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Experiences with Integrating Individuality in Project-orientated and Problem-based Learning POPBL*

L. KØRNØV, H.H.W. JOHANNSEN AND E. MOESBY
Department of Development and Planning, Aalborg University, Denmark. E-mail: lonek@plan.aau.uk

Development of the technical and social skills of students using project orientated and problem-based learning (POPBL) in teams is well documented. In this article the authors are concerned with their experience of integrating individual activities in a team-orientated POPBL setting. The question raised and discussed is: 'can students gain more professional and personal skills and provide better solutions through integrating an individual activity in team-based project work'? Based upon a two year pilot experience, the authors describe the rationale for individuality in POPBL; the way individual activity was structured and performed; and which experiences have been gained. The conclusion is that the introduction of individual activities has clear advantages for the learning motivation of individual students, the quality of group work and for the development of professional and personal competences.

Keywords: problem based learning; project based learning; teams

RATIONALE AND OBJECTIVES FOR IMPLEMENTING INDIVIDUALITY IN GROUP-BASED POPBL

FOR MORE THAN THREE DECADES at The School of Basic Studies of Engineering, Science and Medicine at the Faculty of Engineering, Science and Medicine at Aalborg University, project-orientated and problem-based learning POPBL has successfully been performed. The standard POPBL project model is performed in teams/groups each consisting of four to seven students. Project work has a duration of some 16 ECT (European Credit and Transfer Accumulation System of measurement) out of a total of 30 ECTS (European Credit Transfer System) per semester with the following nine phases or activities normally being incorporated [6] (Fig. 1).

The activities are in line with the project-orientated, problem-based learning as it is generally implemented at Aalborg University covering problem analysis, problem solving and report/documentation [3]. Depending upon the nature of the problem and the interests of the student groups, the focus and time spent on each activity vary from semester to semester, from project to project and from student team to student team. Regardless of the chosen field of study within the wide range of disciplines offered by the Faculty of Engineering, Science and Medicine, all students become well versed in problem analysis, problem solving as well as reporting and documenting their project work.

Long-term experience with the team-based POPBL model shows that the programme is successful and that graduates are highly valued for their high technical performance, their personal and social competences as well as their ability to solve real-life problems in teams [5, 4, 2]. Despite running an effective and successful study programme, the Study Board of Basic Studies decided in 2001 to explore the possibility of developing the POPBL model by including individual POPBL activities in team/group-based project work.

The background for this decision was heavily influenced by the conclusions stemming from the national evaluation of First Year Programmes at Danish universities in 2001. Here the evaluators discussed the benefits and drawbacks of the offered individual and team-based learning structures. One of their conclusions was that:

> A prioritising of individual elements in the study can reduce the positive effects of the team orientation both socially and professionally. A prioritising of the team organization will on the other hand limit the student's possibilities to be tested by and trained in individual performance, and it will reduce the transparency related to the qualifications of the graduates. [7].

This conclusion was in accordance with the wishes of large portions of the student body at the university, who through their elected representatives for some time had expressed a desire for developing the POPBL model in a direction which allowed the students to test themselves further as individuals to supplement their learning through POPBL group work.

In addition, several other possible advantages in implementing and integrating individual POPBL activities in a team/group-based project setting

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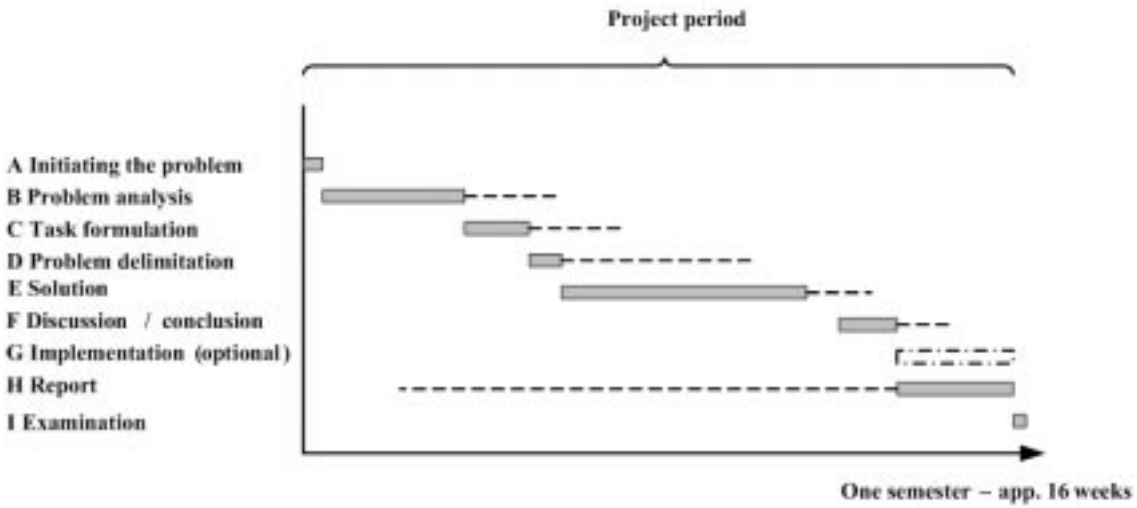

Fig. 1. Typical phases of a project work with relative time allocated for each activity. Phase B and phase E can vary in time allocation

were discussed by the Study Board of Basic Studies; i.e. the possibility of the model to secure better, more diverse, or deeper solutions to the chosen technical problems that the students dealt with in their project work, while at the same time tackling the small but annoying problem of students who for one reason or another are not participating equally in the project work.

In line with the conclusions drawn from the national evaluation of the First Year Programmes at Danish universities, a key issue for the Study Board of Basic Studies at Aalborg University was that any attempt to prioritise, develop and implement individual elements into the study should try to avoid rolling back the positive effects of the already established team-orientated POPBL model.

Specifically, concerns were voiced that introducing individually orientated POPBL into the existing curriculum would risk fragmenting the team-based POPBL project work. This fragmentation could come as a result of direct or indirect pressures upon the students, which would cause them to allocate too much time on their individual POPBL activity with detrimental effects on their team-based project work, or the fragmentation could come as a result of the inability of the students to fit or join their individual POPBL activity with their team-based POPBL project. These time- and project-management challenges were discussed at some length in the Study Board and various models for introducing more individuality into the existing curriculum were investigated.

The resulting model, which the Study Board decided to implement, was a model that was aptly named the extended or embedded POPBL model. This model introduced individuality into the existing POPBL project model by extending the current standard project model with an individual project activity in which each student would be encouraged to develop alternative solutions related to the overall problem being focused upon in team-orientated POPBL work. The overall objectives of the extended model including an individual activity in the POPBL were formulated by the Study Board and fall into three main categories [7]:

Skill development

- Develop students' individual performance skills;
- Create an environment for potentially developing psycho-motoric skills in a design process;
- Develop and sustain innovation skills;
- Develop and sustain entrepreneur skills.

Solution development

- Train students to choose between different solutions in a team environment where individual solutions must be evaluated, tested and the overall best solution selected to be the one to be further developed for the rest of the project;
- Develop and sustain a diversity in the number of possible solutions;
- Create personal solutions to a common problem.

Avoid free-riders

- Deal with the free-rider problem, where students hide in teams without contributing to their team's best performance, thereby potentially creating team conflicts and injustice in assessment.

THE MODEL USED

To facilitate a smooth implementation of the new individual POPBL project model into the existing curriculum, different structures were set in place—structures, which should frame and guide both the student's individual activity and the supervisor's role in the process.

The individual project model covered some two ECTS (one-eighth of the total project work) and lasted for about two weeks. The timing was chosen to match how experienced the students are when they have finished their problem analysis in the group in terms of their readiness to develop, analyse and assess solutions. This is also at a time in the semester with relatively low course pressure.

Based upon the team's problem analysis, the students were asked to develop an individual solution covering the questions: what needs to be solved? How can the problem be solved? Why was the particular individual solution chosen? What impacts might the chosen solution pose environmentally, economically, socially, etc.?

In the project, students were presented with the opportunity to make individual work link with the common problem formulation by the team. The students were introduced to the overall goal of individual activity as 'a way supporting creativity and alternative solutions—based upon individual professional interests'.

The Extended Project Model, shown in Fig. 2, consists of the following activities and stages:

1: Start of the semester with formation of teams.
1–2: The team developed a problem formulation followed by a problem analysis.
2: The problem analysis was completed. Based upon individual interests and discussions within the team, each student selected a theme linked to the common problem formulation to focus upon in the individual part.
2–3: The students worked individually for some 2 ECTS. The outcome was solution(s) for the chosen theme.
3: The students each handed in an individual report and these reports were individually assessed by the supervisors.
4: The students returned to the team-based POPBL work. The different individually created solutions were presented and discussed in the team.
4—5: Based upon the individual parts, the team developed and assessed a common solution for the problem.
5: The team handed in the final report with the individual reports attached as annexes, and this was presented and discussed in a team based exam environment with individual grades/marks for each student.

During the period of individual POPBL work (stages 2—3 in Fig. 1), the students each received individual supervision of approximately half an hour. This supervision was based upon their preliminary individual work.

The supervisors evaluated each individual report with a 'pass' or 'non-pass' grade shortly after deadline. Individual work had to be passed before the team handed in their final report. All individual work was included in the final report and added to final individual marks at the exam. Besides discussing and examining the project and final solution, each student got the opportunity at the team-based exam to discuss their individual solution.

If a student did not pass the individual POPBL

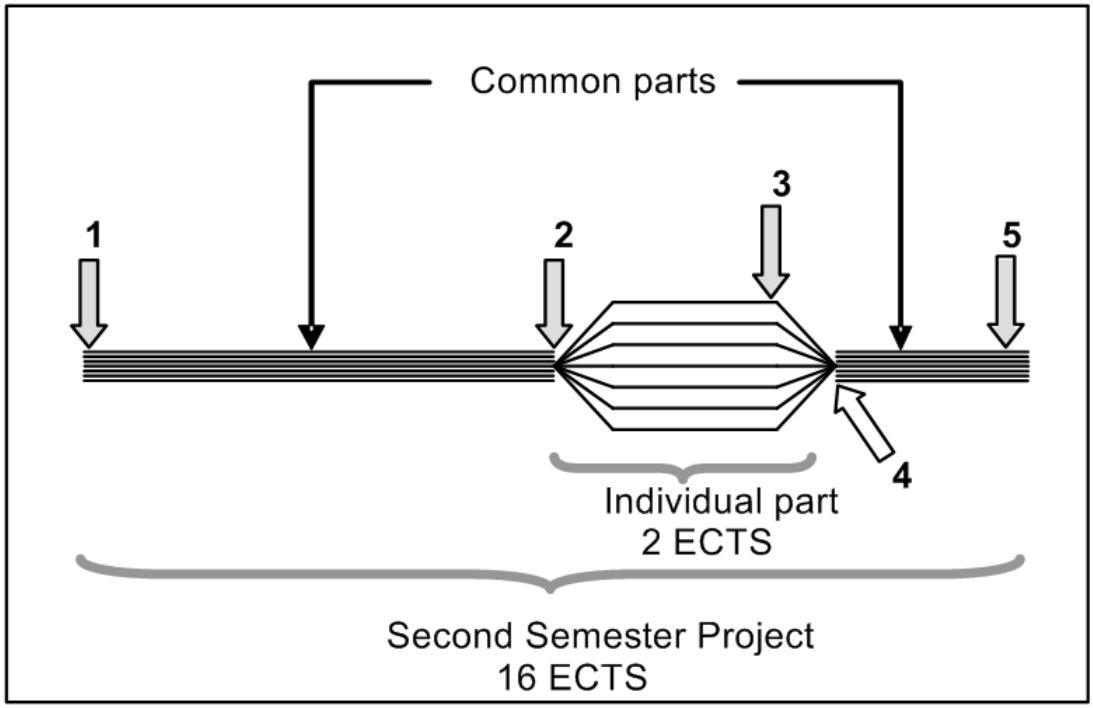

Fig. 2. Extended Project Model. (Revised from [7])

project, the supervisor would be obliged to present a written justification for the results of the examination, which included recommendations for improvement in revised individual work requirement. This revised project would then have to be handed in for a new assessment within a relatively short period of time. So far, all the students have passed their individual POPBL project on schedule—and generally in a very convincing way.

The individual activity was not thought of as the creation of a competitive environment. The authors' general experience is that groups working cooperatively produce better solutions than groups working in a competitive environment. This experience is in accordance with the review of meta-studies done by Prince [8]. The review shows a consistency between studies on how collaboration positively influences learning outcomes. So the focus was throughout the semester on group performance and the common project.

THE PROFESSIONAL CONTEXT

The integration of individuality into the standard POPBL model at the first year has only been implemented within a few professional fields, and this article presents and discusses the results from two years experience of embedding individuality in team-based POPBL in the professional field of Engineering—Planning and Environment. The Planning and Environment Programme aims to teach the students how to analyse, evaluate and make plans and projects for solving complicated problems in society—with an emphasis on sustainable development. In most cases, this is done by combining knowledge from the fields of social science and science of engineering.

Within the POPBL model the supervisors for Engineering—Planning and Environment strived to create a learning arena each semester in which the students work with:

1 Problems that are actual, concrete and real in time (and sometimes space) at the time of the project work, which gives the students the opportunity to analyse processes taking place and to give input to the real-life process of analysing and finding solutions; and to work with;
2 Problems in interaction with the ones affected and/or concerned with the problem and possible solutions.

The authors' experience from supervising is that a very influential motivational factor for the students is the outcome. Being involved with real-life problems when they are taking place and in a close contact with their progenitors (e.g. a local authority, an enterprise, citizens in a local community), the motivation of students for understanding the problems and especially solving them increases many times. The students get to feel that their experience is of value in real-life.

An understanding of the importance of letting students work with problem areas in which they are able to develop and assess solutions that either fully or partly can be used by the ones affected and/or concerned is built into the extended POPBL model.

EXPERIENCE WITH INDIVIDUAL ACTIVITY

Methods

A questionnaire to determine students' experience of having an individual POPBL activity embedded as part of their team-based project work was developed. The questionnaire was given to 20 students from the fourth and sixth semester, who had experienced the new learning model one or two years earlier. The questionnaire covered the following:

A Personal workload;
B Overall quality of the project work;
C Professional outcome compared to the students' experience from 4th and/or 6th semester without individual activity;
D Personal competences compared to the students' experience from 4th and/or 6th semester without individual activity;
E Transition from the collective part to the individual part in the project work;
F Transition from the individual part to the collective part in the project work;
G Overall experience of the Extended Project Model
H Wish for further individual activities.

Student response

Figures 3, 4 and 5 present the student response to the above-listed themes. All of the 20 students asked responded to all questions.

Regarding personal workload, only 10 % of the students found that the workload in the individual activity was less compared with what the workload of the 'standard' project work would have been. In contrast some 45 % of the surveyed students found that the workload was higher in the Extended Project Model than the standard project model.

Regarding the students' estimation of the overall quality of the project work seen in the perspective of having been through the individual activity but without it being integrated, 50 % of the students estimated a higher or much higher quality. 35 % estimated that the individual activity had no influence on the overall quality of the project work whereas some 15 % found that the quality was lower or much lower.

Regarding the professional outcomes when comparing their second semester project with an integrated individual activity with their fourth and sixth semester projects without an individual activity, 80 % found that the outcome was the same or

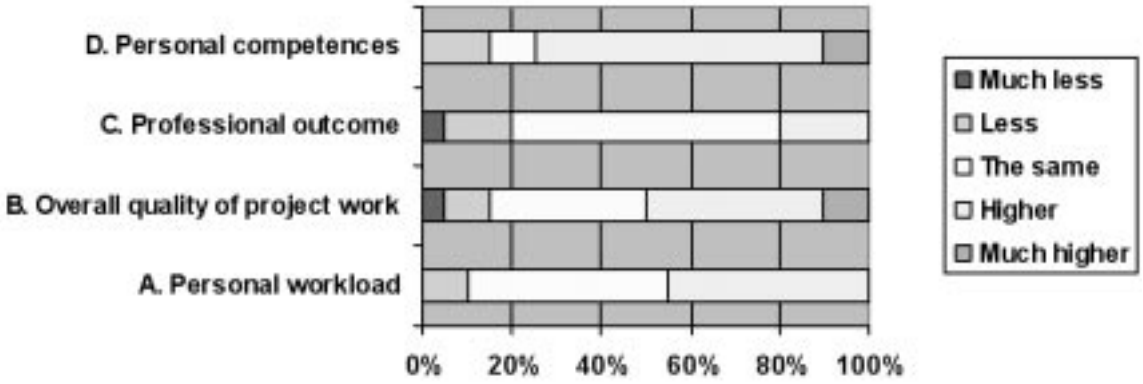

Fig. 3. Student response to question theme A–D

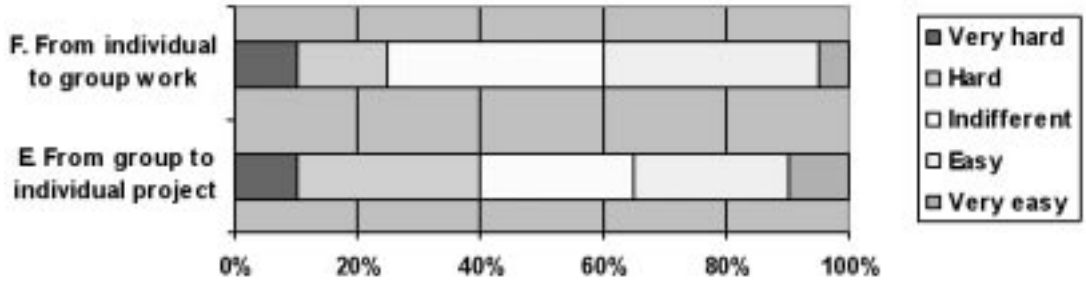

Fig. 4: Student responses to question theme E–F

higher, 15 % found that it was lower and 5 % much lower.

Regarding personal competences, 75 % of the students found a higher or much higher outcome compared to their experiences with their fourth and/or sixth semester standard POPBL project work. 10 % assessed their personal competences to be the same and 15 % found them to be lower.

Figure 4 presents the students experience with the coherence between the collective or team based POPBL project and the individual part of the project.

Regarding the transition from the collective part to the individual part of the project, some 60 % of the students found it indifferent, easy or very easy. However, 40 % of the students found that the transition was either hard or very hard.

Regarding the transition from the individual part to the collective part of the project, the students generally found this transition easier. 75 % found it very easy, easy or indifferent, and 25 % of the students found this transition hard or very hard.

Figure 5 shows the students' assessment of the overall experience of working individually with a problem as an integrated part of the total project. 80 % of them characterized the experience as good or very good.

Furthermore, the students were asked (H) if they would like an opportunity to have more individual activities later in their study; 95 % responded with a 'yes' to this question.

Advantages and disadvantages

Besides answering the above A–H questions, the students were asked to answer the questions: 'what was the biggest advantage in your opinion?' and 'what was the biggest disadvantage in your opinion?'. The main results from the questionnaire are presented in Table 1 and 2. The advantages and disadvantages written in italics are based upon the supervisor's observations. The supervisors were two of the authors of this paper—L. Kørnøv and H.H.W. Johannsen.

The advantages of integrating an individual activity in the general model are primarily linked to the benefits of the creation of space for the students to follow and develop their own professional interests. The supervisors add to this by pointing to the observation that solutions in general have become better after the introduction of the individual activity. In addition to the development of the outcome, the supervisors have in some cases experienced a positive change in the team work after the individual activity. As a consequence of the individual activity, the teams often consist of different team members each an 'expert' within a subfield of the project theme. This can positively change the balance of the team; e.g. quiet or introvert students can take a more active role in the team and students who tend to dominate are helped to have a less influencing role. This experience has been used by the supervisor who, during the group meetings, refereed and integrated the individual experiences in the discussion.

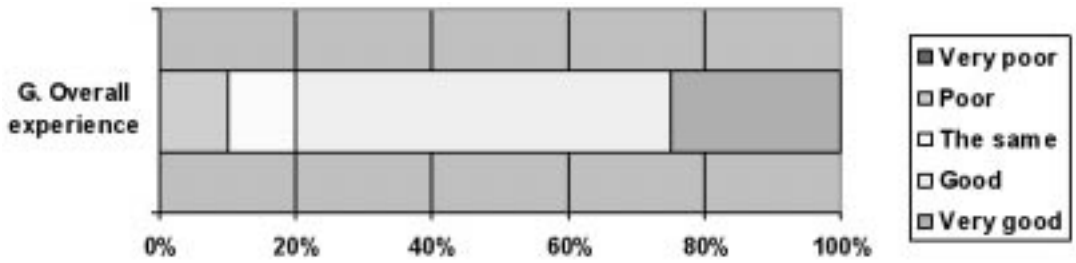

Fig. 5: Student responses to question theme G

The disadvantages are, first, related to the difficulties of getting a good coherence between the team-based POPBL project work and the individual parts, and, second, to the unfulfilled need of individual feedback. The last point is also supported by the observation of the supervisors that the more insecure students (either professionally or personally) are insecure in their ability to manage the task and perform satisfactorily.

Suggestions to improve the extended model

First, the coherence between the collective part and the individual part was less positively experienced by the students than what was hoped for. Forty per cent of the students found that transition from group to individual work was very hard or hard and some 25 % found that transition from individual work to group work was hard or very hard. By being aware of the students' frustration and being supportive in the transition phases it is expected that the supervisors can help decrease disturbance in the flow in the overall team-based project work.

Second, even though the individual activity was found to be very positive, it is still a challenge for the students. Challenges are good for learning experience—*if* there is a match between individual skills and the challenge at hand [1]. The balance between skills and challenge is individual for each student. To enhance learning, supervisors—besides presenting clear goals so students know what is expected of them—need to give immediate individual feedback as to how well each is doing. Thereby the anxiety of the challenge is expected to diminish.

Table 1. Advantages of individual activity in POPBL

The same or higher quality of the project work
Higher personal competences
Test ones capability of working individually and solve problems
Preoccupation in an aspect of special interest
More ideas generated
More width in the final solutions than before introducing the individual activity
After the individual activity the team work became more balanced as a consequence of having 'experts' in the team
The social dynamics of the team often changed as a result of the individual activity in the project. Introvert students often created more space for themselves in the team work as a result of their achievements in the individual POPBL work.

CONCLUSION

Students have individual learning styles and different roles in teamwork—depending upon their different personalities, interests and competences. The learning styles and roles of individuals in team work should not be viewed as a fixed state, but rather as dynamic flows depending upon personal and professional experience and development. The Extended Project Model presented in this article is one way to set a scene within POPBL for promoting the development of individual learning styles and roles. Adding to the tradition at Engineering—Planning and Environment of work with real-life current problems, the individual activity provides a better opportunity for students to follow individual professional interests as well as to test themselves, all of which is very important in motivating and encouraging learning.

Based upon the students' (now in fourth and sixth semester) response and the supervisors' observations the model is assessed as positive regarding learning motivation, the quality of team work and the personal competences. For example 80 % of the students found that the overall experience was good or very good, and 95 % of the participating students would like to have another opportunity for a similar individual activity later in their study. Furthermore, the supervisors have observed positive effects in regards to the width and quality of student solutions as well as in team work.

The experience of students and supervisors also pointed to ways of improving the model. The super-

Table 2. Disadvantages of individual activity in POPBL

Disturb the flow in the team based project
Difficult to combine the individual solutions in one project
Individual feed-back was not sufficient
Insecure students became anxious regarding their capability of managing the challenge

visors should support the students more in the transition phases between general teamwork and individual activity in order to minimize the disturbance in group flow. Furthermore, the supervisors can strengthen the immediate individual feedback to enhance individual learning and lower student anxiety by securing a balance between challenge and skills/challenge and support.

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Lone Kørnøv, Associate Professor in the Department of Development and Planning at Aalborg University, Denmark. She received her Ph.D. in 2001 and her M.Sc. in 1995 from Aalborg University. She is an experienced supervisor in problem-based project-organized group work, and involved in developing the 'Aalborg model' as coordinator in the professional field of Engineering—Planning and Environment at The School of Basic Studies of Engineering, Science and Medicine.

Hans Henrik Winther Johannsen, Research Assistant at the Department of Development and Planning at Aalborg University, Denmark. He received his M.Sc. in 1997 from Aalborg University and is currently working on finishing his Ph.D. He is an experienced supervisor in project-organized and problem-based learning, and has for several years been a member of the Study Board at The School of Basic Studies of Engineering, Science and Medicine. He has served a term as a representative of the Danish Engineering Society on the board of Education and Research under the Danish Confederation of Professional Associations.

Egon Moesby, Head of Studies, and Head of Department of Basic Studies of Engineering, Science, and Medicine at Aalborg University, Denmark. Vice Director of UICEE Problem-Based Learning Centre for Engineering Education—UCPBL, and Director of UCPBL International Consultancy and Capacity Building Programme. Educated within Civil Engineering and Structural Design and had a professional career as a consulting engineer before entering the University. Presently in the final stage of writing a Ph.D. on the topic 'What is an effective way to introducing POPBL in an institution?'