

Teaching Geospatial Technologies with Problem-Based Learning

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Abstract. Problem-Based Learning follows the idea that theory is best internalized when applied to authentic, real-world problems. A large share of the students' education is thus to engage in project work both at the university and with external partners. This position paper outlines how Problem-Based Learning is implemented at Aalborg University Copenhagen to teach geographic information concepts at the undergraduate and graduate levels and discusses the strengths and weaknesses of this learning model in comparison with a more classical university education focusing on lectures and seminars.

The Aalborg Model

Problem-Based Learning (PBL) is recognized and implemented across different universities receiving great interest e.g., in Aalborg (Denmark), Maastricht (the Netherlands), Linköping (Sweden), McMaster (Canada) and Newcastle (Australia). At Aalborg University, PBL has been introduced as an educational approach in which a real-world or hypothetical problem adapted to fulfill educational criteria is the departure point of the learning process. It is essential that the chosen problem serves as the basis for learning, determines the direction of the learning process, and concentrates on the formulation of questions rather than on answers. The learning content has to be related to the context so that students' incentive and understanding is stimulated (De Graaf & Kolmos, 2003; Kolmos, Du, Holgaard, & Jensen, 2008).

All educations at Aalborg university include PBL in which a set of principles are taken as point of departure that constitute the Aalborg model of problem-based learning. The Aalborg model supplies students with tools and instruments for self-acquisition of skills and competences within self-governed group work and collaborative environment in cooperation with internal and external

partners. The Aalborg model is based on the following principles (Inger, Linnemann Prehn, Pedersen, & Thorsø Pedersen, 2018):

1. Project organization creates the framework of problem-based learning,
2. Lectures back up the project work,
3. Cooperation is a driving force in problem-based project work,
4. The problem-based project work of the groups must be exemplary,
5. The students are responsible for their own learning achievements.

At the undergraduate level, the project work accounts for 50% of the students' time, at the graduate level typically even more. Students work on the project and write a report about it in groups of two to seven students. Each group is assessed based on the report and a final extensive oral exam, where the duration is 45 minutes per group member (i.e., a group of 4 students will go through a 3-hour exam). The final also facilitates individual grading of the students, as it leaves enough time to pinpoint the driving forces within a group, and those who contribute less.

Geoinformatics at Aalborg University

While geospatial technologies play a role in a number of educations at Aalborg University (such as the bachelor programs in *Urban, Energy and Environmental Planning, Geography or Surveying*), they are front and center in the master's program in Geoinformatics, which is one of three specializations under the Surveying, Planning and Land Management program. The program attracts an international crowd of 15–20 students per year, who come from a wide range of backgrounds such as building engineering or archeology, but also more closely related fields such as surveying or geography. Teaching and project supervision in the program is largely covered by the authors of this paper.

Since PBL-based project work plays a major role in the program, it only contains four conventional courses with lectures, exercises, and exams: *geospatial information technology* and *modern data acquisition methods* in the first semester, and *geovisualization* and *geocomputation and spatial analytics* in the second semester. The course content has been modeled after the results of the GI-N2K (*Geographic information: Need to Know*) project, which has defined a body of knowledge to prepare geographic information professionals for the labor market (Salvemini et al., 2016). These courses are completed in the first half of the respective semester, so that the second half is reserved for project work. The third semester consists of a professional development module, which can be covered through an internship in a company/agency or a semester at a different university. The fourth and final semester is reserved for the Master's thesis.

Problem-Based Learning for All?

The projects in the first and second semester at the master level are usually conducted in groups of three or four students. Each group develops a project idea and implements it in close collaboration with a faculty supervisor. During this phase, which typically takes around ten weeks, the students get the chance to apply what they have learned in the lectures and initially practiced in the exercises in a real project setting, where they work with real data and need to get themselves up to speed with the state of the art. Most importantly, the students need to reflect on the methods that they want to apply and whether their application makes sense in the context of the given project. Recent projects in the program have dealt with the identification of optimal new locations for charging stations for electric vehicles, the impact on access to public transport of the Metro system currently under construction in Copenhagen, and geosimulations to assess potential future growth of slums.

Since PBL is certainly a unique form of education compared to more traditional programs focusing on lectures and seminars, a critical reflection is required to realistically assess how fit it is for a graduate program in geoinformatics. The strengths of PBL are clearly in its very practice-oriented character, preparing students for work in the job market. Moreover, students are well-prepared for their master's thesis when they start the final semester, as they have already gone through the process of organizing a project and writing a scientific report twice. In our experience, this gives them much more confidence in the way they approach their thesis research. Finally, the projects also present an opportunity for students to focus on their specific interests or select a topic that fits their background. This is particularly the case for students who come to the program with a graduate degree from a different field and want to gain deeper knowledge about geospatial technologies.

Teaching geospatial technologies to a crowd of students with very diverse backgrounds and varying levels of technology savviness and programming skills is the biggest challenge in this context. While not necessarily a problem that is unique for PBL, it becomes most apparent in the projects, where students who are less proficient in the technologies are quickly left behind. It is then the supervisors' role to make sure that those students can still contribute to the project. Students who come in with a background close to geoinformatics and who may already have experience with geospatial technologies have a clear advantage, but at the same time, some of the material covered in the lectures may be repetitive for them. Furthermore, studying in a PBL environment as such is a process of learning by doing, so the group work is most efficient if some of the students have a bachelor's degree from Aalborg University or similar experiences with PBL.

In the context of such a program, we see the biggest potential for a set of core concepts and clearly defined computations for them in forming a common ground for such a mixed crowd of students. Such a solid conceptual basis could even be made a requirement and, for those who do not fulfil it, offered as a prep course. During the program itself, it could help students to form a better understanding of what a certain method does at the conceptual level. Moreover, it would also allow other disciplines to rely on the same conceptual corpus, where – ideally – all tools, from low-level programming libraries to easier-to-use desktop GIS are linked back to the same underlying principles.

References

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