

Reconstructing the Aalborg Model for PBL

- a case from the Faculty of Engineering and Science, Aalborg University

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Abstract

Aalborg University (AAU) has been one of the front-runners showing the way forward for the establishment of a problem based and project organised environment and in 2010, a new PBL model and a rather comprehensive curriculum restructuring took place at the Faculty of Engineering and Science at AAU. Therefore this paper focuses on what this implementation process can tell us about the drivers, challenges and prospects of reconstructing PBL curricula? We address this question by reporting on the experiences from the middle management level based on interview with three school leaders and 11 study board directors. Based on the results, we stress that although innovations obviously have to happen at a certain pace in order to reflect the state of art in society, the pace have to be adjusted to make room for i) pedagogical support and training, ii) a strong coordination to assure an aligned curricula iii) appropriation of the model to local contexts iv) a strong awareness of the difference in the pedagogical methods and the interplay between them. In relation to the last point, different PBL models with different combinations of project, course and case modules are described and discussed.

Keywords: Curriculum development, implementation processes, PBL models.

1. Introduction

Aalborg University, Roskilde University (both Denmark), Maastricht University (the Netherlands), and McMaster University in Canada were all founded in the 1960s and 1970s where the reform pedagogy originated and they have all established university programs within a problem based and project organised (PBL) practice. The four universities have different PBL models, but basically the same learning principles count: problems, teamwork, self-directed and student centred learning, exemplary learning and not least inter-disciplinary in problem analysis and problem solving. These learning processes can then be organized in slightly different ways, e.g. in projects or cases (de Graaff & Kolmos, 2007).

But having established a PBL model once does not mean that the educational prospect therefore is fixed and finished. It is no longer enough (and probably never has been enough) to initiate one radical change from e.g. a traditional model to a more student centred model such as problem based and project based learning. We also need to make on-going adjustments and changes to keep up with internal as well as external political and societal demands and to develop and influence such societal changes.

Those reform universities have undergone phases of change. Neville and Norman (2007) describe three phases of major curriculum change at McMaster University. The change at the medical school that illustrates the dilemma between a more conceptual and disciplinary focus versus a more contextual focus. This is a discussion that most PBL programs and universities can recognise, as this is a core element in the difference between a traditional academic curriculum and a PBL curriculum. At Aalborg University, there is a long tradition for contextualising disciplinary knowledge as an integrated part of the PBL philosophy (see Jamison & Holgaard, 2008), and the PBL model is internationally recognised for its far-reaching PBL pedagogy. However, the Aalborg PBL model is challenged for several other reasons, which had led to a more substantial systemic change in 2010.

AAU has been one of the front-runners for the establishment of a PBL environment. Descriptions of the AAU PBL learning principles by an external consultant are presented in the booklet "Principles of Problem and Project Based Learning - The Aalborg PBL model" (Barge, 2010). The PBL elements described by Barge (2010) have been used in an internal benchmarking exercise and, as such, served as an internal and external signal of how a PBL model may look like. But this process also sheds light on the diversity in the interpretation and practise of PBL at AAU, which questions if there is in fact *one* dominant PBL Aalborg model, taking the practise at the different faculties and different programs into consideration. The formulation of the AAU PBL model has thereby raised internal awareness of these diversities, and initiated discussions of principles as well as practices, and has as such served as in internal energizer for change.

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At the Faculty of Engineering and Science, this process of writing up the PBL principles went on parallel to a rather comprehensive curriculum restructuring in 2010, where the interrelationship between the subjects and project modules were to be considerably changed (Andersen et al., 2009). This was a considerable challenge for the study-boards representing the different programs and the implementation was, as any implementation, influenced by local contexts related to the different programs as well as different perceptions of why and how these changes should happen. Furthermore, reflections after the implementation process have brought strengths and weaknesses of the new PBL model out in the open, providing insight for further development. The question is: what can this implementation process tell about the drivers, challenges and prospects of reconstructing PBL curricula?

We will address this question by reporting a more comprehensive study on curriculum change at the Faculty of Engineering and Science focusing on how the study boards have perceived the process. The overall study has included experiences from top-management at the faculty level, middle management at school and study board level and last but not least from teachers and students. These experiences have been gathered by a mixed-methods approach, including individual as well as focus group interviews and surveys. This article draws upon previous reported interviews with top-management and presents the drivers and strategy for change (see Myrdahl et al., 2011). It also highlights new results from the analysis of the implementation and outcome at middle management level (Kolmos & Holgaard, 2012). This study reports the interviews which involved three school leaders and 11 study board directors. Each interview was semi-structured and lasted approximately one hour. The data were analysed thematically by categorising perceptions of the old as well as the new model and the challenges of implementing and revising the new model.

In the following section we will shortly present the context of the study, first by introducing the overall principles of the PBL philosophy behind the Aalborg model and then by presenting the elements in the old as well as the new model (section 1). After that, we describe the drivers for change, the challenges in the implementation phase, the actual outcomes of the re-construction process and the perspectives for further developments of the overall model (section 2). This leads to specific attention to the challenge of making comprehensive and aligned curricula that secures the interrelation between subjects and projects (section 3). Finally (section 4), we conclude this paper by discussing what the Aalborg case informs about the drivers, challenges and prospects of reconstructing PBL curricula.

2. The former and present Aalborg PBL model

The PBL philosophy embedded in the Aalborg model builds on constructivism as a learning philosophy and democratic values in terms of participant directed learning (cf. Kolmos, 1996) and contextual knowledge (cf. Jamison & Holgaard, 2008). In particular, the principles of the PBL model at Aalborg University follows the three dimensions of PBL learning stressed by Kolmos et al. (2009): i) Cognitive learning based on problems, projects, experiences and context, ii) Collaborative learning by teams and participant directed processes iii) Contents stressing inter-disciplinarity, exemplarity and the relation between theory and practice.

However, there are many ways to structure these elements, and in the following we will present the “old” Aalborg model, which have formed the basis for the structure of PBL curricula in more than 20 years at the Faculty of Engineering and Science, Aalborg University and the “new” reconstructed PBL model implemented in spring 2010.

2.1. The “old” Aalborg model

In the “old” Aalborg model illustrated in figure 1 (Kolmos et al., 2004), the so-called ‘project unit’ covered approximately 75% of the semester and consisted of a project covering 50% of the semester and so-called project unit courses amounting to 25% of the semester. The project unit courses were on topics aimed at being used and assessed during the project. The project unit resulted in a project report jointly authored by the students in the group. Finally, 25% were covered of the so-called general courses assessed in separate exams.

The Old Aalborg Model

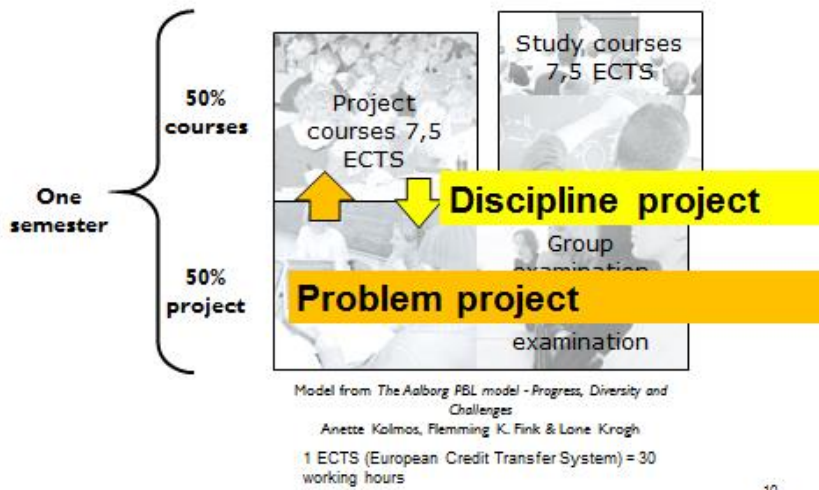


Figure 1. The old PBL model at the Faculty of Engineering and Science.

Typically, the phases of a project module were that a team of students (usually between five and eight), within the frame of a pre-defined project unit theme, formulated an initiating problem (sometimes based on a catalogued of project proposals). Then they moved to problem analysis and based on that, they formulated a narrower problem related within disciplinary boundaries. Taking the point of departure in this problem formulation and a methodological framework they solved this problem and assessed the proposed solution taking results of the problem analysis into consideration. This was reported in a written project report. In the project unit courses, the students were given lectures and worked with assignments which were in direct connection to the semester theme; and due to the close relation between the projects, these courses were assessed during the project exams. This was different to the general courses, where the learning outcomes gained not necessarily were applied directly in the projects in the same semester. The general courses were instead targeted towards more generic skills, to be developed over several semesters. Courses in the field of mathematics and physics were typical examples of such general courses. These courses were assessed separately, in either an oral or a written exam.

The individual project in the courses might be closely related to the project unit themes or, depending on the student's choice of problem, result in very different types of themes. In the case of rather narrow semester themes, the project learning outcomes could be directly related to one or more project unit courses. In such a case, the project's role was to further develop the skills obtained in the project unit courses to competences through addressing real life problems (i.e. a so-called discipline project). In cases, where the project theme were more openly defined (enhancing so-called innovation project), the project unit courses were developed in a more ad-hoc manner in order to address the challenges students were facing in their actual projects. To prepare project unit courses that could capture the diversity of the projects, a high number of small project-unit courses of 1-2 ECTS were developed.

2.2. The new Aalborg model

In the new PBL model, project unit courses are abolished, and thus the project unit as a concept does not exist any longer. In the new model, there is a new terminology: course modules and project modules (section 3.0 discusses the differences of these modules in more detail). The old project unit was limited to the project module, which constitutes 50% of the time. In addition, there are now three course modules of 5 ECTS, each with their own exam (see Figure 2). This new PBL model appears less complex than the earlier model, but the course modules are not necessarily supplementing the projects, although some may be.

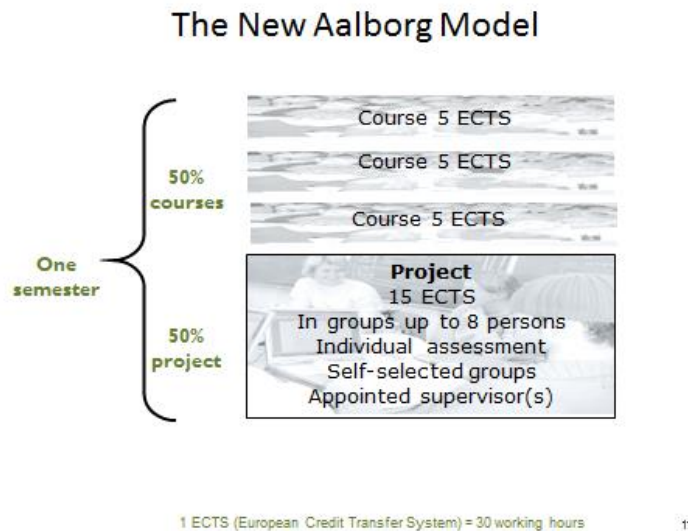


Figure 2. The new PBL model at the Faculty of Engineering and Science.

3. Evaluating the change process

The evaluation of the change process due to the reconstruction of the PBL model has included several components, an analysis of the drivers for change, the organizational challenges in the implementation phase, the pedagogical practice that is derived from the new PBL model as well as perspectives for further developments of the model. In the following section, an overview of the results, related to these focus points, is presented based on the more elaborated report by Kolmos and Holgaard (2012).

3.1. Drivers for change

Analysis of the interviews with top-management indicates that the changes in the Aalborg model were initiated as a response to the considerable changes in the external framework conditions for higher educations in Denmark. These conditions include a decrease in financial support and accreditation demands owing to the Bologna process. The internal reasons were to create a more flexible system for credit transfer and visions of more active learning methods in the larger courses. It also includes an opportunity to reduce the stress of both students and teachers due to the national accreditations process which resulted in that learning outcomes and the number of accredited ECTS in the Aalborg curriculum were adjusted to become similar to curricula requirements at other universities. Before the Aalborg students had worked “too much” for the same ECTS (Myrdahl et al., 2011).

The leaders of the study boards have followed much the same line of reasoning, but emphasized two main arguments for changing the curriculum. The first reason was that there were too many smaller courses and it was difficult to credit other types of courses earned outside the enrolled program. The second reason was related to the assessment of the project unit courses, which became problematic when the Danish government in 2007 banned group-based assessment. This meant that there was not any longer an opportunity to argue and discuss the project as a team and the discussion of the project phases was broken up into short sessions (Kolmos & Holgaard, 2010; Holgaard & Kolmos, 2009).

3.2. Challenges in the implementation phase

One of the biggest challenges in the implementation process was to re-design the project unit courses as well as general courses to fit the standard of having three courses of 5 ECTS each semester and at the same time re-select content for the courses to harmonise the norms for ECTS. This process has challenged existing understandings of what the students have to learn and what the core discipline is all about. Different re-selection strategies have been in play – merging different subjects, excluding specialised subject areas or moving areas of application to be considered in the projects – leaving the theoretical abstractions for the course modules.

A related challenge has been to group often diverse content into three 5 ECTS blocs. This has resulted in strange combinations of content in 5 ECTS modules, such as a course in Mathematics and English. The problem of such combinations is that the learning outcomes becomes so varied that it became hard to design only one assessment session intended for the course

modules. Another problem arose in merging smaller subjects of 2 ECTS each into 5 ECTS module. Finally, due to economic concerns, some of the 5 ECTS modules were designed to embrace different however related programs.

Besides the new course structure, an overarching challenge was to cope with a relatively fast implementation of the new PBL model due to the economic situation and demands from accreditations authorities. At the same time demands for reconstructing the curricula to the Bologna qualification framework as well as a new national grade scale that stipulated the formulation of assessable learning outcome put pressure on the way that learning objectives had to be formulated. These change processes resulted in a demand for a thorough revision of study regulations – considering both the overall structure and detailed discussions of how formulation of learning objectives should be for each module. The study boards were simply overwhelmed by the workload. The other Danish universities were also required had to adapt to the Bologna process and the change of grade scale but they did not at the same time have to change their whole educational structure. Even so, the grade scale change in itself demanded considerable change (e.g. Brabrand & Dahl, 2009). The Aalborg Model, in addition, was implementing even greater changes.

The pace of the implementation also resulted in lack of involvement from pedagogical consultants, and many study-boards sensed that staff was not ready to respond to the new visions of more innovative pedagogical methods. Furthermore the time for clarifying the boundaries between what can and cannot be done was limited, and the interpretation of freedom to step outside the structures of the overall model differed considerably. Overall boundaries were presented, but there were no time to discuss the model in relation to the different conditions in the different study boards and even at program level.

3.3. Practice derived from the new model

The new PBL model has resulted in a variation of practices. One variation of the model is to have a project module of 20 ECTS and 2 course modules of 5 ECTS. There are also examples of project units of 5, 10, 15, 20, 25 or 30 ECTS, respectively; however it is rare that there are any deviations from the standard model in terms the 5 ECTS course module size. It is not in itself a weak point that it is possible to deviate from the model, as there may be pedagogical reasons for this - but not all staff and leaders have been aware of possibilities for deviation in the first iteration of implementation.

Furthermore, the simplicity of the model, combined with the vision of new and more innovative teaching and learning methods in the course modules, has resulted in a rather blurred picture of what is actually project-organised and what is not. This is not a problem if the modules are coordinated and planned carefully in relation to learning objectives together with students' progression and workload. However, there are examples of students who conduct several projects during one semester. Some are mini-projects in the course modules in addition to the project module. There are also examples of the opposite such as integrating lectures in the project module. The existence of such a diverse picture questions whether the new model provides room for a too unilateral curriculum.

In many ways, the need for coordination seems to be crucial to realise the intentions behind the new PBL model. The intention to have more course modules across programs has intensified the need for academic as well as administrative coordination. Furthermore, the increased number of exams, which has been the case for most programs, together with the tendency to combine rather divers learning outcomes in one and the same module, has increased the need for coordination in designing the exams.

Last but not least, a very important result from the analysis, which can be traced all back to the re-structuring of the PBL model, is that the new PBL model makes room for the alignment and synergy between course and project modules. In fact, the analysis shows that educational leaders have experienced that the re-structuring process has led to an increased separation between the courses and the project; and as mentioned earlier the distinction between course and project modules is at the same time becoming increasingly blurred. Furthermore, there were cases where confusion between courses and projects exist, whereby issues on what is to be examined in the project and what is to be examined in the course were raised. In other words, there may be overlap in the exams due to unclear learning objectives. In sum, there seems to be a lack of clarity of how to interrelate course and project modules. In programs with strong cultural carriers of the PBL culture among the staff, the practise does not seem to differ a lot from the previous model and there is clarity of what is the purpose of courses, projects, and exams. However, one may argue that this might be due to the fact that not much has actually changed. However, in programs without strong cultural carriers (for instance with a lot of new staff not knowing the old model), such common lack of clarity in the new PBL model certainly have an effect.

3.4. Summing up on future challenges

The restructuring of the PBL model at Aalborg University points to a number of challenges and indicate clearly the complexity in changing a curriculum structure – and this does not only count for a PBL curriculum, but for curriculum development in general.

All interviewees indicated that a core element in a successful change is training the academic staff. This explains that even experienced staff needs pedagogical training to cope with considerable curricula change especially when the management state a vision of new and more innovative teaching and learning methods. In such cases, training to support the diversity in teaching as well as to align the use of learning techniques is highly needed. In addition, upgrading teachers in handling various forms of assessment methods including formative and summative assessment is crucial. What happened in practice was the that the

academic staff, being used to run projects, in abundance have made use of mini-projects. But this has caused problems in the system, as the students feel overwhelmed by having to deal with so many projects – ironically too much PBL.

But the biggest challenge is in the interaction between course modules and projects where previously there was a more explicit relation in terms of the project unit courses. The challenges of the old model were many, including adaptation of project unit courses to the project, new examination rules prohibiting group exam, students not prioritising courses without separate exams and also a number of administrative matters due to the ad-hoc nature of the project unit courses. The interviews showed however, paradoxically, that although the project unit courses were seen as a one of the biggest challenges in the old model, it is also highlighted as the primary strength of the model.

4. Interlinking course and project modules

In the following we take our point of departure in the new PBL model when describing and discussing four possible models for interlinking course and project modules. We have chosen to introduce case-modules in the models and re-introduce project unit courses, to emphasise the distinctions and the variety of different types of modules. We will distinguish between three types of modules: A *course module* is a type of course that is designed to enhance knowledge and generic methodological skills. A *case module* is a type of course that presents students to pre-defined problems, which can be found in a real life situation, and facilitate that the students come up with correct solutions. In the *project modules*, the students themselves define an open problem and develop solutions based on a thematic framework. In fact, there may be a continuum of types, but these three types of modules we believe can provide a starting point for a discussion of the balancing of the various teaching methods in relation to different learning outcomes.

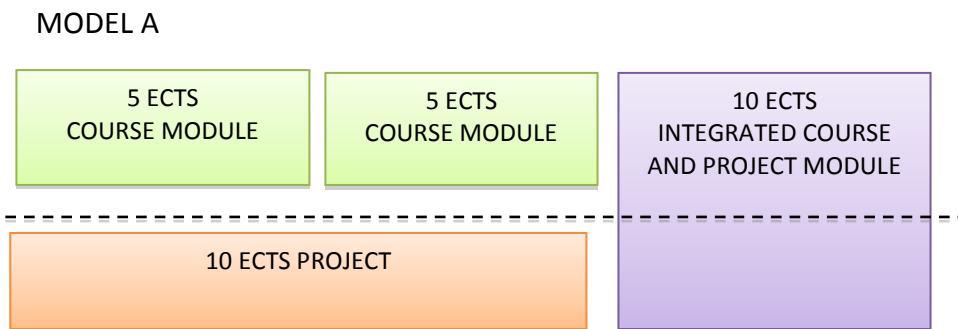


Figure 3. Model A introducing a 10 ECTS mini-project integrated with a course module.

MODEL A (figure 3) shows how two courses and a project module are integrated. This model has the aim that the theory and methodology learned in the course module is supplemented with a mini-project, where students are to define a problem and use the course material to solve this problem.

MODEL B (figure 4) illustrates a structure where a course combines an emphasis on theory and skills with a case to exemplify the use of the material in a real-life context. Students typically work towards the solutions of relatively closed and pre-defined problem formulations.

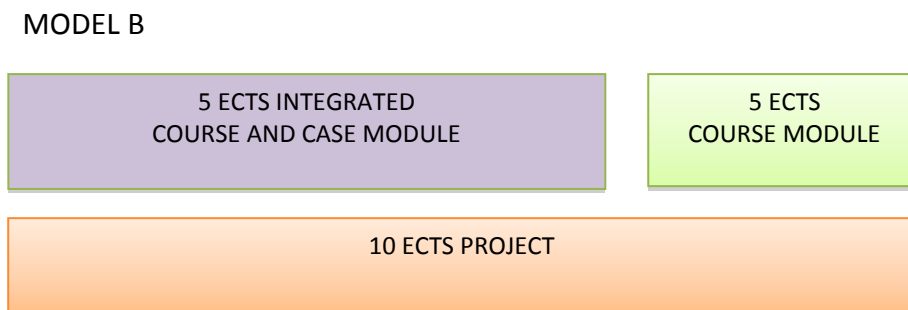


Figure 4. Model B introducing a 10 ECTS combined course and case module.

MODEL C (figure 5): In this model, there is an overlap between two of the course modules and the project. In practice this can be obtained by defining parts of the learning objectives of the courses in direct relation to the project theme. The advantage of this is that the project and courses are better connected, but on the other hand, this might limit the student's possibilities to work with open problems. This has some resemblance with the project unit course in the old model.

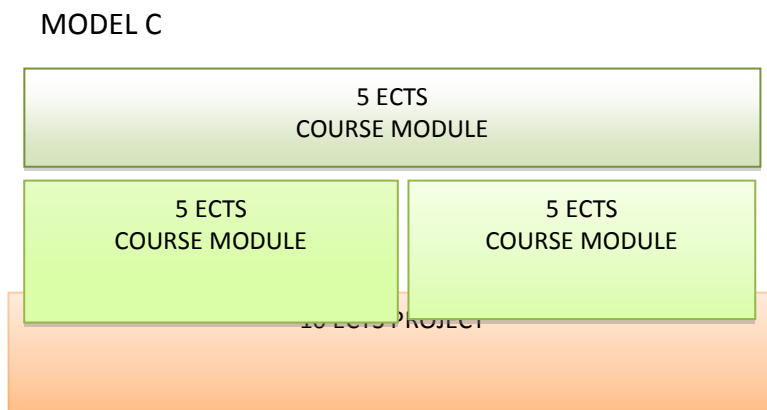


Figure 5. Model C introducing two 5 ECTS courses which have elements of a project unit course.

Model D (figure 6) combines the old and the new AAU PBL model by re-introducing a project unit course, which is examined as a part of the project. For disciplinary projects, this course could be designed directly to supporting the project. For more innovative projects (see section 1.1 for further discussion of disciplinary and innovation projects), this course could in fact be an elective course to take advantage of the fixed 5 ECTS modules. The students are also given the possibility to pick a course from another program, if it is suitable for the project. In these cases however, this challenges the examiners of the project to move into other areas or to carefully select an appropriate external examiner, if the project unit course is to be examined together with the project.

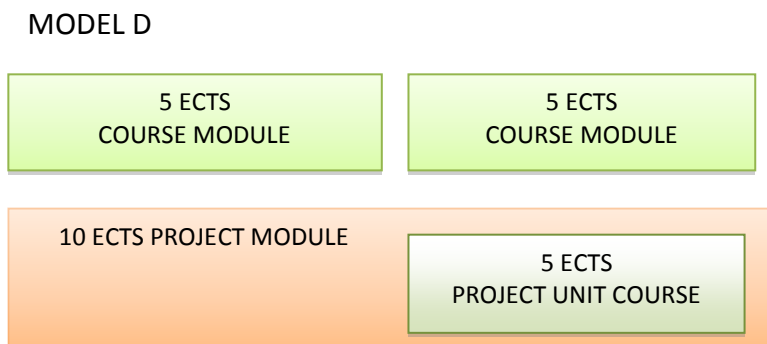


Figure 6. Model D re-introducing a 5 ECTS project unit course.

There are certainly more opportunities than those outlined above, but no matter which model is chosen, it is important that the interplay of different types of modules are explicitly addressed and argued. Furthermore, a model is not enough to realise this interplay. Coordination of teaching and learning (and examination) methods among the modules is to be considered as crucial.

5. Conclusions

In this paper, we have reported and discussed the intentions and experience from the restructuring process of the Aalborg PBL model. Our main question behind this study was: what can this implementation process tell about the drivers, challenges and prospects of reconstructing PBL curricula?

As drivers for change we identified a decrease in financial support and at the same time harmonisation of education across institutions and international borders. These challenges related to the economic crises, harmonisation among European countries and at the same time the increased globalisation of engineering education institutions which is putting pressure on even the most ambitious pedagogical models, underlined the fact that no pedagogical model should be stable.

The challenges we have documented in this study give rise to the following conclusions. First of all, the pace of the implementation process is crucial, but also the large number of changes that happened simultaneously. Innovations of course structure and content have to happen at a certain pace in order to reflect the state of art in society, but the pace have to make room for i) pedagogical support and training, ii) a strong coordination to assure an aligned curricula iii) appropriation of the model to local contexts iv) a strong awareness of the difference in the pedagogical methods and the interplay between them. It is tempting, and maybe especially for engineers, to rush into the implementation process to solve the problems at hand – and build the bridge as we walk on it. However, the first implementation should not exhaust the organisation in a way that fosters resistance towards continual innovations.

In this paper, we identified the weakness of the new Aalborg PBL model whereby the interrelation between course and project modules are not explicitly emphasized, intensifying the ambiguous distinction between courses and project. However, the old model was not without problems either. For instance, students did not always take the project units courses seriously when these components were not used in the projects and usually not formally assessed during the project exam. Taking this as our point of departure we have exemplified, how awareness of the difference in pedagogical methods can be used to develop different PBL models; in this case by distinguishing between projects, course and case modules, and combining them in different ways to emphasise integration and interrelation between modules. It is our hope that these models can serve as inspiration for others constructing or reconstructing PBL curricula. In this way, the new Aalborg PBL model which formally was introduced due to external demands, can in fact be a model that has enough flexibility to continuously adapt and be in the forefront of development. In this way, model becomes models. It may also be a model that due to its flexibility can give the academic staff in different programs the tools to precisely design a structure that is well suited for the learning objectives and goal of that particular program and therefore a way to keep updating, changing and adjusting the Aalborg PBL model(s).

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