Tutors and Teachers in PLEE

Project-Led Engineering Education: a Plea for PLEE Tutor Training

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Summary

Project-Led Engineering Education (PLEE) is a learning environment where students can learn in teams to work on real problems and projects, in which the technical content, skills and attitudes can be applied coherently. This article deals with questions like 'What is a project?' and 'What is (our) view on the role of PLEE Teachers and Tutors?' Finally we hold a Plea for PLEE training tutors.

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1 Everyone is doing Projects

"Of course we do project education. Everyone is doing projects these days. Projects are rather like religion, politics and garlic. Everyone has own opinions on these subjects, but few share the same opinions with others" (Powell & Weenk, 2003, p. 27)

The first question that arises when talking about teaching and tutoring in Project-led Engineering Education is: What is a project? Numerous examples of projects are to be found at f.e.

- government level: current issues dealing with problems in water supply, the control of food and safety, avoiding traffic congestion, etc.
- company level: many projects are focused on quality, improving products or services.
- department level in a company: a product or service used by other business units or the relationship with external customers.
- individual level: a recommendation, a decision on the acquisition or an adoption of a device or organizing a party, a vacation, etc.

There is much confusion what exactly is meant by a project. The Chartered Management Institute defines a project as: "an activity that has a beginning and an end which is carried out to achieve a particular purpose to a set quality within a given time constraint and cost limits" (YESIP, Para 1).

In education projects can take all kind of forms. Iindividual projects just before graduation, a small research and essay assignment or a substantial assignment involving a team of students in solving a complex open-ended problem are all examples of a project in education.

1.1 Inductive Teaching methods

Prince & Felder (2006) state that traditional engineering instruction is deductive, beginning with theories and progressing to applications of those theories. According to them inductive teaching and learning is a preferable alternative. "Instead of beginning with general principles and eventually getting to applications, the instruction begins with specifics—a set of observations or experimental data to interpret, a case study to analyze, or a complex real-world problem to solve. As the students attempt to analyze the data or scenario or solve the problem, they generate a need for facts, rules, procedures, and guiding principles, at which point they are either presented with the needed information or helped to discover it for themselves.
Inductive teaching and learning is an umbrella term that encompasses a range of instructional methods, including inquiry learning, problem-based learning, project-based learning, case-based teaching, discovery learning, and just-in-time teaching. These methods have many features in common, besides the fact that they all qualify as inductive" (Prince & Felder, 2006, p. 1-2).

Prince and Felder (2006) review several of the most commonly used inductive teaching methods. They define each method, highlight commonalities and specific differences, and reviews research on the effectiveness of the methods. While the strength of the evidence varies from one method to another, inductive methods are consistently found to be at least equal to, and in general more effective than, traditional deductive methods for achieving a broad range of learning outcomes.

1.2 Project Based Learning (PBL)

Higher Education Projects arise in a variety of contexts and applications. "There is no one accepted definition of PBL" (Buck Institute for Education, 2009, Para 4).
BIE (Buck Institute for Education) defines standards-focused PBL as: "a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks. This definition encompasses a spectrum ranging from brief projects of one to two weeks based on a single subject in one classroom to yearlong, interdisciplinary projects that involve community participation and adults outside the school" (Buck Institute for Education, 2009, Para 4).

There is a distinction between PBL and education including (some) projects. In PBL the projects are the central organisation form of the curriculum and a means to acquire knowledge, insights and skills. In the latter the traditional curriculum is enriched by projects in which the earlier acquired knowledge, insights and skills are to be applied.

"More important than the definition itself are the attributes of effective projects. The BIE planning model is based on a number of criteria that distinguish carefully planned projects from other extended activities in the classroom" (Buck Institute for Education, 2009, Para 4-5). Outstanding projects

- Recognize students' inherent drive to learn, their capability to do important work, and their need to be taken seriously by putting them at the center of the learning process.
- Engage students in the central concepts and principles of a discipline. The project work is central rather than peripheral to the curriculum.
- Highlight provocative issues or questions that lead students to in-depth exploration of authentic and important topics.
- Require the use of essential tools and skills, including technology, for learning, self-management, and project management.
- Specify products that solve problems, explain dilemmas, or present information generated through investigation, research, or reasoning.
- Include multiple products that permit frequent feedback and consistent opportunities for students to learn from experience.
- Use performance-based assessments that communicate high expectations, present rigorous challenges, and require a range of skills and knowledge.
- Encourage collaboration in some form, either through small groups, student-led presentations, or whole-class evaluations of project results"

In Engineering Education PBL has been transformed in PLEE (Project-led Engineering Education).

1.2.1 Project-led Engineering Education

Powell & Weenk (2003) define Project-led Engineering Education (PLEE) as:
"Project-Led Engineering Education focuses on team-based student activity relating to learning and to solving large-scale open-ended projects. Each project is usually supported by several theory-based lecture courses linked by a theme that labels the curriculum unit. A team of students tackles the project, provides a solution, and delivers by an agreed delivery time (a deadline) a 'team-product', such as a prototype and a team-report. Students show what they have learned by discussing with staff the 'team-product' and reflecting on how they achieved it. The subject of each project exemplifies the theme, and is appropriate to the levels of competencies in the programme at the time it is done. A project is aimed at competencies and not so much on distinctive knowledge or skills.

A series of projects explores different subjects and themes and develops increasing levels of professional competencies. In this way the students learn to master the competencies specified in the curriculum (knowledge, skills and attitudes) in the context of professional practice. The key features of a project are authenticity and a real problem coupled with a future professional situation and context" (Powell & Weenk, pp. 28-29).

1.3 The rationale behind Project-Led Engineering Education

"Engineers have to face new and complex problems which cannot be solved by a simple back-of-the-envelope calculation or sketch" (Powell & Weenk, 2003, p 32).
Because the problems are new there are no known solutions. To handle the problem the engineers need to work in a team with experts from other disciplines. For a fruitful cooperation the members need to communicate and be open to each other's experiences and expertise.

It is not surprising, therefore, that Ruijter (2002) identifies 4 reasons why PLEE is a good choice for innovation within an 'engineering system':

- it is suitable for educating and training relevant engineering competencies.
- students respond well to more varied learning activities (compared with the traditional approach).
- the social commitment to team work stimulates participation.
- students respond well to the relevance (to engineering practice) of the PLEE learning activities.

1.3.1 Life Long learning

"There is an element of truth in the suggestion that part of the basis for getting an old-style degree involved learning facts and learning the tricks necessary to pass examinations. But the half-life of technical facts is short and getting ever shorter; technical problems in real life are not the straightforward closed-form problems often found in examination papers. It is more important to think, to learn how to identify what is (not) known, to solve problems, to find sources of information, to apply the information to synthesise solutions, and to choose the best solution. We try to encourage openness in students and willingness and the competence to ask relevant questions and get answers in order to ensure progression. This is a firm basis for tackling new problems during a career and a basis for learning/acquiring new skills (long) after graduation ('Life-long-learning')"(Powell & Weenk, 2003, p. 70).

The experience of Powell & Weenk (2003) is that "PLEE can develop well and efficiently the required competencies expected of an academically-trained engineer at the time of graduation, and provides a secure basis for life-long learning. Students respond very positively to PLEE" (Powell & Weenk, p. 99).

1.3.2 Vision on learning

Views on education are constantly changing. Three major changes in the past decennia are addressed below.
Learning objectives are no longer the end goal of degree programs. Nowadays objectives of the program are formulated as competencies that are to be achieved by the students (Weenk & Van der Blij, 2010).
A competence is more than the sum of knowledge, skills and attitude. These elements become a competence when the person has insight in their relation and the application in the given context. Van der Blij (2002) defines a competence as: "The ability to apply integrated complex knowledge, skills and attitude in such a way that the person acts responsible and adequately in a certain context" (Van der Blij, p. 2).
In order to acquire competencies students need to learn and practice with real life problems in an authentic context. Next to the disciplinary competences there is special attention for soft skills, f.e. gathering information, communication and cooperation.

Students are no longer consumers but active learners who construct their own understanding and direct their own learning process.
Loyens (2007) describes four basic assumptions of constructivism:

1. knowledge acquisition is a process of knowledge construction in which prior knowledge comprises the frame of reference for the interpretation of new information.
2. learning involves interactions with others such as fellow-students or teachers.
3. knowledge construction benefits from metacognitive skills such as to plan, monitor, and evaluate one's learning process.
4. it is important that learning takes places in an authentic context, preferably similar to future professional contexts.

No longer should the activities of the teacher be the centre of education but the learning of the student
Students get more responsibility for their own learning process in student-centered educational methods. This is consistent with research findings that students learn by fitting new information into existing cognitive structures and are unlikely to learn if the information has few apparent connections to what they already know and believe (Prince & Felder, 2006).
PLEE is an educational methodology that fits competence learning, constructivism and student centred learning,

1.3.3 Efficiency and effectiveness of learning

"If you want faster students, you should train first-year students in their social skills, instead of threatening them with higher tuition fees and loans. It is clear that being successful in studying is not only about doing what a lecturer asks you to do and handing in papers in time. Others things, like motivation and being part of a social circle, are just as important" says education specialist Lilian Eggens (2011a).
According to L. Eggens (2011b) the size of the social network has a positive influence on the study pace.

For the three Dutch universities offering Mechanical engineering, the motivation to change from a classical approach to a project-based approach was:

- to stimulate and motivate students and to acquaint them at an early stage with the profession of mechanical engineering, in particular the aspects of analysis, planning, design and manufacturing, etc.;
- to increase the efficiency of the system in terms of the duration of the study;
- to improve teamwork and communications skills of the mechanical engineer;

- to arrive earlier than before at a point where the student can make a well-founded decision as to whether or not to continue the study of mechanical engineering at a university level' (VSNU, 2000 p. 13).

According to Powell & Weenk (2003) incoming (first-year) students find the team-based project an excellent motivation for finding out what engineering is all about, as well as starting to learn the 'hard' parts of the curriculum. Their grasp of the theory built-up during the first year is at least as good as under the classical system. During project work students quickly learn to work hard and effectively and the team-work accelerates the learning process.

John W. Thomas (2000) has done a review of research on project based learning. Five conclusions on the merits of PBL are:

- There is some evidence that students have difficulties benefiting from self-directed situations, mainly because of problems with initiating inquiry, directing investigations, managing time, and using technology productively. Therefore it is important to help students learn how to learn.
- There is direct and indirect evidence, both from students and teachers, that PBL is a more popular, beneficial and effective method of instruction than traditional methods.
- PBL seems to be equivalent or slightly better than other models of instruction for producing gains in general academic achievement and for developing lower-level cognitive skills in traditional subject matter areas.
- There is some evidence that PBL, in comparison to other instructional methods, has value for enhancing the quality of students' learning in subject matter areas,
- There is ample evidence that PBL is an effective method for teaching students complex processes and procedures such as planning, communicating, problem solving, and decision making,

According to Mills and Treagust (2003) "students taught with project-based learning may gain a less-complete mastery of fundamentals than conventionally taught students acquire, and some of the former students may be unhappy over the time and effort required by projects and the interpersonal conflicts they experience in team work. Moreover, if the project work is done" (in: Prince & Felder, 2007, p. 16).

University of Twente (Powell, 1999), Technical University of Eindhoven (Eindhoven, 1999) and Université Catholique Louvain, Belgium (Milgrom, 2001) all report positive and encouraging results on improved student progression and competencies after implementing a programme in which PLEE plays a major role.

1.3.4 Developments at the University of Twente

The University of Twente plans a curriculum innovation over all the degree programs (University of Twente 2011a 2011). The education should meet the demands of the future: more emphasis on academic skills (transferable skills), less emphasis on factual knowledge. And education should be more efficient and have less study delay. The University chooses flexible teaching modules; each module (15 EC) has a project included. Here, students integrate the presented material, test their understanding and generate new questions. The University has had good experiences with education projects in several programs. Failure and pace of study are related, but there are important differences. Analyses of causes of study delays at the UT show a similar picture as international studies. Delay is greater if there is less pressure, from staff, from fellow students, or assessment. Because of inflexibility in the curriculum study delay is difficult to compensate later on in the program.

In a more extensive paper on the educational model (University of Twente 2011b 2011) the following is stated: "The University has a responsibility to the students and to society. Formally, we have confirmed our ambitions by signing a multi-year agreement with the Minister of Education and Science. Together with other Dutch universities, we are committed to the goal that by 2014 70% of the undergraduate students achieve their bachelor's diploma within four years. "

In the strategic plan Route '14+, the University of Twente has also chosen for adjustment of educational programmes to diversity among the students. "The diversity of students is related to their personality as well as their scientific interest. Students are (to be) identified as 'researchers', 'designers' or 'organisers' (the RDO concept): they have different learning styles, are motivated for different roles in teamwork, and have different positions in society in mind. The teaching approach of UT will focus more on transferable skills" (University of Twente 2011c).
It is clear that the University expects that Project Education will enhance the achievements and the study speed of the students. In order to accomplish this an appeal is done to all involved in education, managers, teaching staff and support staff. The start of this innovation process was at a university conference (April 2011) about the new educational model.

2 Staff and Students are doing projects in PLEE

"Innovation is in its best form an evolutionary process from within, gradually developed and becoming gradually integrated into the functioning of the school" (Van den Berg & Vernooy, 2000, p. 38).

Goodlad, Klein & Tye (1979) make a distinction between various curriculum representations:

- Ideal curriculum: the original ideas and intentions of the designers
- Formal curriculum: the written curriculum (documents, materials)
- Perceived curriculum: the interpretation of the users (especially the teachers) of the curriculum
- Operational curriculum: the actual instruction in the classroom
- Experiential curriculum: the reactions and outcomes of the students

This makes it clear that it's a long road full of pitfalls from ideas to the desired outcomes.

It all starts with the conversion of the ideas and intentions in the design of the education, the curriculum in documents and materials.

2.1 Curriculum design

The PLEE approach devotes about 20 to 40% of the learning time to project work using student teams. The students are addressing the disciplinary competences as well as the required soft skills.

"The curriculum is arranged so that there is a theme in each academic term which represents a part of the complete engineering discipline of the program. The theme covers at least two (contrasting) project-supporting lecture courses which are not closely related to each other academically, but which are found coupled together in engineering practice. The sum of all the themes therefore covers the curriculum and the discipline in a representative way. It is clear how the lecture courses relate to each other during each term and between different terms" (Powell & Weenk, 2003, p. 35).

Next to the project courses often non project supporting courses are offered.

PLEE is not exclusively student-team-led learning. It involves a blend of team-based project work together with lecture courses and sometimes individual assignments f.e. the final project.

2.1.1 Quartile design

Project work and courses are planned during the whole term. The project is a substantial part of the student learning activity. The project starts at the level of about 1 day per week, and expands to about 4 days per week. Figure 1 shows a typical schematic 1 quartile timetable. Each element of the quartile is separately assessed. The student study time includes lectures, tutorials and private study.

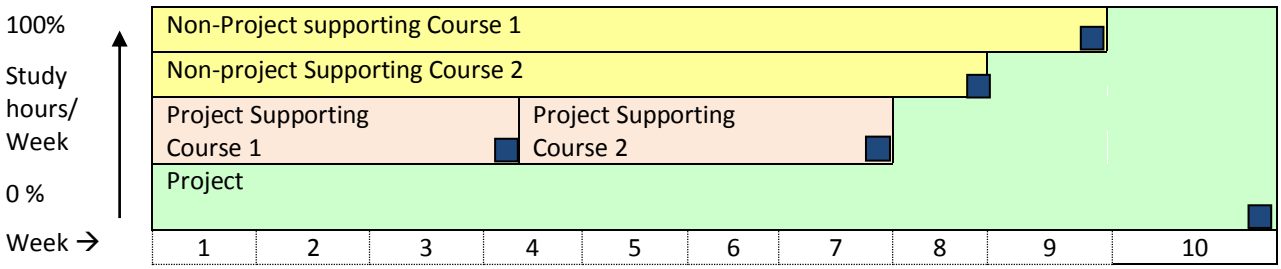

Figure 1: Schematic typical study period (1 quartile) **examination**

2.1.2 Project design

The rough outline of project work is as follows: "A team of students tackles the project, provides a solution, and delivers by an agreed delivery time (a deadline) a 'team-product', such as a prototype and a team-report. Students show what they have learned by discussing with staff the 'team-product' and reflecting on how they achieved it" (Powell & Weenk, 2003, p. 28).

The project assignment should be designed in such a way that the key principles of PLEE are addressed:

1. The focus is on students learning the desired competencies which employers need, and on the student effort needed to master those competencies.
2. The project assignment directs the student team towards mastering the desired technical competencies. All the key technical areas of the discipline are handled – and given major attention – so that the graduate can be recognised as demonstrating competencies in the technical skills of the discipline.

3. Learning is done mainly in student teams by tackling open-ended problems and by getting feedback on what has been done and on what needs further to be done.
4. Students learn the soft skills of communicating in an active way that is integrated within the handling of the technical aspects of the curriculum.

(Powell & Weenk 2003, p. 131)

Box 1 represents a short description of a typical first-term PLEE project scenario (Weenk & Van der Blij, 2010).

Context: Mechanical Engineering at UT/NL
Theme: Provide first years motivating acquaintance with ME, integration of subjects
Project Assignment: Reduce the internal volume of an empty can by 90%
Aim: students' experience of the complete design and production cycle for a can rushing apparatus to be used in the home kitchen.
Specifications: to make the assignment very challenging, e.g. volume, costs, quality. The student team must make a design for a prototype, make the components for it, plan and carry out the production, assemble the apparatus, test it and improve it if necessary. The assignment provides an open-ended, stimulating focus for students to learn about the 'subjects' in the trimester.
Project-Supporting Courses: design, engineering drawing and computer-aided design, production systems, Statics.
Non-Project-Supporting Courses: e.g. mathematics, communication.
Activities: The student team gets the project on the first day of the first term and is immediately confronted with a real problem representative of professional practice.

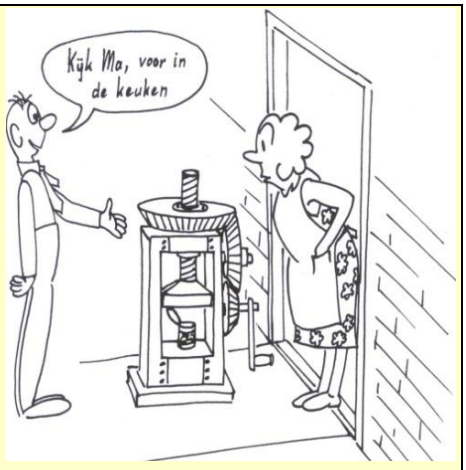

Figure 2: Look, ma, something for the kitchen! (Ray Klumpert in Powell & Weenk, 2003, p. 39)

Box 1: typical first-term PLEE project example

A lot of teachers think that in a team of eight students, only two will do the work, and the rest will sit back and do nothing. In practice this rarely happens. The project is deliberately a little bit too large, so all the students have to do their share fully, otherwise the project cannot be completed on time (and the team fails). There is social pressure from the team upon anyone who will not work. The examination requires that each student shows he can defend the complete project, not just the bit he has (or has not) worked on: with no involvement in the team work, we find that it is impossible that an idle student can defend the project. Moreover the tutors keep an eye on the process of the project, and signal anyone who is not pulling their weight: the examiners are thus well prepared to examine the student closely.

The description of the curriculum and the quartiles, including the courses, and the project assignments are the basis for the teaching staff to implement the curriculum.

3 Teaching activities in PLEE

"Creative activity could be described as a type of learning process where teacher and pupil are located in the same individual." (Koestler, 1905-1983)

As mentioned in the previous chapter the teaching staff is essential for the student outcomes of the curriculum. The way the teaching staff interprets the curriculum in documents and materials, the perceived curriculum is of influence on their activities in the classroom, the operational curriculum.

Powell & Weenk (2003) state that the biggest challenge for implementing PLEE rests by staff members. They need to accept and adopt the vision of PLEE methodology and change their familiar roles and teaching activities.

3.1 Roles of teaching staff

Teaching staff can fulfil different roles in PLEE. In order to fulfil these roles as intended in PLEE a shared vision on education is necessary. Often the teaching staff has already played an important role in the design of quartiles, courses and projects. During this phase many of them have become acquainted with the characteristics and elements of PLEE and the curriculum of their degree program.

The following roles for the teaching staff in PLEE can be distinguished:

- Contractor: The students receive the project assignment from the contractor. The contractor experiences the problem and has the need for the solution. IN order to keep on the right path students need to consult the contractor several times during the project.
- Expert: During the project work students encounter all kind of problems. Often not all the necessary knowledge and skills are already covered in the project supporting courses. It is almost certain that since students define their own problem solving or designing process they need other knowledge then is foreseen. In these cases they may need to consult experts to help them on their way.
- Assessor: The result and the process of project work will be assessed for grading.
- Lecturer: The lecturer is responsible for the courses including lectures and tutorials.
- Tutor: The tutor has the roles of supervisor and monitor during the project work.

"Once teachers feel comfortable with PBL, they usually say they'd "never go back."! They see how well it works for their students, and they enjoy the new role they play. PBL allows a teacher to work more closely with students, acting more like a coach instead of the "sage on the stage." Now, if you *enjoy* being the centre of attention in your classroom, you may think PBL is not for you. But don't fret — there are times when you still will be the focus. Because you know more about the subject, you might still give a lecture, provide a structured lesson, or direct students to resources. Especially in your early projects, you'll still be planning and facilitating much of the work. In future projects as your students are more able to work independently, you may need to plan and facilitate less and less, but you still play a vital role" (Buck Institute for Education, 2009, p. 7).
The next paragraph elaborates on teaching and the role of lecturer, the role of tutor will be covered in more detail in chapter 4.

3.2 Role of the lecturer

The activities of the lecturer are part of the operational curriculum, the last step before the experienced curriculum, the student outcomes. The lecturers are responsible for giving the courses in PLEE. In case of project supporting courses it is important that the lecturer doesn't reveal possible solutions for the assignment. So lecturers should be well informed about the quartile as a whole.
There is a wide variety of styles of presentation in the lecture room. Some lecturers seem to give effortless and spontaneously an inspiring presentation during which all kinds of slightly related topics are discussed. Others are well prepared and give a structured presentation in which all the important concepts and topics are covered. Some lecturers encourage students to ask questions, others lecturers vary their presentations with small assignments to activate students. And some lecturers want to give their presentations undisturbed by questions of the students. In that case the lecturer in figure 3 is walking in front and his students are following.

Figure 3: the lecturer (Powell & Weenk, 2003, p. 150)

In traditional education the lectures are the core of the curriculum. During the lectures the students are supposed to learn knowledge and insights and gain understanding.
The teacher and the teaching is the centre and the students are lost without formal and structured explanation of the concepts. After the lecture they are supposed to do their homework to rehearse what was told.
However, the 'Cone of Learning' (see figure 4) shows that students don't remember too much from lectures in case they don't do more than reading and listening.
The conclusion is that students remember less from listening alone.
Of course lectures can be of use. Lectures are certainly suitable for survey main topics, explain difficult parts, give examples, demonstrate a systematic approach, stimulate students' interest and offer a framework for self-study and application.
Lectures are less suitable for learning problem solving, remembering much from the lecture content, for mediate or weak students and if content is available elsewhere.

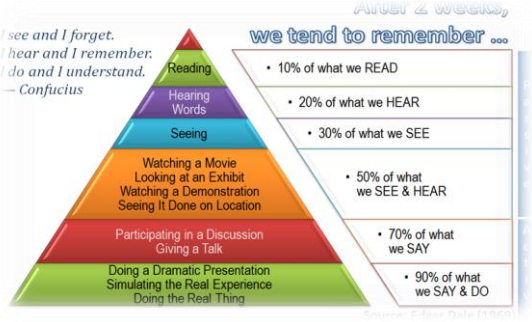

Figure 4: Cone of Learning (Edgar Dale 1969)

4 Tutor activities in PLEE

In all science, error precedes the truth, and it is better it should go first than last. (Hugh Walpole, 1884-1941)

In traditional education teachers prevent student to make mistakes by telling them the necessary knowledge and how the work should be done. The role of tutor in PLEE is quite different. A tutor supervises the project work of the team and reacts to questions mostly with further questions. Only when students really seem to get stuck the tutor can play a more active role.
Just as the activities of the lecturer the activities of the tutor are part of the operational curriculum, the last step before the experienced curriculum, the student outcomes.

4.1 Leader or manager

"Do you prefer to be a leader or a manager? Leaders facilitate problem solving in a group and help the group find their own solutions. Managers control the process and look for prescribed outcomes. In reality, good teachers go back and forth between the two roles" (Buck Institute for Education, 2009, p.9).

The role of the tutor is to support the students by facilitating learning. During the project work students will encounter obstacles and opportunities. Students can't succeed in PLEE without the support of the tutor.

"Many students want their instructors to tell them everything they need to know for the exam—not one word more or less" (Felder & Brent, 2009, p. 4).
However, support doesn't mean to provide them with the answers. Far more it is letting them struggle and make mistakes. It includes being sensitive to their differences in abilities, aptitudes, and learning styles. This requires interpersonal and communication skills. In first year project the tutor also supports the students with the definition of their planning and the deadlines. But the tutor always is aware of the fact that the students are responsible and that the learning process is more important than the project result.
Asking questions and providing students with feedback fit the tutor role. Asking the right question and giving feedback at the right time not only challenge the team, but avoid having students getting stuck during their learning process and ending up treading water. Tutoring involves listening carefully to what students know and then reacting to the student signals by suggesting new or better approaches.
Above all the tutor does not tell the students what to do nor does the tutor solve the problem for the student or student team. Pictorially the tutor develops a 'smaller mouth and a larger ear' as shown in figure 5. He monitors student team discussion.

Figure 5: Tutor monitors team discussion (Powell & Weenk, 2003, p. 98)

4.2 Tutoring and supervising

Rick Reis quotes Richard M. Felder saying that an important part of the job as teachers is equipping as many of our students as possible with high-level problem-solving and thinking skills, including critical and creative thinking. If there's broad agreement about anything in educational research, it's that well-implemented student-centered instruction is much more effective than traditional lecture-based instruction at promoting those skills" (Reis 2011, Para 1).
The work done in teams must be made functional. Supervision is directed towards the teams getting things going and keeping them going. It is important for teams to function well even without the tutor in the vicinity. Getting real work going and structuring it is the function of team meetings. The task of the tutor is to provide help on the *content* of the project and on the *process* of running the project.
"The tutor will suggest strategies for solving problems but his task is not to 'give answers on how precisely to complete (an element of) the project or problem'.

Figure 6: the tutor (Powell & Weenk, 2003, p. 150)

Students are advised to ask each other about how to solve problems, and only ask the tutor if the team as a whole cannot solve the problem. The tutor focuses his energy on the student team rather than on the individual" (Powell & Weenk, 2003, p. 39).
The tutor is going behind the small student groups, observing individuals (as shown in figure 6), and giving feedback just-in-time in order to keep students going in the right direction and in good speed.

Weenk (2000) compares a PLEE tutor and a volleyball coach during the match:
- The coach is not equal to the team players nor being the leader;
- The team players invest energy in active way; the coach observes;
- The coach is seated outside the boarding, while team players are jumping and smashing;
- If the score is going lose, the coach is enabled to ask for time-out;
- Always discussion, feedback and if necessary changing some players.

The tutor needs many communicative skills to interact adequately with the students. In box 2 is shown how different communicative interventions influence the students. F.e. telling them what to do has a different effect as summarizing.

Non directive	**Directive**
Listen to understand –Reflect –Summarise –Orden -Ask questions -Add questions -Add experiences -Offer suggestions –Assess -Telling	

Box 2: Classification of communicative interventions from non-directive to directive

4.3 Different tutor sub roles
The tutor may fulfil the next sub roles in the project (based on Powell & Weenk, 2003, pp. 247-249).

Setter of the assignment
A characteristic of project work is that there are certain learning objectives so that the student and the project team have to plan, communicate and work together, make adjustments, agree to compromises, and so forth in order to achieve the outcome. The learning objectives set the degrees of freedom of the students project work. The tutor monitors the learning progress in relation to the objectives.

Stimulator
The tutors can motivate students. They can do this for example through:
- showing interest and giving attention to student's team work; depending on what team members need, the tutor becomes either a listener, or an opponent who challenges through asking questions.
- asking the team members regularly about the why and the how, encouraging creativity and setting them to go into things in more depth.
- helping the team through a difficult period if things are not going too well; and with projects which last a long time that is very likely to occur at some point.

Monitor of the learning process (facilitating co-operation)
Learning to work together in project teams does not always run smoothly. The tutor will be able to observe that. Confusion on the activities and strategy, poor preparation of the meetings and the team climate are indicators of problems.
The tutor can support the good development of co-operative effort for example through:
- ensuring that the team makes a good start. The tutor must be present at the first meeting and introduce him/herself, the project and explicit the mutual expectations of the students and the tutor.
- insisting on drawing up agreements arranging the activities between the meetings.
- seeing to it that the team works hard and focused according to the procedures agreed on and that every member contributes to a satisfactory extent.
- checking that the chairperson takes turns and coaching the discussion leader in preparing the meeting. Chairing a meeting is a learning experience for everyone.
- observe to see that the team is working together in a useful manner and that team co-operation is discussed in a constructive manner.

Evaluator of the process
The tutor can support team process evaluations on different times and in different ways. This is to improve the quality of the work in the course of the project. During the last ten minutes of a meeting the tutor can comment on the way in which the meeting ran, what has gone well and what could go better. The tutor can discuss for example the work done and project team opinions about the way the meeting went. The team members try to find the weak spots for themselves and think about own solutions.

Expert (specialist)
In some programs the role of tutor is fulfilled by (PhD) student assistants. In many programs however, the lecturer is the tutor. In discussions with the team, the tutor tries to avoid explaining and teaching, so that the team is forced taking the active role. When the team is really stuck the tutor may give a short explanation of a difficult point on request of the team in the role of expert. The tutor uses judgement based on academic and professional experience to guide students to reach solutions to open-ended problems. There are no 'perfect' or 'unique' solutions to proper PLEE problems or projects. Staff may from time to time feel exposed to unfamiliar situations where they have no 'ready-prepared' answers to team questions, and feel uncomfortable about this. This need not weaken their position; such exposure places them in much the same position as the students, but the staff can draw upon their wider experience-in-general when handling the student questions or commenting on student proposals.
Another aspect of the tutor role as expert is to pay attention to the soft skills, f.e. communication, planning, gathering information, cooperation. The 'soft' skills are frequently underdeveloped in the traditional approach. All the evidence is that engineers need the soft skills as a part of their necessary competencies. When the students learn to study effectively (often in tutor meetings), they can then learn more engineering more effectively as well.

5 PLEE needs Tutor Training

Whoever is a teacher through and through takes all things seriously in relation to his students -- even himself. (Nietzsche, Beyond Good and Evil, Part Four, p. 63)

As described in the previous chapter the role of tutor differs completely from the more traditional role of the teacher. "New PLEE Tutors are well accustomed to the traditional role of lecturer, but need training to fulfil their new role" (De Grave, Moust & Hommes, 2001).

Prince & Felder 2007 say: "The more resource-intensive the method, the greater the need for existing resources or external support to implement it. Instructors should be mindful of the time demands of each method and take advantage of existing resources, experienced colleagues, and teaching centre consultants who can offer tips on implementing the method and dealing with problems that arise in its use" (Prince & Felder, p. 18).
The implementation of PLEE in Higher education asks a lot of all involved, non-teaching staff, teaching staff and students. Powell & Weenk (2003) say that without staff agreement a PLEE-style reform will lead to an overload of frustration.
The change of the role of lecturer to tutor is not an easy change for everyone. Some lecturers really benefit from support of colleagues or a more formal training to make the transition.

The teachers are employed to do research and to teach engineering to engineering students. Often they do not have the necessary skills to tutor groups during project work and handle team work and play a part in the soft skills. The experience is that "once the teachers see how PLEE is to be handled, they respond well to a good training session on the relevant soft issues. Moreover, teachers are reassured during the tutors' liaison meetings once the project gets under way: the exchange of tips and experiences is very much welcomed" (Powell & Weenk, 2003, p. 93)
The tutor training supports the transition from the formal curriculum into the perceived curriculum, how the documents and materials are interpreted as well as the operational curriculum, the teacher's activities.

In this paper we assume that there is a change from more traditional education to PLEE. The following part will elaborate on tutor training to help the teaching staff to handle the changes.

5.1 Elements of Tutor training

In this paragraph the most important elements of tutor training are presented.

5.1.1 Before the start of the project

Supervising a PLEE project is different from supervising a final project or a course. A PLEE project is closely related to the project support courses and the teaching staff should work as a team during the quartile.
The PLEE tutor should before the project starts be familiar with, and preferably have discussed with colleagues, at least the following issues:

- The planning of the quartile
- The content of the project supporting courses
- The objectives of the project work and the relation with the competencies
- The project assignment and the appropriate activities of the students
- The expected roles of the tutor: f.e. setter of the assignment, supervisor, expert, evaluator
- The composition of the teams: f.e. at free will, based on tests, f.e. Belbin team roles
- The planning of the project: deadlines, etc.
- Assessment of the team work, result and process

This way the tutor is familiar with part of the formal curriculum, in documents and materials. By discussing it with colleagues the interpretation of the quartile, the perceived curriculum, is aligned.

5.1.2 At the start of the project

Powell & Weenk (p. 252) suggest that at the first meeting, the PLEE Tutor will get to know the members of the student team, and the students get to know the tutor. The first meeting sets the tone for the future. It is important that the students and the tutor know what they can and may expect from each other. The relationship between the tutor and the team members often is more close then the relationship between a lecturer and the audience. Students like to get to know the tutor as a person and not only as an expert. So it might be appropriate that the tutor tells something about him or herself, f.e. the research project in progress, the academic background and may be something more personal.
When the students don't know each other the tutor can stimulate that they get acquainted with each other.

Especially in the first year students are often uncertain about what is expected from them. The tutor will clarify and explain the assignment and the expected outcomes. The tutor also "summarise the business of running a project – the objectives, the phases, the end point (deadline), as well as mention the importance of running meetings, working as a team, and planning the project" (Powell & Weenk, 2003, p. 252)

Agreements can be made on the method of working of the student team for example:

- The roles in the team, chairman, secretary, presenter, etc.
- Preparation for the meetings and the general agenda
- Planning of the project work
- Dealing with absence, phone numbers, etc.
- Personal learning questions, f.e. from the previous period
- How to give and receive feedback

5.1.3 During the project

As said before the tutor can fulfil different roles during the project. All of these roles can be addressed in the tutor training.

Setter of the assignment
The tutor can simulate to be the contractor of the assignment. He knows exactly the nature of the problem and has understanding of the criteria for the result. During the project students may wander from the original assignment and the contractor can give them feedback on the focus of the team and the intermediate products. Also he can clarify obscurities in aspects that play a role with the problem.

Stimulator
The tutor sometimes needs to motivate the team or individual students. The role of stimulator is a tricky one. Too much stimulation can make the students dependant on the tutor. Too little stimulation may be interpreted as disinterest. Sometimes students explicitly want to have their questions answered. To respond with another question or only a suggestion where they can find the answer themselves may frustrate them. But some frustration is part of the project work. Together with the team the tutor can explore how the students can motivate themselves and each other.

Monitor of the learning process
The tutor has to monitor the learning process of the team and the individual students. The learning process has two important elements: the academic learning of the disciplinary content and skills and the teamwork including the interpersonal skills. Next to that some individual students have personal learning questions like overcoming fear for presentations. Through observation the tutor gets signals. Sometimes it is better not to react too soon and let the team sort it out themselves, learning from their mistakes. Sometimes it is better to react immediately and prevent big problems later on. When the tutor is also assessor this double role may sometimes hinder the more personal guidance that is needed.

Evaluator of the process
Just as the role of stimulator the role of evaluator may be a tricky one. Often the tutor takes pride in a good result of the team. This can lead to a more directive approach giving the students little room for their own ideas and creativity. On the other hand, too little feedback and direction may leave the team in uncertainty and may even paralyze them. Too much positive feedback may make them over confident, but too much criticism may diminish their motivation. It is important that the evaluator observes objectively and gives constructive feedback so that students learn to evaluate their own process.

Expert (specialist)
Often the tutor is one of the lecturers of a project supporting course. The most important pitfall is that the tutor takes too often and too much the role of expert. Lecturers take pride in their knowledge and like to explain students the way things are. Often they have to learn to take pride in the outcomes by letting the students find the solution themselves. The results may be less perfect but the confidence and pride of the students may be bigger. In the long term this leads to graduates who can solve problems themselves. The role of expert should be executed with caution. The expert gives advice on the problems the students mention and tries to avoid an overload of information. Sometimes the students get a card for ten consultants with the expert. This way they have to determine themselves when it is really needed to get the help of an expert.
The tutor in the role of expert can also be a trainer in soft skills. During tutor meetings the tutor, as monitor and evaluator, makes the students aware of the importance of the soft skills. Short training sessions may help the students to develop these skills.

5.2 PLEE Tutor Training
In the previous paragraph the elements of the tutor training are discussed. This paragraph describes the various activities during the training. The Educational Service Centre at UT offers tutor-workshops beside individual sessions on how to tutor in PLEE. Role-playing and simulations help to understand and develop appropriate tutor competencies.

5.2.1 Outline of the training
The first session (4 hrs.):
- The definition of PLEE
- The vision of PLEE
- Why PLEE

The second session (4 hrs.):
- The tasks of the Quartile coordinator
- Designing the project assignment
- Designing the assessment of the quartile and the project.

The third session (4 hrs.):
- Questions on and issues concerning tutoring
- The Do's and Don'ts in tutor behaviour
- Agreements for the application of the project

Methods that are used during the training are short introductions, discussions, subgroup work, simulations, role playing, cases studies, etc.
At the end of the training the tutor should be able to answer questions like:
- What is the PLEE methodology?
- What are the roles of the tutor?

- How to give and receive feedback on process and product?
- How to make the students aware of different team roles and their influence on teamwork?
- How to apply the basic skills of communication: diversity of questions, summarize, reflect content and emotions?
- How to monitor the team work?
- How to handle problems in the team?
- How to supervise the first meeting?
- How to supervise the students with developing soft skills?

The next paragraph elaborates on these soft skills.

5.2.2 PLEE Soft Skills.

In the described role of the tutor it becomes eminent that the tutor has a very important role in supervising the process of project work. During the project work the students learn, next to the knowledge and skills necessary for attaining the result, the so called soft skills.

Soft skill examples

According to Weenk & Haijkens (2008) 'soft skills' is a sociological term which refers to the cluster of personality traits, social graces, facility with language, personal habits, friendliness, and optimism that mark people to varying degrees. The tutor should support the students with the learning of soft skills. The best way the tutor can achieve this is by only asking questions. In box 3 a short overview of soft skills and appropriate questions is given. Of course there are many more skills than mentioned in box 3.

Soft skills	*Discussion aspect*	*Typical (PLEE Tutors') specific questions*
Planning	definition of problem	What is the problem statement?
	research issues	What are you going to research?
	time-work schedule	Who will do what and how and when?
	planning	How will you re-adjust the planning?
Organising	division of tasks	How will you determine who does what?
	team organization	What will you do individually, in sub teams or full teams?
	adjustment of tasks	How will you mutually adjust contributions?
Co-operating	rules	What rules has the team agreed on?
	norms	What are sanctions for exceeding certain rules?
	co-ordination	How has mutual adjustment between sub teams been settled?
	productivity	What agreement has been made on producing output?
Evaluating	procedure	What agreement about evaluating project work?
	product evaluation	What progress did the team make on tackling problems?
	process evaluation	How is the co-operation going within the team?
	result	What is done with the evaluation results?

Box 3: Tutoring soft skills

6 Conclusion

The PLEE methodology is consistent with constructivism and inductive teaching methods. Numerous research findings support the idea that PLEE enhances effectiveness and efficiency of students learning.

The essence of PLEE is that students solve open-ended assignments for which the solutions are not yet known. They do this by gathering actively the necessary knowledge and skills in (inter-disciplinary) team work. These knowledge and skills elements not only concern the discipline(s) but also soft skills for a lifelong learning.

In PLEE the teaching staff performs different roles. The tutor plays an important role. Instead of answering question as is usual in more traditional education, the tutor mainly asks questions. For that the tutor needs to be an expert in the tutor role. That is why tutors need training.

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