

MATHEMATICS AND PROJECT-BASED LEARNING EMPLOYING TECHNOLOGIES

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ABSTRACT. The paper deals with project-based learning making use of computers in mathematics lessons in order to clarify teachers idea of a students project; primarily targeted at learning goals and secondly, it is to explain the difference between mathematics lessons implementing project-based learning (PBL) and non-project work. The first part of the paper is theoretical. It summarizes reasons why teachers do often reject PBL and offers a general guidelines for preparing, leading and evaluating a good project work (e. g. by means of 3 Cs method). The second part is conceived practically in order to present several suggestions all of which involve computer work including communications possibilities of the Internet or Cabri a dynamic geometry learning interface. This text is based on selected extracts of the authors book [1].

CAN MATHEMATICS AND PROJECT-BASED LEARNING MATCH?

Looking for new dynamic approaches enabling students to explore real-world problems or challenges while applying their own skills achieved in geometry leads to efforts to involve students in open-end tasks. It is indisputable that PBL is beneficial. (A project imitates the work of an independent employee, tests skills from a complex perspective, examines the abilities to use that what has been mastered while solving a particular problem). Project-based work seeking its ways even in traditional tuition of mathematics should not be considered as an order. There are many excellent teachers searching for projects, they are even creating and applying those themselves. However, the situation in mathematics is more complicated.

If we comprehend mathematics as a science, we actually accept a common conception that school mathematics is an objectifying transfer of curricula and books content more than any other school subject might be [1]. Respecting this concept, then students only responsibility is to learn what he or she is being given in good faith by a tutor. Features typical for such learning approach:

- formality tutor refers to the importance of mathematics without providing any acceptable proof to students;
- compulsivity it is only up to students if they learn what they have been explicated at school;
- unilaterality any motivating or evaluating efforts are focused upon extrinsic motivation coming from the outside [3].

An investigation done by Kubínová [3] proved that knowledge constituent of curricula dominates in our school education high above key competencies development which is absent.

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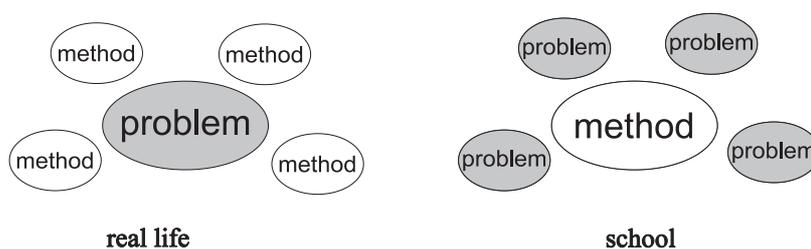


FIGURE 1. Place of problem and method in real-life situation and in school mathematics

PBL presents a new approach in teaching mathematics which is different to the typical school one. If everyday life brings us to problems in such order, where the problem is given first and we have to choose among methods that may be applied (on the left), then school offers one central method for which some problems need to be found. These can be solved by the particular method (on the right) [4]. Tasking and being involved in a project as a part of learning imitates the real-world much better than traditional schooling

Mathematics appears as a subject inconvenient for project-based learning. The main content of a traditional lesson is problem-solving. However, even the complex problems are not conceived project-like, which excludes students from taking part in setting, among others. Interdisciplinary projects in which students can count or draw are considered as application projects. However, many teachers avoid running such activities as those are not considered intense enough and the subject matter as well as the learning goals fade.

A teacher might apprehend only a part of the project involves mathematics and the rest is rather time-consuming to the detriment of learning new competencies. Nevertheless, such presumption is false. Working on projects and teamwork are highly valuable in terms of overall education. Indeed, it cannot put off concerns that such application methods might distract from mathematics itself; especially in senior pupils learning. Such fears might grow due to a former pedagogical failure (a teacher fails to prepare and manage a project or pupils are not able to projectwork as they have not learnt it in any other class yet).

Computer technology as a tool for applying mathematic skills is a way enabling teacher to find a convenient application environment for projects and still stay focused on learning. Apart from raised motivation among new-comer students attracted to mathematics by computers, there is also a positive fact that almost whole project can be made as a mathematic issue.

1. HOW TO IDENTIFY A STUDENTS PROJECT?

If we wish to include PBL in current structures of educational forms it could be done within classwork and groupwork from the point of view of social forms. From the point of student activities features, it could be implemented between, so called, related form (student operates within the matter that is currently being presented by tutor) and guided discovering (rediscovering a generally known fact for oneself). Then it is neither individual tuition nor open-ended research [5].

Any project has its own **typical features**: self-organization and responsibility, target-orientation, product-orientation, emphasizes practical work, aims at interests of the involved, situational aspect, social learning and last but not least it is intercurricular [5].

It is essential to make difference between a teachers project and a students project. If a teacher prepares his / her lessons in an untraditional way, e.g. makes experiments, discoveries, actively involves students, presents new topics and relates them, etc. it is a highly praiseworthy work. Then it is a teachers project, a way of his / her tuition, but it does not necessarily determines students to work project-based.

Project-based work can be easily **distinguished from a non-project** according to how much the solver takes part in setting the problem. Practically, it usually requires work of the one who carries the project out, committing him / her to specify the setting or making even major changes after having them discussed with the submitter. Supposing that the submitter might not be a specialist or might not know technology procedures, innovations, etc. enabling him / her to handle the problem effectively and specify the setting any further. Students projects are trying to simulate the situation described.

PBL resembles the work of an independent employee in a company. Such employee is given tasks by his / her supervisor that need to be carried out within a deadline. The solution has to meet introductory requirements and possess other qualities implying employees skills in controlling computer technology or experience and knowledge of other subjects, ability to work creatively or in a team.

It is crucial for students to be able **to take part in project setting** (possibly, adapt it to themselves). It is an immensely important element of a students project as they can identify with it. Other outstanding features of students project are an open-end (neither result nor method are known in advance), it is targeted, selforganized, creative, involves activity and originality.

Project is not a series of short successive tasks that need to be worked out. It is not a long-term activity either, in case that students task is appointed strictly, which diverts students from taking part in project preparation. It is not often set concretely, nevertheless, its set criteria have to be met.

A project is often passed off as an so called integrated thematic instruction [6], in which one topic covers a number of class activities. At first sight, it seems to be the same tuition method where teacher elaborates extended lesson preparations, which curricula is designed originally, implements unusual problems, the instruction can take place in various subjects, etc.

We are not trying to claim such method is inconvenient, worse than project-based one, or that it should not be applied in class. On the contrary, such activities are often very well designed and as they do not require any special approach to class management they are usually very well taught off. We are only trying to inform that in such case it is not a students project and a teacher preparing such lesson ought to know that applying this method does not train the skills and the attitudes necessary to have towards a project-based work.

2. STAGE OF REALIZATION OF STUDENTS PROJECT

Ahead of project

In this stage, teacher chooses and adapts the content, searches for a unifying topic