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Staff Development for Change to Problem Based Learning*

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Recent years have seen an increase in transformations in educational methods towards Problem Based Learning (PBL). In the process of organizational change, staff development remains one of the key elements. This paper presents a pioneer program in staff development based on PBL learning principles, the Masters in Problem Based Learning in Engineering and Science (MPBL) at Aalborg University, Denmark. Drawing on current experiences and reflection, the paper discusses the outcomes as well as the existing challenges in combining a PBL approach with technology-supported on-line delivery as a strategy for staff development in engineering education.

Keywords: engineering education; staff development; problem based learning; e-learning.

INTRODUCTION

WORLDWIDE, Problem Based Learning (PBL) has become a well-known approach to teaching and learning in engineering and science. An increasing number of engineering educational institutions are undergoing a transformation process towards PBL. The efficiency of PBL is to a great extent dependent on the success of the conceptual change process—and the most important factor in this process is the ability of teaching staff to take on new roles in a PBL environment—in other words, new teaching skills are important [1].

In general, staff development plays an important role in educational change processes [2–4]. This is particularly true in the transformation towards PBL, because the establishment of a PBL culture demands many interrelated aspects to be considered, such as: organizational structure, administrative support, and the engagement and belief of staff members in the change process [5, 6]. For individual staff members, implementing PBL in their teaching practice involves complex teaching competencies including knowledge, skills, awareness, engagement and personal commitment [1, 7–10]. It is important that staff members have the motivation to implement innovative pedagogical methods by analyzing the advantages and disadvantages of various options based on what they are presented with [11].

Training academic staff for an educational innovation, such as PBL, is a challenging task and the question of how to develop effective strategies for training so as to facilitate efficient participation of staff members in implementation of PBL has not yet been solved. This paper discusses current practices of staff development activities in engineering education in general and, more specifically, the experiences of developing an international staff development program for PBL, the Masters in Problem Based Learning in Engineering and Science (MPBL) program at Aalborg University, Denmark. First, the learning principles underlying PBL will be described and the skills needed for teaching in a PBL environment will be discussed.

LEARNING PRINCIPLES AND PEDAGOGICAL SKILLS IN PBL

PBL learning principles

The widespread use of PBL has led to a range of diverse practices—from single courses with limited elements of PBL through interdisciplinary courses to complete curricular systems. Despite the lack of consensus on defining PBL, Graaff and Kolmos [1, 12] have summarized the main learning principles in three approaches: cognitive learning, collaborative learning and contents, as shown in Fig. 1.

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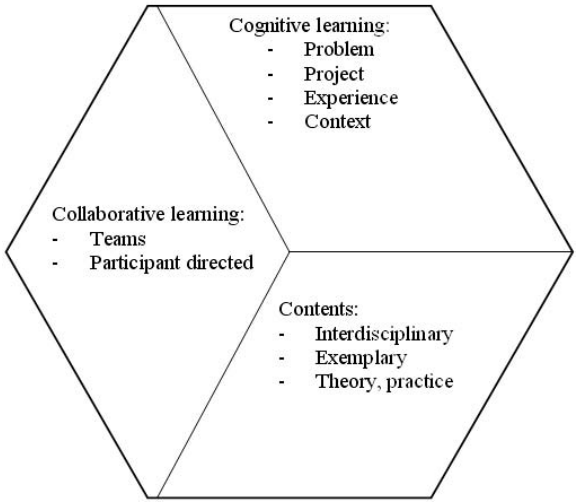

Fig. 1. PBL learning principles.

- The **cognitive learning approach** means that learning is organized around *problems* and is carried out as *projects.* This is a central principle for the development of student motivation. The problem is the starting point for the learning processes, it places learning in *context*, and ensures that learning is based on the learner's *experience.* The fact that learning is organized around a project means that it is a unique task involving complex and situated problem analysis and problem solving strategies.
- The **collaborative learning approach** is team-based learning. The *team* learning aspect underpins the learning process as a social act where learning takes place through dialogue and communication. Furthermore, the students learn from each other through the sharing of knowledge and they learn to organize this process of collaborative learning. This approach also covers the concept of *participant-directed* learning, which indicates collective ownership of the learning process and, especially, the formulation of the problem.
- The **contents approach** especially concerns *interdisciplinary* learning, which may span across traditional subject-related boundaries and methods. The learning practice is *exemplary* in the sense that the learning outcome is exemplary to the overall objectives and supports the relation between *theory* and *practice* by the fact that the learning process involves an analytical approach using theory in the analysis of problems and problem solving methods.

Skills for practicing PBL

Teaching and learning according to the PBL learning principles demands changes in the mode of teaching in higher education, from knowledge transfer to facilitation. It seems, however, to be difficult to define precisely what makes 'good teaching' in a PBL context, partly because there is a general lack of agreement on the required pedagogical skills for university teachers [13], and partly because there is a diversity of widely differing PBL practices, demanding different skills.

What can be agreed upon is that practicing in PBL environments demands not only skills, knowledge, awareness and strategies, but also engagement and personal commitment [1, 7, 8, 14]. Barrows and Tamblyn [15] have proposed that instead of telling students what and how to learn, the teacher (sometimes called the tutor or the facilitator) should help students determine on their own what they need to know and how they need to learn it. Savin-Baden [8] summarizes two challenges for teaching staff in PBL: (1) to be a facilitator who is aware of the way they teach, why they teach that way and how their teaching is perceived by students, and (2) to equip the students to take up the challenge of taking control of their own learning. According to her, it is more important to explore and influence the personal and pedagogical stances of academic staff than to merely generalize the behavior and outcomes.

STAFF DEVELOPMENT STRATEGIES

Staff development in engineering education

Staff development remains an essential aspect in all educational development. During the 1990s staff development programs featured high on the European agenda. In the Nordic countries a number of staff development centers have been established. Experience has shown that it is difficult to motivate senior university teachers, who are rather occupied with research work in their technical fields and therefore have little time to participate in longer-lasting pedagogical development courses [3]. Obligatory participation in pedagogical training is more easily effected for newly employed staff due to a formal requirement of individual pedagogical qualifications.

In the Netherlands, Belgium, the UK and Germany, staff development came onto the agenda as an integrated part of academic development. Training activities for improving pedagogical skills are offered to assistant professors at many universities in Northern Europe. The same trend is now to be seen in Southern parts of Europe. This means that there is a platform for educating new and young staff in particular to new teaching and learning methods.

There is a lack of documentation of the effectiveness of staff development in general. One study has, however, shown that the long-term impact of staff development activities depends on contextual aspects, including the extent to which the staff development is integrated into the work setting of the participants [16].

In the U.S., staff development also remains a challenging task [17]. It has been a hard task to recruit engineering professors to participate in training activities to improve teaching skills, partly due to their distrust of the effectiveness of

the training, and partly due to lack of time and motivation [18].

Staff development for PBL

As mentioned, staff development is a key aspect of the organizational transformation towards PBL; the training methods applied in such staff development activities are diverse—from reading literature through to inviting experts for short term courses, seminars and workshops to long term pedagogical training programs. A commonly used method of training is through PBL seminars and workshops [8, 10]. Through these activities individual staff members are provided with opportunities to experience PBL as learners [4].

The objective of training is not so much to improve existing educational practice within the institution; rather, it involves establishing an altogether new educational practice based on a new understanding of the concepts of teaching and learning. Therefore, it is crucial that participants, through staff development training, experience the new practice and are trained in designing a PBL curriculum, based on the students' interests and needs while still fulfilling the overall curriculum objectives. Such skills are not learned overnight or by participation in a two day workshop. Rather, they are obtained by constantly experimenting with and reflecting on the practice of teaching in a context where members of staff are given the possibilities of trying out their own ideas. In this process, teaching staff are confronted with the conceptual challenges of the new perceptions of teaching, learning and knowledge, as well as with the changes in their own positions and roles in the learning process.

Savin-Baden [8] suggests that for the academic staff, the place for starting the change to PBL is not in problem based seminars, but

> a long way before that in the conceptualization of the place of problem based learning in the curriculum, their views about what counts as valid knowledge and the way in which problem situations are constructed [8].

In relation to the contents of the training program, Maudsley [7] suggests that staff development should ensure expertise in group processes, raise awareness of the effects of subject knowledge and role modeling, and support tutors who are unfamiliar with the contents of the problem scenario. In terms of method, Kolmos [5] suggests that teachers should be provided with the opportunity to practice active participation and cooperation with peers. Collaboration among academic staff is a prerequisite to the effective practice of PBL and therefore active steps have to be taken to facilitate this collaboration. For the effectiveness of educational innovation, Cavanaugh [19] suggests that the best approach to designing incentives for staff members is to have a range of options that can be tailored to individual needs.

Concerning methods of delivery, on-line education or e-learning has seen a tremendous growth in the last two decades and the combination of PBL and on-line education has received some success as a constructivist approach to education [20]. However, it has been a challenging task to combine PBL and on-line education due to the nature of PBL [21] and because many of the current models of on-line education focus on teacher centered learning [8].

From the above it can be concluded that the development of staff training activities in a PBL context demands the careful consideration of a number of interrelated factors: formal requirements, institutional support, staff motivation and engagement, incentives, contents of the training program, methods of delivery, time and room for cooperation, as well as for individual and group reflection, etc. It involves a progressive process of development for individual staff members, because it involves new ways of perceiving knowledge, teaching and learning, and it also involves a new way of viewing others as colleagues and in doing so professional identities are confronted [21].

A model example of an engineering staff development program has been proposed and carried out in the U.S. [18]. The program covers pedagogical training and support as well as campus infrastructure and climate. The program is, to a great extent, dependent on the institutional and national contexts and the lecture based learning environment in general. Even so, some essential principles of pedagogical staff development in engineering education can be drawn from the experiences of this program. These principles include: (1) the use of nontraditional methods for pedagogical training; (2) technology supported training; (3) active learning via participant-directed activities; (4) team based activities, and (5) high quality and innovation in training [17, 18]. These five principles have inspired the staff development program described in the next section.

MASTER IN PBL IN SCIENCE AND ENGINEERING—AN EXAMPLE OF STAFF DEVELOPMENT FOR PBL

Introduction to MPBL

With the support of the UNESCO chair for Problem Based Learning in Engineering and Science, an international master program, the Master in Problem Based Learning in Engineering and Science (MPBL) has been established at Aalborg University (AAU) (http://www.mpbl.aau.dk). The target groups are teaching staff from engineering educational institutions (and other interested individuals) who wish to undertake faculty development in order to transform educational programs from teacher-centered to student-centered pedagogy, such as, for example, PBL.

The main aim of the MPBL program is to enable the participants to continuously develop their own teaching practice, leading to ongoing improvement of the quality of engineering education. This aim is

pursued by providing a meaningful and practical learning opportunity for engineering teaching staff to receive formalized and credited pedagogic training.

The MPBL is a two-year part-time master program structured in four modules (or semesters) of 20 weeks each and credited with 60 ECTS (European Credit Transfer System). The program is an international and interdisciplinary, technology supported, distance learning program with participants located worldwide. Flexibility is ensured by allowing participants to choose between the full Master program of four modules and a number of so-called single subject courses (SSC) that are credited should the participant decide to pursue the full Master program.

The MPBL program encompasses three types of study activities: project work, project courses (P-courses) and study courses (S-courses). Both the P- and the S-courses provide learning resources such as: readings, on-line lectures, activities, discussion forums, etc. The main difference between the two types of courses is that the P-courses that support the project work are examined indirectly through the project exam, while S-courses may be studied independently from the project and are examined directly in an individual oral exam based on a submitted mini-project report. The project unit consisting of the project work and the P-courses is credited with 12 ECTS and the S-course with 3 ECTS.

The contents outline of the MPBL program is as shown in Table 1.

In the next section the program will be described in more detail, followed by a case study to illustrate the activities undertaken in the program by participants and facilitator.

The PBL learning principles—implemented in the practice of MPBL

Based on the belief that it is important for teaching staff to experience PBL themselves as learners in order to achieve a thorough understanding of the philosophy and practice of PBL, the MPBL program itself has been designed to act as an example through its own structure, i.e. it is problem based and project organized and the program participants work in teams, in accordance with the PBL learning principles discussed above. This means that participants experience a virtual PBL environment while being at the same time required to integrate educational experiments involving PBL as a teaching model into their own teaching practice. Furthermore, they are encouraged to reflect on their own learning and teaching experiences, individually and in teams, from both theoretical and a practical points of view.

In keeping with the cognitive learning approach, the main study activity in three of the four modules is a problem based project where participants are expected to work with educational experiments. The participants have to identify their own problems, preferably taken from within their own teaching or organizational practice; thereby the principles of contextual and experience-based learning are satisfied. Furthermore, the participants are encouraged to select interdisciplinary and exemplary problems that may be solved only by drawing upon both educational theory and practice, thus satisfying the contents approach. The teaching experiment designed as a solution to the identified educational problem is of course also supposed to reflect a substantial proportion of the PBL principles.

Concerning the collaborative learning approach, participants are requested to work in teams of two to four participants throughout the entire program—either in study groups providing a forum for discussion and peer review, as happens in module 1, or in project groups where they have to submit a joint project report, as happens in modules 2 and 3. For the Master Thesis in module 4 participants may choose to work in project

Table 1. The MPBL program outline

Module 1—Development of teaching competencies	
Project	Teaching portfolio
P-course	Learning theory for engineering and science
P-course	Engineering didactics
S-course	PBL models in engineering and science
Module 2—Planning of teaching experiments	
Project	Planning of teaching experiment
P-course	Development of process competencies
P-course	Scientific methods in engineering
S-course	Intercultural learning and PBL
Module 3—Implementation of teaching experiments	
Project	Implementation of teaching experiments
P-course	Evaluation and quality development of engineering and science education
P-course	Strategies for management of pedagogical development
P-course	Engineering competences in a global information society
S-course	Project supervision
Module 4—Reflection and evaluation	
Project	Final thesis
P-course	Research methods

groups or individually, although still supporting each other in study groups. Thus, the program provides an opportunity to participate in a global pedagogical learning community for engineering teaching staff.

In order to support the project work, a variety of resources are provided. Figure 2 illustrates the diverse learning resources, which include:

1. *Course Sessions*: These include on-line lectures in the form of any combination of streamed video, PowerPoint presentations, audio presentations, and text.
2. *Discussion Forum*: Course participants can discuss individual contributions, proposals and drafts, contents of on-line lectures and reading material, answers to proposed questions for discussion, etc.
3. *Reading Material*: On-line articles, links to relevant literature on the Internet, and references to books.
4. *The Aalborg University Library*: Here they can find further reading material, including on-line literature in virtual databases connected to the library.
5. *Facilitation*: A university teacher facilitates the project. The role of the facilitator is to enter into dialogue with the participants, asking facilitating questions and giving feedback to written work by discussing the structure and contents of the work, overall as well as in detail.

Given the available resources, the participant is expected to organize his or her own learning together with peers and develop a study plan, including such issues as when to study actively, how and how often to 'meet' for discussion, how to give feedback on individual contributions, etc. These study plans are important not only for the smooth collaboration of the group but also for the communication between facilitator and the participants, and especially for the progression of learning.

The project work for module 1 is the writing of a personal Teaching Portfolio, a task which by nature is individual. The study groups, which for the first module are administratively formed, were used for discussions between participants and between participants and facilitator on issues such as: P-courses, peer review of drafts of teaching portfolios and practical issues. The individual oral exam is based on the Teaching Portfolio.

Fig. 2. Learning resources for a problem based project in the MPBL program.

For modules 2 and 3 the participants form themselves into project groups. Project work in these two modules deals with the planning and implementation of educational experiments, and involves substantial elements of PBL learning principles, drawing upon subject contents from the P-courses. By the end of each semester a written project report describing the theoretical and practical perspectives of the project work, as well as a written process analysis reflecting the participants' working processes, including issues such as project planning, team work, collaboration with the facilitator and the individual and collective learning processes, has to be submitted for the individual oral exam.

The project work for module 4 may be carried out individually or in project groups, formed by participants. The contents of the project work deals with the systematic analysis, evaluation, reflection and possible improvement and expansion of the educational experiments. Again, a written report, the Master Thesis, has to be submitted together with a process analysis, whether the participant is working individually or in a project group.

In order to support communication and collaboration between participants and between participants and facilitators, the web based platform called Quick Place (QP) was employed as the working tool; this provides the possibilities of: (1) arranging group rooms; (2) employing asynchronous communication in the form of discussion boards, and (3) using synchronous communication in the form of on-line chat and sharing of documents. Furthermore, the MPBL program uses the free and open source software Skype for audio and video contact, for virtual 'meetings' between participants and between participants and facilitator, as well as for the individual oral exams at the end of the semester.

The MPBL program started in February 2006 at Aalborg University with 15 Master program participants from five countries. An attempt to make an on-line start-up seminar allowing the 15 participants interactive participation was unsuccessful. A second batch started in September 2007 with three Master program participants from three countries. This time the start-up seminar was conducted via Skype, whereby the three participants could hear each other and their personal presentations. Also, more than 70 single subject course participants from six countries have until now (January 2008) participated in the program. In January 2008 the first participants will be awarded Master's Degrees in PBL.

In the next section a case will be presented to illustrate the activities within the main study activity, the project unit.

A case example—a MPBL module 2 project

As mentioned, the program participants are expected to form groups and to conduct a project each semester. The following is an example of a

Module 2 project conducted by a group of three participants: one from Saudi Arabia and two from the same university in Australia.

According to the guidelines for the project work in this module, participants were to plan a general teaching experiment based upon the same thematic approach and drawing upon the same theoretical foundation but implemented as different cases in different institutions and/or contexts. Based on this the team conducted a project with the title 'Learning to Solve Design Problems in Engineering Education' [22], in which they formulated a thematic approach as well as a plan for the implementation of the teaching experiment in the institutions of the team members. The five-month long project proceeded as follows:

> Problem analysis—Project proposal—Building the theoretical framework—Planning teaching experiments for implementation (three cases)—Report writing—Exam.

At the beginning of the semester, they identified a problem of shared interest:

> Learning to solve design problems is a skill that graduates of engineering education require in their careers and the instructions for this purpose need to be designed such that students could develop the competencies required for solving design problems. [22]

Through analyzing the problem, they agreed to conduct a project in order to 'formulate an educational approach based on which engineering students learn by solving design problems, and to plan the implementation of the educational approach in different contexts.' [18]. With this aim, they proposed a study plan that included a weekly work schedule as well as details of how to use different resources, such as literature, S-courses, P-courses and facilitation.

Based on a reflective review of learning theories from a constructivist perspective as well as of design problems in engineering, the team members formulated an analytical framework for the 'learning of solving design problems' [22]. This framework provided a basis for designing three contextually different teaching experiments in engineering design:

1. A design problem for students in the postgraduate Master of Engineering in Microelectronic Engineering program in Australia. The design problem was in an integrated circuits course.
2. A design problem for undergraduate students in the Bachelor of Engineering in Electrical and Electronic Engineering in Australia. The design problem was on microprocessor systems.
3. Faculty development for supervising design projects in the university's undergraduate engineering programs in Saudi Arabia.

At the end of the project, the team submitted a 60 page long project report plus 10 pages of process analysis. In the process analysis, they reflected on team formation, organization, project management, group communication, team meetings, facilitation meetings, and the report writing process. An extract from their process analysis follows:

> This project has proven to be very stressful for all. The problems all teams have with coordinating team meetings have been magnified by an order of magnitude by the fact that we live in different time zones. We believe that we have formed a completely functional and cooperative team despite these problems and we have used a variety of communication techniques to minimize our problems. Linking the research in our report to current and previous MPBL modules has allowed us to reflect upon not only the product, but also the processes we have used for achieving this product. We have been able to directly incorporate many aspects of courses such as Scientific Methods, and more indirectly significant aspects of Learning Theories, Intercultural Learning, PBL Models etc., etc. We have also lived by the rules and techniques being concurrently revealed in Process Competencies. We have been fortunate not to have had problems within our team organization. Mutual respect and willingness to listen to team-mates have been paramount in our success. Having a supervisor who is flexible and willing to attend meetings in the middle of the night also helped.
>
> The fact that we have three cases within the same 'design problem' teaching experiment means that we can look at three different cohorts of students almost simultaneously. This means that, in addition to the process and product components within the three disciplines, we will also be able to look for cultural aspects of the teaching and learning continuum that we will be creating. [22]

The project was assessed and the three participants were awarded a good mark in the individual exam based on the quality of the report, their ability to reflect on theories in relation to practice and their good presentation skills.

Based on the detailed description of the contents of the MPBL program in the previous two sections, the next sections deal with experiences and reflections, challenges and lessons learned.

MPBL participants' experiences

Following on from the case above this section sets out the experiences seen from the participants' perspective. The contents of this section is based upon the three evaluation surveys conducted so far, in which qualitative questions were asked about participants' opinions on different aspects of the program The software SurveyXact was used for the on-line questionnaire, with response rates of 100%, 90% and 85% for the three modules, respectively.

The overall impression from the evaluation surveys is one of satisfaction with the program, with the negative aspects mainly being attributed to the participants' own lack of time and effort during the program. Condensed results supplemented with extracts from the three surveys are presented in a structured format under the headings: Motivation; Progression; Diversity; Time consumption; Personal development; and Organizational change.

1. *Motivation.* The participants felt highly motivated in the learning process, which is not only a process of gaining knowledge and skills, but also a process whereby they exchange teaching experiences and design for new practice in PBL settings. According to the participants, this mode of pedagogical training allows room for deeper reflection, compared with other short-term forms of staff development activities. A group of participants reflected on their project work for module 2:

> The general atmosphere was always positive with high motivation. Instruction was largely self-instruction within our group, but the activities were very motivating—our group got a lot out of discussions.

2. *Progression.* Through the three academic semesters in MPBL, the participants experienced progression of learning by obtaining new perceptions of teaching and learning and by gaining deeper understanding of different aspects of PBL as a student centered learning environment. As one participant reflected:

> This is a form of self-evaluation. We hiccupped our way through with lots of concentrated input at times followed by 'pause' when we were involved elsewhere.

3. *Diversity.* An international and intercultural perspective stands out through the cross-cultural project and team work, as well as in the discussions in the discussion forum. The diversity of the participants in terms of their backgrounds and situated environments helped them obtain better understanding and inspiration from each others' experiences and enriched the knowledge about and experiences with PBL:

> This made me realize how different people could be, and I learned so much about cultural diversity and the role of culture in teaching and learning environment.

4. *Time consumption.* The stipulated time consumption for participation in the MPBL program is around 20 hours per week. Some of the participants found that this estimate was below the time actually spent on the study program:

> . . . the quantity of reading materials does not match the time available; not for me at least!
>
> The workload is not insignificant and I ask myself if the requirements on 'compulsory reading' and 'recommended reading' really are possible/realistic combined with a full time job.

5. *Personal development.* Participating in the MPBL program has proven to be a meaningful learning process, especially for participants who from the outset were new to the concept of student centered learning. Thus, all participants have reached a higher level of self satisfaction as university teaching staff:

> This course made it possible for me to become the lecturer I really want to be! It made me realise what a bad lecturer I am!
>
> It has broadened my mind and my thinking so much!

6. *Organizational change*. In the cases where several staff members from the same institution participated in the MPBL the personal development of staff has in turn played an influential role in their institutions in terms of establishing an encouraging and open atmosphere. As a group of participants, all from the same institution, reflected:

> In macro terms, [our institution] has had the outcome that learning theory and practice is much more open and a welcome subject for discussion for many more at the lunch table.

The general impression from the evaluation surveys is one of satisfaction with the program. The topic of the next section is the result of self-critical reflection on the part of the MPBL staff whose experiences and reflections will be discussed.

MPBL staff experiences and reflection

In this section the main experiences to date (January 2008) seen from a staff perspective are discussed, including reflections on underlying causes. The two main aspects are the work load of staff and the on-line activity of participants.

Concerning the *work load*, the amount of work needed in preparing course material for on-line learning, whether lectures, study activities, reading materials, etc. has been higher than expected. This may be due partly to the fact that most of us were not very familiar with on-line education before we set out to develop the program. Also, when discussing the practicalities of an on-line program, pedagogical issues tend to come to the fore in a very explicit way, demanding a clear and consensual decision on procedures and practices, meaning that decision making requires time consuming discussions. This was especially true because the program was developed as an EU-project by an intercultural group of university teachers from four different countries with different educational systems and with most of the developers having had very little exposure to PBL before the project took off. Another time consuming activity has been familiarization with the technology used originally and with new technology introduced along the way.

Our experience with participants' *on-line activity* in the asynchronous discussion fora is that it has been varying throughout the program, depending upon: group constitution; study activity; insistency of facilitator; and individual personal commitment elsewhere.

Some of the groups formed for modules 2 and 3 (and even module 4) consisted of staff members from the same institution who could take advantage of their geographical proximity to meet face-to-face while others were intercultural groups meeting only through Skype. For obvious reasons, participants in same-institution groups did not make as much use of the QP platform for project work as did the cross-institutional groups.

The on-line activity in connection with the teaching portfolios was not very high for the first batch. This has, however, changed with the second batch where the group of three has met regularly and with their facilitator, and several drafts of Teaching Portfolios have been exchanged and discussed during the semester. This difference may be attributed to the fact that the three participants of the second batch had a chance to talk to each other already in the start-up seminar.

In connection with courses, there has in general been more on-line activity in S-courses than in P-courses. This may be explained by the fact that in the S-courses a mini project report was to be submitted and an independent oral exam was set, as opposed to the situation in the P-courses, which are indirectly examined via the project exam. Another reason may be a higher degree of activity and insistency of the S-course lecturers. The on-line activity increased during the second semester, especially in the S-course 'Intercultural Learning and PBL' where most participants took advantage of the diversity of the group to discuss issues of culture and education and to receive comments to drafts of mini-projects from the other participants. Thereby, the participants came to 'know' each other somewhat better, with increased communication in the other fora and in the following semesters as a consequence.

There is, however, a clear and consistent tendency throughout the program that it is the same few participants who are active on-line and who participate in discussions by placing drafts and offering contributions, proposals and ideas in the discussion forum. Approximately one-third of the first batch has been very active, one-third has been somewhat active and one-third has been passive.

Having thus described the experiences so far, the next section will describe outstanding challenges that have to be addressed to improve the program.

Outstanding challenges

Although the main impression is that the experiences so far are positive, some outstanding challenges that are likely to affect the impact of the program for future participants need to be addressed. These challenges may be classified as follows: the low level of on-line activity; the lack of understanding of the AAU model concepts, including lack of experience with group and project work; the limited experience with academic writing; and technical problems.

- Despite the high motivation and the strong interest expressed in the evaluation surveys, it has been difficult to actively involve all the participants in the asynchronous on-line activities, since as full-time working teachers they also need to spend time on teaching and research, not forgetting family and leisure time activities.
- Another challenge is the use of synchronous communication. Although the flexibility provided by asynchronous communication is appreciated, synchronous dialogue seems to be rather difficult to use for immediate needs of facilitation, partly because all 'meetings' need to be arranged in advance, and partly because of the differences between time zones of participants from different parts of the world.
- The MPBL program is modeled upon the so-called Aalborg PBL model, a study structure that is found in few other universities of the world. Therefore, it has taken some time for most of the participants to come to understand the structure and the concepts of this model, such as the P-course, S-course, project, mini-project, etc.
- Another aspect of this is that, given the emphasis on and the encouragement of participants' self management in the learning process, MPBL staff members faced challenges in relation to striking a balance between encouraging, motivating and interacting with participants on the one hand, and instructing, guiding and intervening in their work on the other.
- Although the entrance requirement for the MPBL program is a relevant Bachelors Degree it was found that some of the participants had had limited exposure to the art of academic writing as required at the Master's level.
- The advanced level of technology used (the QuickPlace platform, the Skype software, virtual 'meetings', streamed video lectures, on-line reading material, etc.) has given rise to technical access problems for participants from so called 'developing' countries.

Lessons learned

Based on the above sections on experiences, reflections and challenges, this section summarizes the main lessons learned from the MPBL program development and implementation so far.

On the negative side, the main lessons learned are as follows:

- Securing a high level of on-line activity involving all participants in this e-learning program requires ongoing effort and insistency from staff members. An interactive module 1 activity, such as the planned on-line start-up seminar with a round of presentations might alleviate this problem.
- Group formation in a diverse environment such as the one found in the MPBL program remains a challenge—whether homogenous groups or heterogeneous groups there are advantages and disadvantages in both situations, and while some participants will prefer one, others will prefer the other.
- Synchronous communication via Skype is perceived as far superior to asynchronous communication in the discussion fora but the timings of

such communications is a challenge that can best be overcome by agreeing at an early point in time on dates and times for Skype meetings throughout the module.
- The concepts and the practices of the Aalborg PBL model, including group work and academic writing, need to be communicated to participants at an early stage, preferably from the start of module 1. A preparatory course integrating these issues might be considered.

On the positive side, the lessons learned are as follows:

- The evaluation surveys document a high degree of participant satisfaction with the program—no major changes and/or improvements have been suggested.
- The overall aim of enabling the participants to continuously develop their own teaching practice seems to have been fulfilled to a fair degree, based on the description of teaching experiments found in the project reports. It is still too early to judge whether this will eventually lead to ongoing improvement of the quality of engineering education within the institutions of the participants.
- For the MPBL staff—and hopefully for the participants as well—it has been exciting to have this opportunity to interact with experienced and mature engineering educators from many countries and to discuss pedagogical issues, an opportunity not often found in the busy daily schedule of most university teachers. We can truthfully say that this has been an experience of mutual dialogue and learning.

CONCLUSIONS

This paper discussed issues and challenges of staff development in the process of educational transformation towards PBL. It is argued that in order to enable engineering teaching staff to participate successfully in this transformation process, it is necessary to provide opportunities for them to experience PBL as learners and to provide training opportunities. Based on the description of the MPBL program, this paper presented the experiences of combining PBL as a tool for staff development with a delivery mode of on-line distance learning.

By employing PBL as an approach to staff development, a learning environment is established where participants are not only provided with knowledge about PBL, but are also given opportunities to experiment and develop their own teaching skills and curriculum based on their educational and institutional needs and contexts. On-line team work provides opportunities for sharing experiences and for international collaboration in the development of PBL as an educational model, locally as well as globally. Thus, it can be concluded that the combination of PBL and on-line learning offers a new and flexible learning space, where technology is used to support new and innovative forms of interactive learning.

However, the experiences from this pioneering practice of using PBL on-line as a method for staff development towards PBL are still very limited. More research and further development is needed in order to provide a consolidated staff development program for PBL specifically and for staff development at international level in general.

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