THE FORMULATION OF A PROBLEM

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What is a project ?

According to common usage of the word, a project often refers to earlier parts of a fairly large end complex undertaking. The word is also associated with research, irrespective of the state of progress. A project emphasises the ideas and the processes which - when accomplished with skill - eventually lead to a satisfactory result. The processes often include elements of induction from observation and experience, at least some of which has to be generated during the project.

In higher education, research projects have for a long time been included in the later parts of the programs. In their thesis work, the students are thus expected to have acquired sufficient knowledge and skills to work on (given) scientific problems to which no answers have yet been found. Projects are, however, showing up in earlier parts of tertiary education as well as in the secondary school. Still projects at these levels are quite different in style, aims and duration.

One possible way to characterise different types of these learning activities may be to consider the degree of student influence on the choice of subject matter and of the student's responsibility to go ahead.

On the one side well-planned, "standard projects" are known. Such student-activities, which may be repeated by the next group of students are often valuable supplements to textbook-reading. These "case-studies" may help the students to comprehend (possibly at a higher cognitive level) the discipline in question because they illustrate concepts, facts and theories from the syllabus. Still the teacher is pulling the strings, keeping the students on track towards the "correct" answers.

The other type of projects include learning activities characterised by some problem being formulated and studied by a group of students assisted by their supervising teacher. When problem-oriented, this type of projects put emphasis on several aspects of the processes of scientific inquiry not normally being experienced by younger students. The aims of such projects are clearly broader than those of the case studies, and point towards more general professional skills and attitudes not aimed at by the discipline-oriented part of the program.

Science programs at Roskilde University

Science-based curricula including this last type of problem-oriented projects have been developed and tested over the last twenty years at Roskilde University. During the first two years of these curricula - the Basic Natural Science Program - half of the time is thus **project**-organised (one project each term), whereas the other half of the time is devoted to a number of discipline-oriented **courses** (two courses each term).

From their upper secondary school the students know of the subjects - the disciplines - of science and mathematics, to which they have been exposed, the one subject isolated from the other. They might have had some experience of the "case-study"-approach, but they do not, for several good reasons, master the problem-oriented project-organised learning situations, different from most of their prior learning experience. Accordingly the students have to **learn to learn**, while **learning** mathematics, science and technology **by doing** projects.

On top of that the students are asked to think "orthogonal" to the disciplines: In the three first projects (one term each and evaluated separately) they have to study science (and mathematics) in different perspectives; in turn the headings for these three terms are : applied science, pure science and meta science.

Words as tools

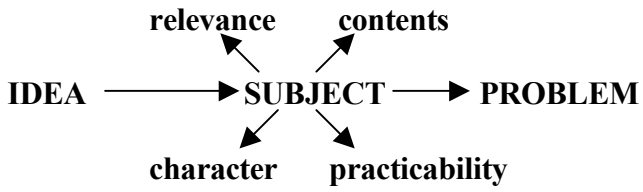
The successful accomplishment of this program puts heavy demands on the teachers and depends very much on the learning environment, including elements such as routine procedures and written instructions, yet always influenced by the individual teacher's style and attitudes, and of the didactics of the subject.

Sketches of procedures etc. using few but significant words are often valuable tools, when discussing what and how to do in a group of students.

One such sketch deals with the processes through a(n experimental) problem-oriented project:

1	Formulation of a problem	Suggest, list, define
		Reduce and choose
		Formulate
2	Investigations	Design and find equipment
		Carry out and obtain data
		Reproduce and calculate
3	Evaluation	Interpret and compare
		Conclude
		Document

The formulation of a problem as a question, which at least in principle can be answered by scientific methods is very often experienced as a fairly difficult and lengthy process. The following sketch from IDEA to PROBLEM may be used as a tool of making this process easier:



The triggering **IDEA** comes from different sources: newspapers or magazines, incidental observations or knowledge, review articles, TV-news or -feature programs, proposals from a teacher or an older student, a lecture, or simply from conversation with an "expert", or even from rumours or sayings. Once the idea is there, it is not very important where it came from as long as the source gave at least some hints about where to get more information. The idea will grow through reading, discussion and reflection to an area of possible study, in short: a
SUBJECT

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In the processes from **IDEA** to **PROBLEM** a lot of facets of the project has to be elucidated. The aims and goals and the conditions for the work have to be analysed carefully and adjusted accordingly in order to make a powerful or just functioning plan.

The keywords may be expanded:

The **relevance** of the subject and of the way it is going to be treated is in part *internal*, i.e. a motivation factor for the student, and involve at least two components:

the experience from the past (related to attitudes) e.g. "it was really fun" or "I was good at such things in school", and

the prospects for the future (related to educational or career goals) e.g. "It will help me to pass the examination", " I would like to learn more about it" or "I aim at getting that type of job".

In addition, the treatment of the subject towards an answer might have an *external* relevance, (which the student might find highly motivating too):

to Committee X (which is about to make a political or administrative decision in a case),

to Interest Y (which is about to find arguments for its points of view or to find out whether the arguments hold or not),

to Business Z (which needs a better procedure or product for a certain purpose) or

to the Scientific Community (which in principle is interested in the results of any research).

The **character** of the work to be done might be seriously influenced by the actual formulation of the problem. And the other way round, if the work for some reason have to have a certain character, the formulation of the problem will become different. The character of the work can be

Modelling, i.e. the use or modification of an existing model or the development and testing of a new model will be central to the project.

Reviewing, i.e. the work will concentrate very much on understanding a number of related observations, a theory, or a topic in order to be able to present **the state of the art** or to make some **didactic** presentation in relation to a defined target group.

Experimental, i.e. the clever design and skilled performance of experiments in order to obtain data and new insight or the critical investigation of an existing method or the development of a new or better experimental procedure for a well-defined purpose.

The **contents** with respect to knowledge and comprehension obtained through the project will to some extent be predictable. The type and extent of *empirical facts* to be needed, the experimental and theoretical *methods* to be used, the *elements of sub disciplines* to be understood, the *concepts*, the *models*, the *topics*, the .....

Drawing up a mental or real list of these learning objectives make the analysis of the problem more detailed and might have some influence on the formulation.

The analysis of the **practicability** of the project in its present formulation is of course of the utmost importance. Among the **resources needed** to complete the project at least two types exist: the intellectual and the material ones. The *intellectual* ability or the cognitive level of the student group themselves might of course be prohibitive for the accomplishment of certain advanced processes, and the expertise among the available supervisors will put a limit on the

possible projects. The *material* resources including equipment, available time, literature, money, and methods etc. should likewise be carefully considered before **the final formulation of the problem** to be studied will be clear, and a realistic planning of the project-processes can be done.

Concluding remarks

These four dimensions, when properly considered, analysed, and formulated by the students in relation to an arbitrary step of their formulation of the problem, will certainly force them to make a **precision** of their own conceptions and ideas and to make **decisions**, i.e. to choose one detailed step or major direction over the other.

It is of course not an "once and for all" procedure, although it is concentrated in the first part of the project period. It takes its time. It is necessary to read around, write and discuss about, and work on the project during the process to make an effective and proper **formulation of the problem**. This in turn implies, however, that important features of the planning of the project have already been done.

For the freshmen of the Basic Natural Science Program at Roskilde University it might take about one third of the project-period to formulate the problem and make a detailed working plan. At that time the state of progress is presented to another group of students together with their supervising teacher at an informal seminar, in order to get response from "unbiased" colleagues.

The saying "well begun is half done" goes very well for the accomplishment of educational projects by inexperienced learners. The procedure sketched above might be of some help.

from
Ole Vinther (ed.) Prodeedings from the SEFI-seminar ""Project-organized curricula in engineering education" Copenhagen (1993)