 If the lectures are solely based on clips, the efficient updating of relevant materials.
- 9 Students do not always grasp the essence of the clips when watching at double speed.
- 10 Sharing stories and experiences from 'insiders' – lecturers participating in real-life situations in an online setting.
- 11 Efficiently developing course material.

6 Conclusion

Recently, active online education has gained significant traction in five geomatics Master's programmes in Europe. When it comes to teaching practices, approaches differ between and within universities. Two approaches were distinguished: (1) online active teaching and (2) digitisation of the traditional classroom (lectures). The students appreciated that the traditional classroom was transformed into an online learning environment within two weeks during the Covid-19 pandemic, allowing them to continue their studies. However, they preferred the quick change to the new format of true online teaching with clips, in-depth discussions, forums, chats, and discussions in break-out rooms even more.

We are only at the very beginning of the implementation of active online education, and many issues remain to be addressed, such as how to maintain the attention of students, how to involve all students, and how to efficiently develop course material. However, as one teacher put it in 2021, Covid-19 made it possible to successfully implement in five weeks what we have been discussing over the past five years.

Acknowledgements

This paper was written as part of the SPIDER: open SPatial data Infrastructure eEducation nEtwoRk project under the Erasmus+ programme (project number 2019-1-DE01-KA203-005042). The SPIDER toolkit is available at <https://sdi-spider.github.io/toolkit/>

References

- Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: Definition, rationale and a call for research. *Higher Education Research & Development*, 34(1), 1–14. <https://doi.org/10.1080/07294360.2014.934336>
- Bonwell, C. C., & Eison, J. A. (1991). Active learning: Creating excitement in the classroom. ASHE-ERIC Higher Education Report 1. George Washington University.
- Drake, J. R. (2012). A critical analysis of active learning and an alternative pedagogical framework for introductory information systems courses. *Journal of Information Technology Education: Innovations in Practice*, 11, 39–52. <https://doi.org/10.28945/1546>
- Fink, D. L. (2003). *Creating significant learning experiences: An integrated approach to designing college courses*. Jossey-Bass.
- Fink, D. L. (2005). Integrated course design. IDEA PAPER #42, March. IDEA Paper series, IDEA. https://ideacontent.blob.core.windows.net/content/sites/2/2020/01/Idea_Paper_42.pdf
- Lopez, M. (2004). The implementation of online courses at a classroom university. Case: University Center of the South. <http://www.rieoei.org/deloslectores/1198Lopez.pdf>
- Mansourian, A., Vancauwenberghe, G., Pitz, N., Schulze Althoff, J., Welle Donker, F., van Loenen, B., Molano Bernal, S., Zhao, P., Tomić, H., & Kević, K. (2022). Showcase of existing active teaching practices. Report for the project SPIDER: open SPatial data Infrastructure eDucation nEtwoRk. Erasmus+ Strategic Partnerships. https://sdispider.eu/wp/wp-content/uploads/2021/12/IO4-Report_2021_10_14.pdf
- McManus, D. (2001). The two paradigms of education and the peer review of teaching. *NAGT Journal of Geoscience Education*, 49(6), 423–434.
- Neri-Vega, J.C., Gonzalez Neri, A.I., Gonzalez Neri, H.M. & Albertti Gonzalez Neri, R. (2019). The creation and correct operation of the virtual platforms as teaching support in face to face classes. *International Journal of Innovation and Research in Educational Sciences*, 6(3), 369–382.
- Singh, V., & Thurman, A. (2019). How many ways can we define online learning? A systematic literature review of definitions of online learning (1988–2018). *American Journal of Distance Education*, 33(4), 289–306. <https://doi.org/10.1080/08923647.2019.1663082>
- Vancauwenberghe, G., Lacroix, L., Casiano Flores, C., Welle Donker, F., van Loenen, B., Calzati, S., Keßler, C., Küppers, N., Panek, M., Mansourian, A., Zhao, P., Tomić, H., Kević, K., Poslončec-Petrić, V., & Bačić, Ž. (2023). Development of new active teaching practices. Report for the project SPIDER: open SPatial data Infrastructure eDucation nEtwoRk. Erasmus+ Strategic Partnerships. https://sdispider.eu/wp/wp-content/uploads/2023/04/SPIDER-_IO6_FINAL.pdf

