Student Projects in the Educational Process

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Learning and teaching are links of the same chain. They represent an interactive, constructive and continuous process. Many modelling resources and tools are available in teaching and used in curriculum from introductory to advanced courses and across disciplines. Learners are unique. They have, among a number of things, different skills, experience, background and attitudes. Hence, whatever works well for one group may not work for another. Therefore, different strategies should be used in teaching that are aimed at encouraging students and making their learning informative, effective, and at the same time, pleasant, enjoyable and relaxing. The best learning happens when all accessible teaching tools are properly used.

This article focuses on the use of student projects as a challenging teaching technique. Individual and team projects play an incredibly important role in the learning process in that they add a challenging dimension to the teaching/learning process. They represent an important method of integrated learning, which is the mainstream of modern teaching philosophy. Here, students do not listen to lectures (which they forget by the next class) but are challenged to work independently. The major problems with this approach are to convince students to remain task-oriented and to provide them with appropriate challenges. You cannot force students to do this unless they are interested in the project itself and understand that the project is a self-portrait of those who do it. Thus, the first task to ensure success is to encourage students to put some magic into the chosen topics.

Projects can be on various topics, depending on the goals of the course. To avoid repetition of the same projects year after year, it is necessary to change the titles or the theme for each term. For example, one algebra class may be devoted to scientists who founded algebra; namely, "Al-Khowarizmi and his manuscripts," "Viète and Cardano" or "Pascal and his discoveries." Next term's theme may be on the basic steps and discoveries of algebra with projects like "The Birth of Algebra," "Quadratic and Polynomial Equations" or "Magic of the Pascal's Triangle." As one can see, there are corresponding topics in these two groups. They cover approximately the same material: it is impossible to look at the first steps of algebra without talking about Al-Khowarizmi and so on. Thus, different classes will discuss the same topics without noticing this.

The same idea can be used in assigning projects to any class. Examples of some related projects in Calculus 1 could be "Newton and Leibniz," "Derivatives and Limits," "L'Hospital and His Rule" or "Applications of Derivatives," and in statistics, "Gauss and de Moivre" and "The Normal Distribution."

When assigning a project, the instructor should be clear about the goals, expectations, completion dates and examples to be used. Discussing mathematicians' discoveries and presenting interesting, non-trivial details of their life are very beneficial. One's brain always pays attention to anything out of the ordinary. For example, in the case of Euler, it is important to give dates of his life (1707–1783) and mention that he discovered definitions of modern trigonometry and analytic geometry. He was a pioneer in differential and integral analysis, was a creator of variation analysis, worked on popularization of mathematics and published more then 500 papers, textbooks and monographs. Students will be even more impressed if one adds that Euler was completely blind for the last 17 years of his life during which he continued his research. Dictated books provided mathematical proofs in his mind using his extraordinary abilities. Euler also had 13 children. Such information always keeps the students focused and generates more interest. It can often awaken even the most unwilling and uninvolved students.

It is essential to encourage students to show their best, but even if a project is below the expectations, one should try to find at least something useful in the project to develop and discuss. Show that the project is worth the time and effort students employ, make them proud of the work they have done and the next project will be better. Students need this support and a student who needs the teacher's

support the most is often the one who appears to deserve it the least.

Working in a team is a very important educational process and experience for the students. Students may create teams by themselves or an instructor may assign them to a team. Each team of students is required to prepare a poster, make a presentation and submit a report. A poster reflects basic ideas and steps of a presentation. Working on a poster, students learn how to choose the most important facts and organize it on the poster, making it visible, understandable and helpful. A presentation teaches students how to express themselves, organize their thoughts, provide vocal delivery, speak mathematically, answer questions and defend their opinion. Frequently, students gather much more material than they are able to outline. This is a reflection of their lack of presentation experience. In preparing a report, students learn how to work with various sources, such as scientific and popular journals, monographs and the web. They have to provide collaborative research and interactive investigations. Preparation of a project, as well as explaining the content to each other will help students understand the material better.

Evaluation of projects consists of three criteria: peer evaluation, evaluation within a group and instructor evaluation. The peer evaluation is provided by all students of a class. They grade each project, express their opinion, write their comments and demonstrate what they have learned. In so doing, students will refresh the project again. The peer evaluation can be turned into fun if the instructor decides to play a lotto game with a class, which requires the student to arrive at the same grades as the instructor. The student will then receive a bonus.

Unfortunately, not all members of a team make the same contributions. Evaluation within a group, where each student evaluates his or her co-members, helps determine each student's contribution to the team project.

Information tends to be forgotten quickly when students are passive or do not review at least some basic concepts or information. A presentation of a project alone does not guarantee that learning takes place. The more students are involved and engaged in discussions, the more they are likely to learn and remember. There are many ways to enhance students' learning, increase their attention and encourage them to participate in presentations. Two have already been mentioned: peer evaluations and adding some memorable facts of a biography. Other ways may include granting bonus points for each question to speakers, additions to a presentation topic and an open note quiz on projects at the end of all presentations. The quiz helps rehearse basic ideas of projects. If students expect a quiz, they will often take notes, especially if the instructor points out all the questions that might be on the quiz.

As one can see, a project itself is an effective integration of research and learning. It stimulates learning through the excitement of discovery and broadens the participation of students into an educational process. Projects also increase the students' mathematical culture and literacy, as well as develop analytical and communication skills. Discussing the lives and discoveries of great mathematicians sets up positive examples for students and helps them find and establish their lifetime goals because the human brain naturally searches for patterns as a way to succeed.

I have successfully used projects in all my courses. My students enjoy working on projects. Some of them continue to use their projects in their own teaching and organize weeks devoted to a certain page in mathematical history.