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# Curriculum Development for Project-Oriented and Problem-Based Learning (POPBL) with Emphasis on Personal Skills and Abilities\*

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In this article, the author addresses the reasonably difficult topic on how to plan for implementing Project-Oriented and Problem-Based Learning (POPBL); this incorporates the development of students' personal skills and abilities, which are to be considered equally important to developing students' technical or professional competences. The author presents a series of reflections, which are based on a formulated vision, providing a possible model to develop a successful adaptation of a change process. Furthermore, through illustrative figures, the author advances the process in a logical way before presenting a profile that is based on decisions drawn from the reflection process. The author seeks to provide, in a clear and pedagogical manner, the results that can be used in adapting the process prior to implementing a new educational model at an institution. In the concluding section, the author supports his method by giving examples on recent comparisons of students' learning outcomes between a project oriented learning model and a conventional teaching model.

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## INTRODUCTION

In curriculum development, especially when seeking to implement changes towards a new educational model that is based on the philosophy of Project-Oriented and Problem-Based learning (POPBL), one of the elements that are reasonably difficult to deal with is training students to develop their personal skills and abilities. Such skills are normally referred to as transferable and incorporate life-long learning abilities. These elements are generally stated in the vision statements of institutions, but yet have proven difficult to implement with regard to the operational levels in an organisation, as the focus is traditionally on science and conventional technical issues. No room is left for additional elements in the established curriculum.

The development of a new curriculum must include,

\*A revised and expanded version of a paper presented at the 8<sup>th</sup> UICEE Annual Conference on Engineering Education, held in Kingston, Jamaica, from 7 to 11 February 2005. This paper was awarded the UICEE bronze award (joint fifth grade with one other paper) by popular vote of Conference participants for the most significant contribution to the field of engineering education.

apart from the usual planning tasks, securing vertical and lateral coherency for the technical and scientific content. Furthermore, it must deal with the additional aspects on how to find time for the project work itself, and how to find training gaps in additional elements like personal skills and abilities. This often leads institutions to review their curricula and rethink their overall objectives from the perspective of a new project oriented educational model. This process can be hard, as academic directors, planners and teachers have been brought up with a traditional paradigm that is based on lectures.

Because of this traditional paradigm, academic directors usually encounter major difficulties in introducing new elements, as the institution may be hesitant to view new additional objectives as being *so* relevant that they need to be focused upon separately. Indeed, teachers may focus more on their own field and not look at the learning process from a wider perspective. Yet this wider perspective focuses, importantly, on developing students' personal skills and abilities that are demanded competences from industry and society, as well as demanded from students themselves.

In this article, the author focuses on those problems that are interrelated to curriculum design, and provides examples on how personal skills and abilities can be *built into the planning phase* and presented to teachers in the initial phase of the change process; thus, it will hopefully be accepted and adopted before the implementation itself [1]. The examples utilised here are based on the author's experience from workshops on change processes when training university staff for POPBL.

## THE WORKSHOP SET-UP IN GENERAL

It may be appropriate to spend a few words on the structure of the above-mentioned workshop in order to gain an overall image of the following description of one of the elements in the workshop scenery. The workshop is aimed at training academic staff to be able to plan for relevant changes when implementing POPBL at their respective institution. During a five-day workshop, participants go through a complete planning circle as a pre-planning experience prior to the total POPBL implementation planning phase. Participants are basically guided through all the phases of the process through working on different topics, as well as by being supervised by instructors.

It is important to form teams that comprise academic directors as central teachers from the relevant department or educational programme in order to ensure that planners and teachers work towards a common goal. Further, this set-up can establish vertical communication between teachers and academic director levels, and lets both levels gain a better perspective of the problems that affect each level, thereby establishing mutual understanding in the organisation.

The workshop set-up is based on decisions that are characteristic for three levels, namely:

- Executive decision level;
- Academic director decision level;
- Teacher decision level.

During the workshop, the characteristic problems for the different levels are addressed. This also adds to the establishment of a coherent planning group, as the planning group experiences topics that are characteristic for each level. Thus, group members gain a better overall understanding of the complexity of the change process through all levels in the organisation in order to generate a plan that takes all aspects into consideration.

The first activity is to develop a departmental vision or a vision for a specific education programme.

This initial task is important in order to formulate a common platform for the team for their further work. Furthermore, the discussions lead participants into a common understanding of where the department wishes to go and how they can realise it.

The next section in this article is an example of one of the initial activities that are conducted during the workshop briefly described above.

## BOOSTING THE TRAINEES

When working with trainees in workshops, as described above, which are aimed at developing a curriculum that incorporates personal skills and abilities, the author gives trainees a simple task as a revelation to the problem. This task is given as an introduction to the concept of teams before they actually begin working in teams, and is planned to be an *eye-opening* event. The task is as follows:

*You are working in an engineering company with a major research department and your company needs to employ more engineers. You receive a call from the Human Resource Manager to give him inspiration for an advertisement in the newspaper. He is under a deadline and he is only able to give you five minutes to come up with key words specifying competences for the new colleagues of yours. Therefore, he asks you to find key words and send them to him in five minutes.*

Trainees work individually with this for five minutes or in minor teams. They are then asked to put forward all their key words, which are written on a blackboard or flip-over board so that they are visible for all.

An (edited and reduced) example of an outcome of such a task is as follows:

- Cooperation skills and project management;
- Linguistic skills;
- Ability to work in teams and manage teamwork;
- Ability to organise complex work and solve problems;
- Technical skills;
- Problem solving abilities [2].

The next step is to establish a discussion on whether the key words can be classified as personal skills and abilities, or as technically related key words. After a discussion, trainees may tackle this evaluation of the key words as follows:

- **P** Cooperation skills and project management;
- **P** Linguistic skills;
- **P** Be able to work in teams and manage team work;
- **P** Be able to organise complex work and solve problems;
- **T** Master technical skills;
- **T/P** Problem solving abilities [2].

The bold **P** indicates topics that are related to personal competences, while the bold **T** indicates technical related competences. Trainees then have to answer the question: *Is this then the profile of the students leaving your university?* This question usually generates a period of silence followed by an internal discussion and uncomfortable smiles.

The next target is to present some facts regarding actually *getting* to an interview, as shown in Figure 1.

In Figure 1, it is obvious that the professional qualifications are the most focused in selecting applicants *for getting to* an interview. In addition, the experience gained through internships is valued highly. In the POPBL model at Aalborg University, Aalborg, Denmark, internships are exchanged for project work, but the projects are generally real problems and solved in cooperation with industry or with the management of society related projects [4].

Figure 2 is then shown to participants, identifying those qualifications that are focused upon *during* an interview.

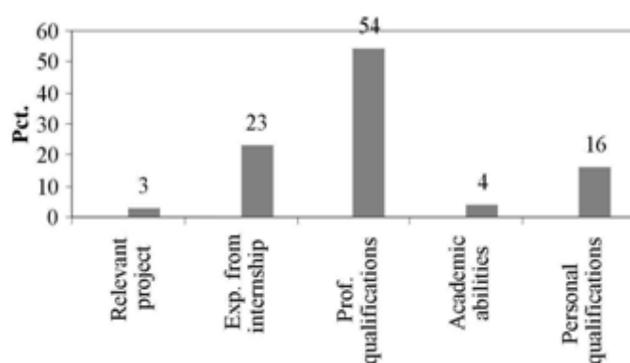


Figure 1: Qualifications for *getting* to an interview [3].

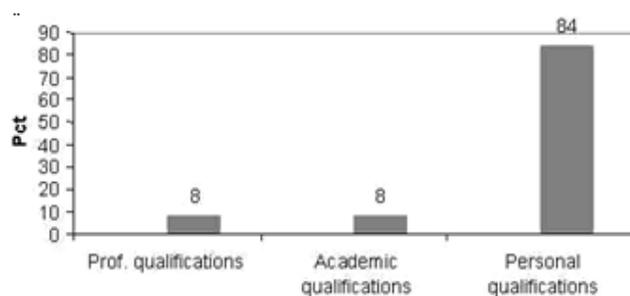


Figure 2: Qualifications focused on *during* an interview [3].

The qualifications focused upon *during* the interview involve basically personal qualifications. This illustration generally comes as a big surprise to participants. This process entails enlightening trainees with the need to focus not just on professional qualifications, but also personal competences. Of course, this aspect is important to realise as universities move towards an increasingly competitive situation to gain students, so if the perspective on addressing personal qualifications is missing, then one of the significant parameters of this competition can be lost. After this session, participants are generally more open to developing a curriculum wherein personal competences are considered equal *fundamental* components to the technical components.

After this exercise, participants are asked to look at the vision statement of the institution to see if the list developed during the exercise matches their institution's vision. Participants can now perceive the overall vision with greater awareness, as they have to make the topics stated in their respective vision operational at the departmental level or educational programme.

## A POSSIBLE OUTCOME

After this exercise, participants form groups and develop their own departmental vision or vision for their educational programme that they are currently serving in. They elaborate on the outcomes of the brainstorming activity and combine these results with the institution's overall vision, thereby formulating a vision that they can work under in their continued work in finding a possible structure for a revised curriculum that takes these new issues into account.

Because of such work, workshop participants generate a list of topics that they *have* to implement according to the new vision for the programme for which they are going to generate curriculum planning, namely:

- Interpersonal-social skills;
- Communication skills;
- Respect;
- Teamworking;
- Critical thinking;
- Ability to debate;
- Adaptability and flexibility;
- Learning and process oriented approach;
- Learning to learn [5].

However, the following examples are also achieved from workshop results, but edited by the author in order to cluster the topics and make a more friendly presentation set-up:

- Abilities to learn how to learn;
- Collaboration skills;
- Perception of context;
- Academic behaviours;
- Conflict solving capabilities.

This list will facilitate a discussion on *how* to make an operational plan for having these topics built into the curriculum. Furthermore, this discussion will lead to the problem regarding *which semester* the different topics should actually be focused upon. Of course, the topics need to be described further, and the objectives and goals must be formulated, but these need only to be described at a general level when the discussion relates on *where* to address them in the curriculum.

Many institutions argue that they already have these areas built into their curriculum, and they may be right – at least the objectives may be formulated. However, they often keep silent when asked the question, *How do you teach them the theories for, and train them in, eg collaboration and conflict solving?* The courses given, activities, case studies, materials, etc, do not directly support the skills and abilities desired. The author sometimes then asks this question: *If you want your students to acquire mathematical skills, what do you do then?* They all agree that they definitely need courses in order to secure learning. When asked the same question, but this time related to personal competences, there is normally not the same enthusiasm to offer answers. If institutions are serious about having their students acquire these competences, then these areas need the same focused awareness as there is for the more traditional areas.

**Integrating How to Learn in the Curriculum**

Programme planners have to decide at which semester the different topics need to be addressed. The topic covering *to learn how to learn* is maybe something that one could claim is naturally present in all semesters. Indeed! However, if students are further sustained with professional tools and a theoretical background, then students may grow into even better learners during the rest of their studies. Therefore, by investing time at some point in their studies, students become better qualified to perform their continued studies.

Because of a discussion on where in the curriculum to focus the *training* of the students' ability *to learn how to learn*, participants usually decide that it makes sense to focus on the *training* and its application *in the first semesters*. Figure 3 illustrates how this decision can be communicated in the adoption phase. See refs

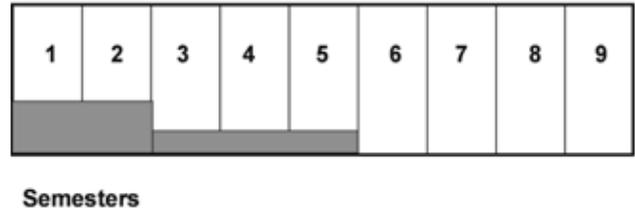


Figure 3: Training *how to learn*.

[6] and [1] for further information on communicating decisions made for institutional staff.

Figure 3 shows the decision made by participants to focus intensively on the *training* for competences on how to learn in the first two semesters. This is then followed up and expressed as objects to be *focused* on by students in their project works in the 3<sup>rd</sup> to 5<sup>th</sup> semesters.

The term object to be focused on highlights the importance of keeping focused on the topic – even after the actual training has been conducted – to keep students focused on the continued importance of the topics. This can be achieved by converging on the topic in the form of using a portfolio that documents the individual student's learning and – even better – having *teams* develop a reflection document that includes descriptions and analysis of their learning outcomes during the semester through weekly documented reflection documentation. This document could form the basis for the examination of personal competences as a supplement to the project report itself.

**Integrating Collaboration Skills in the Curriculum**

The same exercise is then carried out for the next topic stated in the list: *collaboration skills*. Figure 4 shows how participants decide on training students more in the first semesters with follow-up exercises later in the programme.

The formal training can be undertaken in the first two semesters, but the next blocks indicate that there must be a focus on the topic organised through the project work to force students to use portfolios or reflection documents in order to detail their collaboration skills.

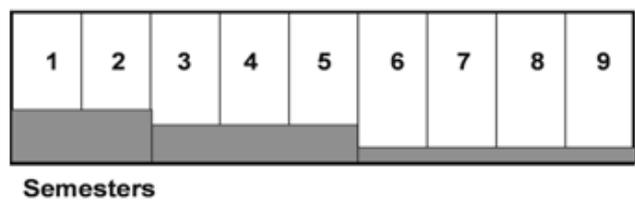


Figure 4: Training in collaboration skills.

### Integrating the *Perception of Context* in the Curriculum

The term *context* can create some uncertainty, as the term may not be familiar to all participants, especially those who have been working under a traditional vertical oriented paradigm. However, in a project environment, the vertical, as well as the lateral, orientation is of great importance. Since every product is outcome-based on a previous process, the current process should address how a possible solution will impact society, or how society will influence the development of the product. This interaction is normally referred to as the context.

In order to bring the context into project work, students need to analyse and identify those factors that may influence the development of the solution and/or those factors that are influenced by the solution itself when introduced.

Figure 5 shows the end result of a discussion covering where to focus *the perception of context* in the curriculum. The discussion behind this profile is to train participants in gaining a wider understanding of the complexity – the context – in which any solution appears, and that the problems that students are trying to find solutions for are, most often, problems from industry or problems generated by society. Not many problems are generated without any relation to industry or society. Training in this area is more equally spread over different semesters.

The *Modified Hour Glass Model* has been described previously by the author [5]. This profile signals the need for a higher degree of *training*, eg by giving lectures presenting methods, etc, from the very first semesters. This will serve to secure that students recognise the inherent complexities and realise the importance of the context when developing, evaluating and introducing possible solutions. The model further points towards having the context interwoven as a *natural and integrated part* in the higher semesters.

### Integrating *Conflict Solving Competences* in the Curriculum

In the students' process of developing social competences, the solving of team problems and team

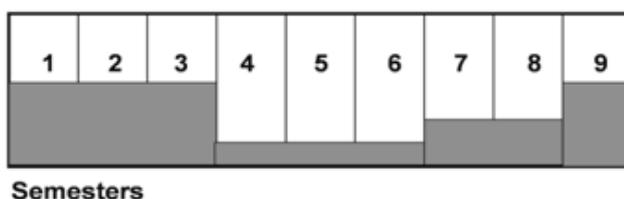


Figure 5: Training the perception of context.

conflicts is a very central issue. If students are left alone without any formal training on these topics, the outcomes of their process may depend upon chance. However, by setting up a formal programme in which topics, such as group processes, character profiles, causes for conflicts and conflict solving tools, are presented, then students gain professional tools that can be useful when – or if – a team enters into conflict. Students can analyse their situation and hopefully find a solution to their present situation. Of course, this is an ongoing process and students will become more and more professional in their performance in solving conflicts over the semesters.

The training shown in Figure 6 shows the training of conflict solving competences for the first two semesters, while in the following semesters, the supervisor follows students' development.

### Integrating the *Training of Academic Behaviours* into the Curriculum

When addressing the topic on the training of academic behaviours, which is an essential issue, one should relate to not only techniques on how to make a correct reference to works used during the process, but also on focusing on ethics in general. Unfortunately, gradually more cases can be observed where students copy material into their reports without proper referencing to the original author. This forces institutions to spend time and money on tools that can uncover any abuse of material.

On the other hand, how can educators expect their students to be aware of illegal usage if such academic behaviours are not introduced and discussed with them? It must be impressed on students that it is perfectly fine to use another person's material – as long as there is a reference to the work from where it is to be found in accordance with proper academic tradition. This should be carried out not only to avert potential fraud, but importantly also in order to go behind the presented material to see if the referred material really supports the theses or circumstances in which it is used by students.

At Aalborg University, there have been cases where a student's work had to be re-evaluated. Fortunately, at Aalborg University, there is documentation that

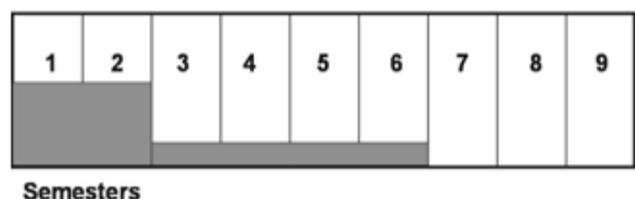


Figure 6: Training of conflict solving competences.

lectures and courses on the topic have already been covered in the first semesters, including focusing on the issue during the project work, so a student cannot, in this case, claim innocence by not knowing about these academic behaviours. Normally, a disciplinary board deals with these cases, and they can be helped in their work by clearly addressing such issues in the curriculum.

Figure 7 illustrates how participants have decided to train academic behaviours in the first two semesters and how participants have elected to focus on the issue through all of the remaining semesters.

Figures 3 to 7 shows different profiles for direct training and the indirect focus for each of the specified topics. If participants are concluding their discussions and decisions, then they must add all these profiles in order to create a *combined* profile that fulfils the objectives formulated in the vision and overall objectives in the study programme for which they are planning.

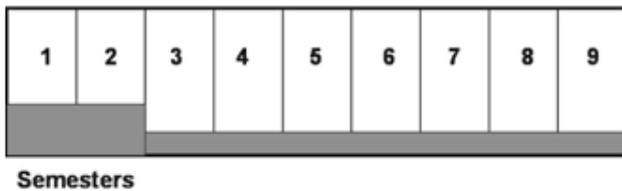


Figure 7: Training academic behaviour.

### Creating a Personal Skills and Abilities Planning Profile

If the different profiles are arranged in such a way that each activity occupies the same amount of time as foreseen in each of the individual profiles, it can be noticed that the personal competences are focused mainly at the first semesters and less in the middle semesters. A sum-line can be drawn to illustrate the time-distribution on when to focus on personal competences and when to focus on professional competences during the semesters.

Figure 8 illustrates this split very well, as the profiles developed are based on discussions and decisions made on the basis of a formulated vision that has been made operational for the department or educational programme. It is possible to develop an illustrative figure that will be very useful in discussions with teachers at an institute that is in the process of adopting the idea of giving room to personal skills and abilities as equal learning outcomes to technical competences.

Figure 9 shows the split between the intended time to occupy for personal competences and the time required for technical competences. The *fat* curve divides the two areas of competences – the professional

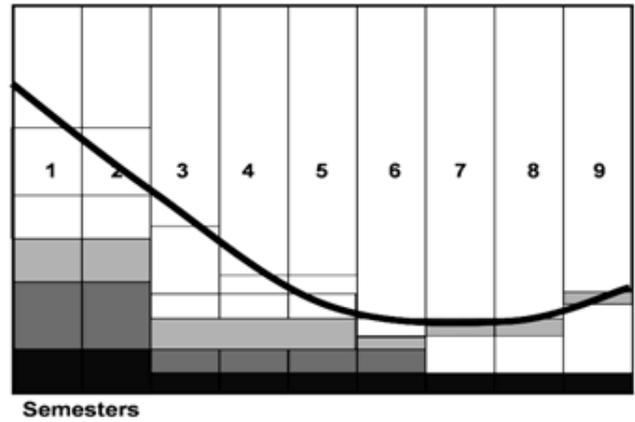


Figure 8: The combined profiles sorted with a *sum-line*.

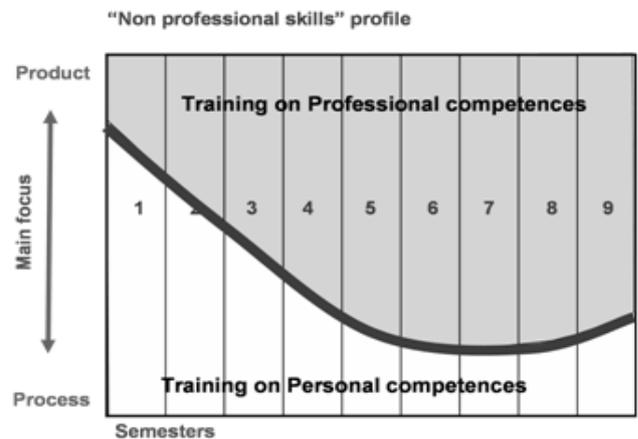


Figure 9: The split between intended time to engage for personal competences and time to engage for technical competences.

competences and the personal competences. Figure 9 shows the inclusion of two new issues, namely *product* and *process*, and identifies on which topic the main focus could be during the different semesters.

Besides the training and focus on personal skills and abilities, the profile in Figure 9 also shows where to address the training regarding professional competences.

Figure 10 shows how Figure 9 can be stretched to illustrate how project work can be perceived as an activity that combines personal and professional competences. The two dotted lines illustrate the time allocated for project work in relation to professional and personal competences. The area between the two dotted lines is shaded and indicates the time allocated for the project work and the bold line at this point illustrates the split between the two competences throughout projects in different semesters. In this way, it is made clear that, in the first student projects, the focus is very much on developing students' personal

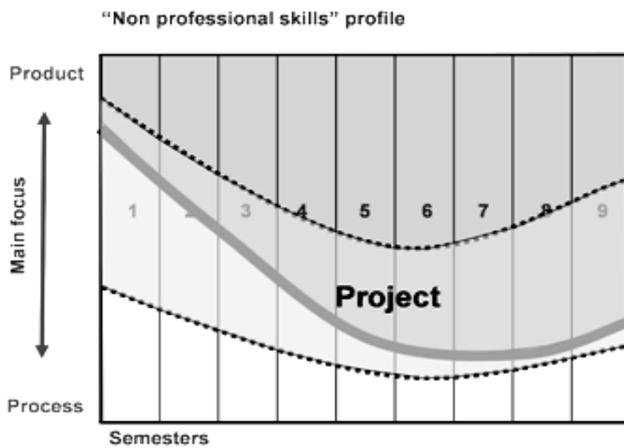


Figure 10: The split between the intended time to engage personal competences and the time to engage technical competences within project work.

competences, and that the focus during the semesters transforms towards increasingly more professional competences. This is a natural consequence of having addressed personal competences in the first semesters, and they need not be directly focused on later in the studies as students become more and more competent during their continuous practice while undertaking project work. The subject of variation of process and product is discussed in detail in an earlier article by the author [7].

## COMPARISONS OF OUTCOMES

Given the discussed principles for building a curriculum where the focus is on professional and personal competences, many may ask if there is any research

supporting the presented model as being superior to conventional teaching. First of all, it is not easy to make direct comparisons between two very different teaching methods. However, it is possible to measure the outcomes of students' learning and their perception of their education. It is also possible to ask employers if they recognise any difference in the graduates they employ.

A recent survey conducted on students from Aalborg University, which generally is regarded as a POPBL institution, and students from the Technical University of Denmark, which is generally regarded as a conventional taught institution, supports very well the philosophy presented in this article. It gives the same credit to the two Danish institutions concerning professional competences, but the personal competences that students develop in the POPBL approach, are significantly higher when compared with conventional techniques. The learning outcomes concerning personal competences are significantly higher within the POPBL approach than from conventional teaching. Figure 11 shows a comparison between the outcomes of personal skills and abilities developed in a POPBL environment compared with traditional teaching. Further data can be found in Kjærdsdam's paper [8].

## FINAL REMARKS AND SUMMARY

In this article, the author's intention is to provide examples on how to bring in some of the objectives formulated in an institutional vision into an operational vision for a department or an educational programme.

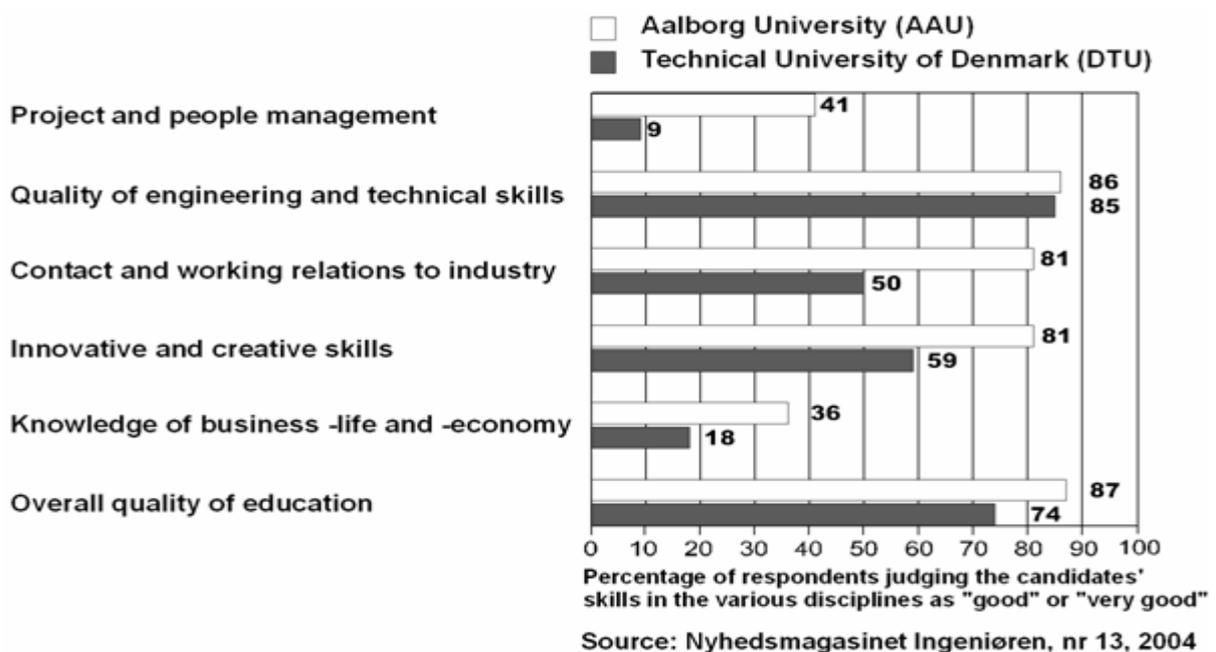


Figure 11: Comparison between the outcomes of personal skills and abilities developed in a POPBL environment compared with traditional teaching [8].

This can be achieved by letting academic directors or educational planners and teachers from the same department or education work together in developing a new curriculum in a guided environment, such as a workshop.

After the described method is introduced in the initial phase of the presented workshop, discussions on the need to implement personal skills and abilities as equal and natural elements in forthcoming planning is missing. Participants still discuss the topics, but rarely tackle whether they need to be there or not, but rather on how much time to cover the topics is needed according to the formulated vision, and in which semester it should be addressed or focused on in the curriculum.

It is the author's hope that this article and the illustrations presented herein can act as a guide for an area that is considered to be a difficult part of the process by making new ideas *known* and by having them *adopted* by teachers. If readers, after having read this article, have gained a clearer idea on how to transmit the need to address and focus on personal competences as a necessary and active part of the curriculum, and has found new ideas on how to communicate it, then the author has reached *his* objectives by writing this article.

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## BIOGRAPHY



Egon Moesby was born 1952 in Denmark and has a BSc of engineering, civil and constructional engineering from Esbjerg Engineering College, Denmark. He was a consulting engineer at Anderskov & Thomsen, Esbjerg, from 1981-1986, before becoming a consultant of international turnkey operations at Natural Gas Company Naturgas Syd. He was also a consulting engineer at Ramboll & Hannemann from 1989-1999.

Egon Moesby is currently assistant professor and associate professor at Esbjerg Engineering College and Aalborg University, respectively, since 1989. He was in charge of implementing the Aalborg PBL educational model at Aalborg University's Esbjerg campus between 1995 and 1996.

Since 1996, he has been the Director of Studies and Head of the Study Board at the School of Basic Studies in Science and Engineering, Aalborg University. He is presently a Deputy Director of the UICEE Centre on Problem-Based Learning (UCPBL), a UICEE satellite centre, based at Aalborg University, and is involved with several distinguished engineering and educational advisory boards.

He is the author and editor of several publications and has participated in numerous international and national workshops, as well as satellite transmissions, particularly in the field of PBL implementation. His research interests include studying the changes in educational institutions when implementing a new educational programme.