

A Roadbook for the Professionalization of Project-based Learning Courses

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Abstract

Project-based learning (PBL) is a teaching method that encourages active, experimental learning and transforms students from passive recipients to active participants. This method shifts the educational process from a teaching-centered to a learning-centered environment, thereby promoting effective and sustainable learning outcomes. Although a large number of research articles deal with learning outcomes from the students' perspective and the adjustments made by teachers, the transition from traditional to PBL-based teaching methods can be a challenge for all involved. The roadbook method provides an in several university courses tried-and-tested, development concept with defined result types and creation processes for project-based teaching. It also works for several cooperation partners, topics and student teams at the same time and allows sufficient flexibility in execution. In addition to the advantages of a project-based course for students, it also simplifies the necessary activities for lecturers and cooperation partners.

Keywords: *Project-based learning; Development Concept; Data-centric process.*

1. Introduction

Project-based learning (PBL) is a teaching method that promotes active, experience-based studying and turns learners from passive recipients into active participants (Thomas, 2000). This method, based on constructivism (Reinmann-Rothmeier, 2001), shifts the educational process from a teaching-centered to a learning-centered environment, thereby promoting effective and sustainable learning outcomes (Helle, Tynjälä, & Olkinuora, 2006). At Munich University of Applied Sciences, business administration students from Munich (Germany) and IT students from Tampere (Finland) were to work in several teams to solve different digitalization topics from several cooperation partners in a joint course in one semester.

According to Thomas (2000), PBL involves the completion of complex tasks that usually result in a real product, service or even just a presentation to an audience. But, the support for lecturers

(Condliffe, 2017) often remains at a very basic level. A more or less free-form project-based course can become a risk. Especially, projects in the field of digitalization of business processes are accompanied by the creation of a business concept with subsequent IT design, development and testing. Due to the complex, company-related context with changing cooperation partners from industry, go along with current challenges and authentic customer behavior such as unclear tasks and change requests.

Since industrial practice also follows fixed procedures such as design thinking (Jia, 2023) or optimization of business processes in order to minimize risk and maximize success, it makes sense to use these structures as the basis for detailing the weekly course sequence for project-based courses as well. The roadbook concept provides lectures and students with a structure of procedures that they are often already discussed in theory, allowing them to concentrate on the content and interaction with cooperation partners and fellow students. Lecturers benefit from the fixed framework from faster planning and initiation of a course, structured implementation of projects, even with several cooperation partners and topics. For the cooperation partners, the clear, previously agreed structure facilitates participation in project-based courses through fixed tasks, time frames and interaction points.

The following section outlines the current state of research and provides an overview of the roadbook concept and its theoretical derivation. The following section reports on the practical application at the university.

2. Related Work

Although a large number of research articles deal with learning outcomes from the students' perspective, the transition from traditional to PBL-based teaching methods can be a challenge for teachers. Among others, Zhang and Ma (2023) show in their meta-study that PBL has positive effects on learning outcomes with a focus on academic achievement, thinking skills, and affective attitudes. Furthermore, it was found that the effects are influenced by various conditions such as subject area, course type, academic period, group size, class size, and experiment period. Many aspects such as group size, the need for a real-life task, and interdisciplinarity increase the burden on teachers. Also, Almulla (2020) explores the effectiveness of the PBL approach as a means of engaging students in the learning process. The results show that the PBL method improves student engagement by facilitating knowledge and information sharing and discussion. Therefore, a framework for PBL for lecturers is requested, consisting of guidelines for teachers to incorporate the PBL approach in different areas of learning and learning processes. Helle et al. (2006) also point out that the majority of scientific articles are exclusively course descriptions of individual courses. In addition to the technical aspects, it is analyzed that the organization and administration of project-based courses is time-consuming. According to Condliffe (2017), there are several levels of use for PBL. The

teacher-initiated PBL is most flexible but lecturers start these courses "from scratch" or gather input for the course themselves, which means a great deal of individual effort. For the effective use of PBL, Barron & Darling-Hammond (2008) call for support for the role of the lecturer. According to Blumenfeld et al (1991), the lecturer should also be supported with a "project support environment" that provides knowledge about implementation, help for self-help and for planning and management. Groschel and Roth-Dietrich (2018) reports on the implementation of a project-based course with external cooperation partners with an organizational and process structure, which describes a general technical and rough time schedule within the framework of a practical project in a course. Bernstein et al. (2005) take the approach of using a virtual software development company and a standardized procedure from software development. Although the need for lecturers is partially addressed, there is no discussion of operational support to get that framework.

3. Roadbook Concept

With the help of a universal roadbook concept, a project-based course is to be professionalized by providing a clear and accepted course structure in the form of procedures and results, but also offering freedom of scope and feedback opportunities for students.

3.1. General concept

A roadbook is intended to make it easier for lecturers to plan and implement a PBL-course with known objectives and result types, but also for students to master the challenges that arise with unfamiliar project topics. A roadbook is a detailed guide that offers participants through orientation, efficiency in planning and implementation and safety, but also freedom in terms of content. A project-based roadbook usually consists of the following components:

- Project starting point in the form of defined assignment descriptions and project end point in the form of expected result types, i.e. deliverables for the client and lecturer like software and business concepts
- Overview of the overall process
- The content-related tasks between the individual course slots (and the overall course) as sub-results types
- Detailed descriptions of the procedure to be used (process for creating the sub-result types)
- The roadbook uses templates to standardize the creation of the sub-result types
- The roadbook contains a detailed schedule in a specific time frame (i.e. semester)
- Notes: Helpful notes and explanations increase success.

3.2. Data-based processes for building the roadbook

The key elements of a roadmap are the standardized partial deliverables (i.e. sub-results like a `Persona` in design thinking, an `IT Architecture` in software development or a `Retrospective` in scrum) and procedures (i.e. the process to develop the sub-results) that offer participants orientation, efficiency and security in planning and implementation. The approach of Müller (2007) for the development of a data-driven process structure serves as a basis for the design of project-based courses. The aim is to reduce effort by increasing model reusability, i.e. not “reinventing the wheel” in each semester and maintainability and a parallelization of several projects and cooperation partners in a group of students.

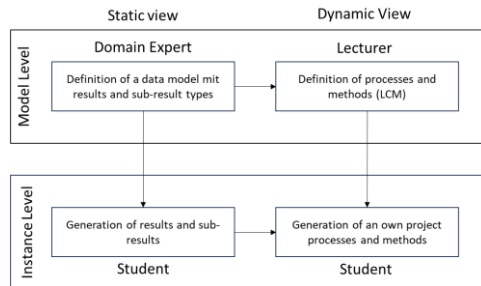


Figure 1. Data-based process – derived from source: Müller et al 2007.

In general, this requires (Fig. 1) the definition of the (sub-)result types and their relationships as a static view and the definition of the processes as a dynamic view for generating a course schedule. Furthermore, the two levels, i.e. model level in planning by the domain experts and lecturers and instance level in the implementation by students are required.

Static view

The domain specific data model consists of object and relation types and is specified by domain experts. This data model will be instantiated by the students in creating the specific project results during the project time. The object type represents a (sub-)result type of a procedure for solving a task. A relation type reflects the relationship between two object types. For a design thinking project, a domain expert will request sub-result types such as a `Persona`, a `Storyboard` or a `Vision` (Fig. 2). In addition to instructions for implementation and tips, templates are also provided.

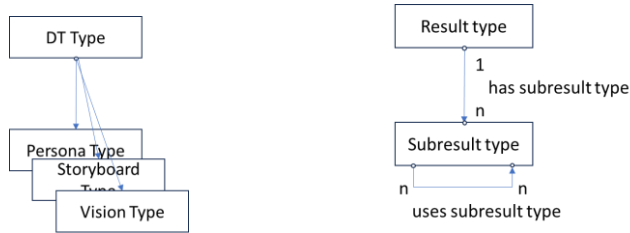


Figure 2. Result Types and Design Thinking Example on Model Level

The instance level is established during the implementation of the student projects. Instances are the specific `Persona` for the respective case: these are created in the implementation of the project and are vertically related to the specification of the model level. The materials provided in the model level support and standardize the student's results.

Dynamic View

Dynamic aspects of the creation of the object types are described by the lecturer in the processes at model level in order to derive the course sequence. The lecturers describe the dynamic aspects of each object type by modeling the "life cycle" of the objects/ sub-results through processes and their sub-processes. The LCM (Life Cycle Coordination Model), named by Müller et al (2007), structures the states and creation of the result types and their dependencies. Each result and sub-result type is described in the LCM with its dynamic aspects. For this purpose, the activities for changing the result and sub-result types and their status are modeled (fig. 3).

The actual creation of the results by the students is shown at the instance level and is derived from their results under the specified process structure. The difficulties lie in the process, but also in the dependencies of the different results.

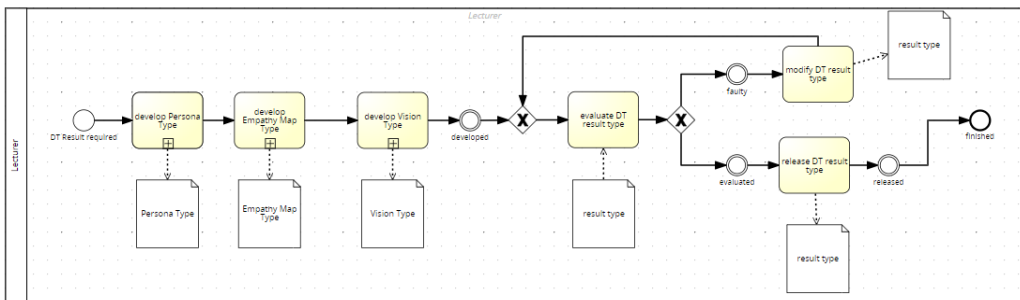


Figure 3. Example Design Thinking of LCM on model level modelled in BPMN

3.3. Procedure for creating and improving roadbooks

Roadbooks are set up initially by domain experts and lecturers, but are subject to a continuous improvement process, as each implementation provides new insights and potential. Based on

the data model and process model at model level, the roadmap of a course can be derived by adding specific course content, times and other restrictions to the course.

1. Design initial data model from existing procedures at model level by domain experts: Collect of all necessary result and sub-result types and their dependencies and derive specific templates, descriptions and work instructions
2. Derive initial processes and sub-processes from data models by lecturers with their corresponding states at model level through process modeling with dependencies, interfaces, roles and result types and mapping to the respective time slot of the class
3. Implementation of a class with multiple instantiations in parallel projects through students. Of course, the weekly time slots of the course are fixed for lecturers and students.
4. Optimization of data models and processes after each implementation such as adding new data types, smoothing interfaces, new interactions or improved quality assurance.

4. Sample Case

A typical setup can be found at the Munich University of Applied Sciences in the Co-Innovation Lab (www.co-inno-lab.org), where each semester approx. 50 business administration and computer science students with several cooperation partners from industry, associations or authorities are to solve real challenges in teams of approx. 10 students, in which a business concept and an IT prototype are to be implemented on a cloud platform. The duration comprises three months (one semester) with approx. 150 hours of working time, of which approx. 50 hours in attendance. The examination is a project paper. The course comprises the three phases of preparation, implementation and follow-up.

- In the preparation phase, domain experts optimize and fix the general (sub-)results at model level. On the IT side, this includes an IT architecture; on the business side, it includes a process model. A lecturer from business and a lecturer from IT are usually used for this. From a dynamic perspective, the rough schedule is laid out in terms of semesters and vacation periods in order to finalize the roadbook. Before the start of the projects, the students receive an information package about the requirements of the project paper with result and sub-result types, the general procedure and the PBL process.
- During implementation, the projects are carried out by the respective teams - usually five to six projects in parallel with the help of the existing structure. Analogous to Bernstein (Bernstein, 2005), the module begins with the description of the "consulting firm" by the lecturers as the management team. On this basis, the challenges and cooperation partners are then introduced, teams formed and topics assigned. The actual processing takes place on the basis of the roadbook, in which students work on the result types independently,

customize the process for their own team and topic. Several sub-results are discussed each week in class. The cooperation partners are invited at predefined times to review the results and provide input.

- In the follow-up, the results are finally submitted to the cooperation partners and the supervising lecturers and blog posts are published. In a joint discussion between lecturers and domain experts, adjustments are made for the next semester.

4. Critical Discussion

Nevertheless, there are issues that can only be dealt with to a limited extent, even through professionalization, but rather require individual treatment. Despite the professionalization of the process, human problems such as intercultural or interdisciplinary conflicts can arise among the students, different time availabilities outside the course, but also development problems due to a different understanding of result types. Dealing with cooperation partners and understanding the current situation is particularly unfamiliar. Lecturers are often faced with the question of when and how to intervene in teamwork in terms of organization or content, or which controlling function should lie more with the cooperation partner. The cooperation partner should be informed in advance about the expectations regarding the scope of the results and, if there is too little project experience, about the tasks such as content-related feedback on results during the project. Important here are the additions for quality assurance on sub-results by the participants through group discussions, performance assessments, solution reviews or self-assessments (Barron et al 2008). It should also be noted that this type of synchronization of several parallel projects using the roadbook only works if the project types and result types are the same.

5. Conclusion and Outlook

The roadbook has proven to be a suitable tool for planning, but also for the implementation of project-based courses. Also in international cooperation projects, it makes it easier for everyone involved to organize courses that are based on process-driven challenges. The students are placed in a highly complex and challenging situation due to the project topics, the cooperation partners and the interdisciplinary approach. However, the roadbook helps all those involved to obtain certainty and planning in advance and still retain the freedom to shape the content. A side effect of this realistic lecture is the opportunity for application-oriented research for academic staff and for theses, which arises from a variety of challenges faced by the participants.

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