

# PBL – PW

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**PROBLEM BASED LEARNING**

**PROJECT WORK**

**REPORT FROM DISCUSSION GROUP ON PBL & PW  
IBS AT HUT IN HELSINKI, 27-30 SEPTEMBER 2001**

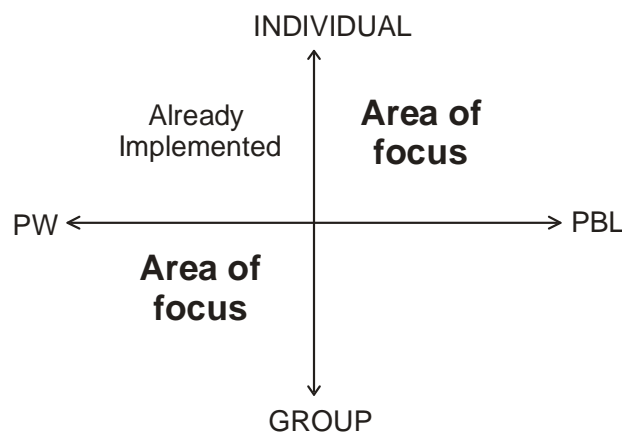
## Introduction

Engineering is the basis and the foundation on which human civilization relies in order to further itself. Engineers have been the driving force of technological developments that literally transformed our world. From the dark ages, we've moved on to the renaissance and the industrial age. We have now crossed over to the information age. Telecommunications advanced computing, perfected transportations have formed the world in which we operate today. And the rapid pace of technological evolution that was introduced to us during the 20<sup>th</sup> century is far from being exhausted. Indeed, experience so far tells us that this is merely the beginning. In the light of these facts, we are forced to recognize the importance of responsible engineers. Engineering scientists fully aware of their work and their place within the whole. Engineering minds that are able to efficiently cooperate within their field and outside of it. Problem solvers, that can drive technical difficulties to their practical solutions.

While keeping these points in mind, we also acknowledge the importance of responsible, efficient and developing engineering education. Having recognized these, BEST, in the framework of E4 Activity 5 once more gathered students from all over Europe to discuss matters of engineering education. In this report you will be able to find the conclusions of the discussion group concerning Problem Based Learning (PBL), and Project Work (PW).

## Findings of discussions

The matter of interest in this discussion group was the exchange of ideas and practices, as well as impressions and suggestions on Problem Based Learning in conjunction with the practice of Project Works. The group decided that defining those two concepts would be of benefit to the sense of direction of the discussions. Following we provide these descriptive definitions of PBL



*Figure.1*

And PW. However it should be dearly noted that these definitions do not pose a final conclusion on the nature of the practices. Nevertheless, these definitions are a valuable tool used in order to make this report. There are several other types of PBL and PW, but no emphasis is placed on them in this report.

## Problem Based Learning

The group tried to define the idea of PBL individually. Based upon personal experiences thoughts and ideas.

Problem based learning has been approached by the group as an individual process. (Advise relative figure.1 for reference). The approach adopted on the basis of personal experiences thoughts and ideas. A learning method that will provide the student the opportunity to learn for him-self. An educational process that combines pedagogical elements beneficial to the development of the student's way of thought and work.

Problem Based Learning has been perceived as a series of finite modules along the duration of a PBL enhanced course. Periodic exercises in a frequency of perhaps a weekly or a fifteen-day basis. A problem-minded assignment in the sense that each module will incorporate a specific problem to be solved. A defined problem that requires a solid solution. The point is solving the problem and in the meantime, learning and better understanding the method used in order to solve it. The specific real-life problem will give the student a tangible goal, and a firm grasp of the reality behind the theory.

Beyond these abstracts, the group felt that it would be important to identify some of the factors that would ensure the successful application of a PBL enhanced course.

**The time scale.** It has been commonly accepted that PBL would work in a more efficient way if it were realized within the temporal parameters listed above. Small-scale exercises that would last up to 1-2 weeks. A narrowly defined, concrete problem should be the core of the exercise. The work cases used in PBL modules should not be overly challenging, as the advantages of PBL would turn into handicaps

**The practical resources.** It has been deemed necessary that the information needed to solve a PBL problem will not be directly provided in the course textbook. The student will have to enlarge his search in related bibliography. He will gather and analyze information beyond the given way. In the end the accumulated information combined will lead the student to the solution.

**The final goal.** In essence, the objective of a PBL enhanced course would be the better understanding and longer-lasting memory of the procedures and methods involved in the solution. The main reason why PBL is preferable in the achievement of this goal is the inherent "learning by doing" approach of the method. Abstract formulae will receive real-life references, and theoretical problems now solved will create valuable associations needed in the better understanding of future studies.

All in all, PBL is considered a good way of building the basic knowledge in the early years of technology education. It will help students improve their knowledge foundation, which is necessary for a successful completion of their studies.

Apart from it being a valuable teaching method PBL can also be helpful in the more objective evaluation of the student. A portfolio where all your work during the semester is gathered can be assessed and taken into consideration on your complete evaluation. This could also be done in a combination with an oral exam where the examiner asks questions both from the curriculum and the work the student presented during the semester.

It has also been important to us that these ideas can easily be applied in most technology institutions. As a tangible example we indicate the courses called "Electronics and components" from RUG in Belgium and "Material Strength" from TUC (Technical University of Crete) in Greece. The success shows that it does not demand much to start the path towards better learning methods.

## Project Works

Project works is also an invaluable educational method. However it serves a different goal than that of PBL. The focus of PW stands on efficient groups conducting responsible teamwork on original or extensive subjects. A group of experienced students are encouraged to study the subject in a researcher's point of view with the contribution of everyone on the team according to task assignments.

One of the objectives of PW which will take it further away from PBL is that the students are encouraged to come up with innovative ways to approach an old problem, or to produce original research when working on an original problem.

In order for PW to meet this ambitious goal, it is critical that the students have already acquired the necessary basic scientific knowledge. It is essential to be able to apply prior knowledge from the first years of study so that the team may effectively explore new fields of engineering.

The Project Work is designated to be a large-scale exercise both in time and context. In order for PW to fulfil its goals it would be prudent that the PW course covers an entire semester. It should not replace all other semester courses like a diploma, but it should be a significant part of the particular semester's work so that the group can fully concentrate on its work and achieve maximum performance. It is also important that the final definition of the project is laid on the hands of the group. An important part of the educational process in such a Project Work will be the challenge for the members of the group to identify their own expectations of what the outcome and the problem should be. This research minded project will probably demand a broad field of knowledge and significant experimentation before the work can deliver its intended purposes. Hence the scope of a semester-termed PW is not unreasonable.

## Ideas & Thoughts Around PBL/PW

Having so far given these descriptive, yet insightful definitions, the group wished to share certain general thoughts concerning PBL and PW. Something that troubled the group was the fact that a Group Problem Based Learning enhanced course would provide the kind of work that is crucial for the preparation of students for more demanding project works in their later studies. Due to

the limited amount of time available to the group, not much focus was awarded on this type of work. However the group felt obliged to emphasise that Group-PBL work is a formidable way of joining the notional gap between PBL individual work with the fully group based PW that students will meet in later years of study. In order for students to understand how group processes work, they need time to develop the skills needed.

In another point of importance, it would be an oversight not to underline that according to the group's accordance, PW done individually is already implemented in technology education all over Europe. The final project or the diploma in the ending semester of ones studies are both research based and demand individual guidance. Therefore, we believe that this part of the education is not in demand of immediate change.

As a result the focus of this report can be traced on PBL work done individually and PW done in groups.

## How to use PBL/PW

When changing the teachings of a course to PBL or PW there are some factors, which have to be kept in mind:

1. Personal contact with a mentor is essential. Tutors need to be in contact with the groups at least once a week. Scheduled classes should also take place at least once a week. Additionally it has been found to be a good practice from the supervisor's point of view to keep an e-mail address open for all sorts of inquiries concerning the work.
2. The tutors could be older students. If that is the case, then before students can take up this responsibility they need to undertake some basic pedagogical seminars before the classes begin. Contact with fellow students is also important in the individual PBL. When scheduled tutoring classes are offered it should and must be imperative to encourage students to work together and help each other.
3. Cooperation with the industry and other relevant employers for students with a technology education is essential to make the problems and project related to more than books. One of the reasons PBL and PW will encourage learning is that it will relate more to real-life problems in the student's eyes. The industry can contribute with essential information and why not even problems suggestion.

Apart from the theoretical assumptions reached above, the group felt that it would be essential to offer some working examples of PBL and PW. Following we have a working practice of PW in the form of a semester course held at the NTNU university of technology in Trondheim, Norway. The course is called "Experts in Team" or "EiT" for short.

EiT is a course in the 8th semester of the study for all engineers at NTNU. In this course students from different study programs (civil, mechanical, chemical etc.) are working in teams consisting of three to four students. The course receives extensive approval from the Norwegian industry, which recognizes the importance of its use. The positive response has been one of enthusiasm

because this kind of course provides invaluable experience to future engineers. By preparing students for teamwork, graduates will be able to operate in a large variety of different research related positions. Admittedly, a necessary skill in their later professional lives.

The purpose of EiT is to learn theory of team processing and how to use this in a real life situation. The teams are related to a “village”, with a professor as the leading figure. The villages have a widely defined task, which the different teams will redefine and eventually solve. One of the main and most important purposes of the course is that students which come from very different speciality backgrounds, such as chemistry and electrical engineering, learn how to join their expertise and solve problems together.

The final grade is based on a weighted combination of the merits of the final project report, an oral presentation of the report and a paper describing the group process within the group. More information available on <http://www.eit.ntnu.no>

## When to use PBL/PW

One of the goals of PW is defined as producing knowledge. In the first years of technology education it is important that students learn basic knowledge to use as a tool later on in both education and work situations. This is why the later years of education are easier to combine with the PW. It is of course possible to introduce students in their first years to PW, but this should preferably be more similar to group PBL.

	First years	Later years
PBL	X	X
PW		X

## Advantages of PBL

After defining what Problem Based Learning is, the need for a justification for its use was deemed necessary. PBL, as an educational practice would present the following advantages in the educational process as a whole.

More resources would be available to the student. Tutors able to help the student understand the essentials of his studies. More personal contact with the teaching staff would mean increased motivation as the student feels the attention and the responsibility to return the attention and confidence shown in him.

The student, as afford mentioned, will also receive an increased sense of direction for his later studies. He will be able to identify courses and sectors of work that are more interesting to him. In addition the student will be able to discover the reaches of his ability, and what he is best at. Thus it will be easier for the student to choose a direction, or particular sector as he reaches the final semesters. Further more, the student will have direct responsibility for his own education.

Finally, a major advantage of PBL is a more balanced evaluation system. As the semester's work receives credit for satisfactory performance, the examinations pressure seems somehow lighter, and the student is encouraged to work more during the semester than just try to memorize formulas 15 days before the examination day.

## Advantages of PW

In the Project Works framework, students will learn how to cooperate efficiently. How to join forces and pull all their resources in the scope of a common objective. Reliable teamwork will be the outcome, and the benefit for the students will have tremendous effect on their future engineering careers.

Project works will provide a sense of direction to the student as far as his future employment opportunities are concerned. The student will be able to experience actual working conditions that give him the chance to have an idea of what to expect after graduation.

Project Works also develop an increased sense of responsibility, as you are no longer working only for yourself. You are bearing an equal part of the total workload. What you do, and what you provide work-wise has a direct effect on the other members of the group. The problem to be solved is now a Project that involves equal partners. Proper communication and effective cooperation, equals success.

An added bonus to the above is the fact that such Projects help the student to build his own confidence in his skills, knowledge and abilities. The undergraduate experiences the sense of being the expert in one particular field, as everyone undertakes a different aspect of the work.

## Motivation for Professors

The teaching professors will have a series of reasons that would justify the transition from a traditional lecture-lab only course into a PBL/PW enhanced course.

Primarily, financial resources would be accessible more easily as the professor would now need more facilities at his disposal and with a proper excuse. The improvement of the course offered. There have been examples around Europe, where funds were available for specific projects such as course improvements, but since the university departments had not expressed interest in newer techniques and practices, the funding was directed elsewhere. On the other hand, it has been proved that sometimes industry is more than eager to assist such efforts, as they recognise the direct benefit towards them.

PBL/PW enhanced courses would result in more attractive courses. Professors would be able to “recruit” students to their field as the course stimulates the student and motivates him to work in the same direction. Also, the professor would be able to receive helpful feedback from the students on what difficulties are encountered from the student’s point of view.

Additionally, the sometimes unusually heavy workload laid on the professor’s shoulders would be eased, as tutors would assist him in his daily routines.

Another important aspect that should be carefully examined, is the fact that the use of such enhanced courses would be a factor discouraging female prospective engineers from dropping out of technical university studies. A phenomenon quite widespread among countries all over Europe.

## Fundraising for PBL/PW courses

Undoubtedly, these courses would require significant financial and material resources in order to function as intended. Below, the group mentions a few solutions to the adjacent economical problem.

Government funding should always be sought for. Pilot projects are often sponsored and supported. Grants can be awarded for the following up of the project in later phases. University authorities should always be on the look-out for such opportunities.

European Union funding can also be considered. In the framework of, educational programmes and thematic networks of the EU, universities may seek the opportunity to receive finance for their pioneering efforts.

Finally industrial partners can also be taken into consideration. Specifically, associations of companies are probably the best-suited candidates. Constructions industry associations, communications, electronics, chemical, information.

Along with the above it should also be mentioned that a critical issue is that the universities remain independent research educational institutions, guided by no one but it’s one quest for the further pursuit of knowledge and development.

## Assessment

Finally, one important aspect of the discussions concerning such enhanced courses was surrounding the assessment of these courses. How are they supposed to be rated? After extensive debates, the group came up with the following suggestions/guidelines.

### 1. PBL course assessment

The PBL part of the course should be receive a percentage of the final grade that would not surpass the 50% mark. The work done during the semester could be taken into consideration anywhere within the range of 20%-50% of the overall grade in order to be effective.

An oral exam could also be considered valid as an added way to assess one's work. Things that the student worked with during the semester would pose no problem of being part of a discussion between the professor-tutor and the student.

Finally, there is portfolio assessment. During the whole semester, the student would have collected a portfolio of his work in a form of a dossier that could be handed over and assessed.

### 2. PW course assessment

A practical solution to the PW assessment problem would be the following. Project Work is assessed for three basic aspects. Group process, Project report, Presentation.

Group process is the ability to cooperate efficiently, Project report is the final paper produced by the group, and finally the presentation of the project completed is self-explained. Each one of these aspect can receive a dynamic percentage of the final grade. Below we have an example of percentages division in the afford mentioned "Experts in Team" from NTNU in Norway.

Project Work	Theory	EIT
Group	X %	25%
Project	Y %	50%
Presentation	Z %	25%

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