

SMALL PROJECT BASED LEARNING IN A COURSE OF FINANCIAL MATHEMATICS. A CASE STUDY

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Abstract. The teaching of financial mathematics requires the proper selection of tasks that illustrate and supplement theoretical issues. One cannot miss out tasks arising from the practice of the operations on the financial markets. The students may choose such problems themselves and realize them in project mode with one or two partners as a team. The article shows the method of small projects that differs from the classic project based learning, known from the literature, by the scale of the project. The small project method allows one to use it as part of the coursework in financial mathematics, while the general project based learning cannot be applied due to the short time of the course. The article compares the classical project based learning with the proposed method of small projects and shows its implementation in teaching financial mathematics at University of Warsaw.

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1. Introduction

One of the subjects taught at the Faculty of Management at the University of Warsaw having a dual nature – theoretical and practical – is the mathematics of finance. The aim of the theoretical part is to present to the students the process of capital appreciation (under various conditions and situations). These purely theoretical considerations are usually presented in the form of a lecture, linked with the calculations performed by the students using given rules as an illustration of the theoretical deliberations. The subject has also a practical aspect: students must be taught the use of the presented knowledge according to the actual situations. For this, they use the properly prepared examples whose main purpose is to make students practice methods of calculations using the appropriate formulas. However, regardless of the quality of those artificially prepared examples, they describe the laboratory conditions rather than the actual financial instruments.

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Of course the examples at the beginning of the course should be as such, but in the end the students should work on the real life products.

Project Based Learning (PBL) has a rich literature (see review article [Thomas 2000]). It primarily affects teaching at school level (from elementary to secondary). It involves engaging students in activities called projects, which results in the mastery of specific skills and the acquisition of specific knowledge by tracking the project. This is the application of the principle described and distributed by John Dewey of teaching by the joint work of the group. The project designed to meet the assignment conditions should be on a long scale. Some authors argue that students should spend on project work from 8 to 50 hours, and whether such rules can be transferred to University. On PBL in higher education, some papers have been written considering variety of contexts (for example [Lubina 2005; Wróblewska 2012]) indicating that it is an effective method of teaching. However, the biggest problem with using this method is time. Financial Mathematics is being taught (at the Faculty of Management at the University of Warsaw) in the course of one semester, for 30 hours in the form of exercise classes combined with the lecture with standard (approximately 25 students) groups. This is one of the many subjects in the second semester of the first year. Can you engage the students in an extensive project with financial math?

In the section “Small projects”, we discuss the adjustment of PBL to the conditions specified above, so that its application does not endanger the overall performance of the first year students, but at the same time increases the effects of training in relation to the standard theoretical classes. In the next chapter, “Implementation”, we describe the use of this method during the course of Financial Mathematics at the Faculty of Management at the University of Warsaw. In the summary, we provide the idea of the implementation of this method.

2. Small projects

PBL is based on the teaching around the project, which becomes the main element of the students involvement. The teacher helps students do the project, and not teach directly. In this method, the most important part is only a student and his/her actions based on appropriately designed job (project). We start considerations on the adjustment of the PBL method to teaching Financial Mathematics as for the definition and discussion of the project itself. As the definition, one can take a set of its characteristics:

...projects are complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations... [Thomas 2000].

Two of the characteristics of the project: an open and complicated problem and a long time for the implementation of the project, causes the application of PBL in the established conditions of teaching mathematics of finance very difficult or even impossible. Indeed, it is difficult to imagine that students studying the markets and financial instruments will discover all the rules governing the appreciation of the capital at the time, construct the appropriate formulas and learn about ways to perform calculations. Even believing in the ability and commitment of the students, one has to agree with the fact that this way of learning financial mathematics will not be effective, nor efficient within the specified time.

Moreover, one needs to take into account the criticisms of this method of teaching. Some teachers can see danger in applying this method, both from the students' point of view: *...students cannot really know what might be important for them to learn, especially in areas which they have no prior experience... [Learning-Theories.com 2015]*, and from the teachers' point of view: *...teacher adopting a PBL approach may not be able to cover as much material as a conventional lecture-based course... [Learning-Theories.com 2015]*.

Therefore, the first natural step to customize this method should be to reduce the scale of the project. We give up complex and difficult issues. In addition, we assume that the project should not require too much time. Note that putting simpler questions immediately eliminates the danger of losing the students. A clear and simple (conceptually) problem will indicate clearly what the student has to learn during the execution of the project. Limiting the time (for example, to 1-2 hours) dismisses objections to covering enough of the material: it becomes obvious that this is one of the many issues in the whole area of the course.

3. Implementation

The specific issue that we propose to implement in the form of a project in financial mathematics is the analysis of a commonly available financial instrument chosen by the student or the comparison of several such instruments. Such a project is to be performed by small, two-three person groups

and presented in the classroom. In the following paragraphs we show how such a task implements, in reduced scale, a PBL method.

As a tool for the analysis and comparison of our Small Project and PBL methods we will use the seven basic principles of PBL formulated by John Larmer and John R. Mergendoller: 1) *A Need to Know*, 2) *A Driving Question*, 3) *Student Voice and Choice*, 4) *21st Century Skills*, 5) *Inquiry and Innovation*, 6) *Feedback and Revision*, 7) *A Publicly Presented Product* [Larmer, Mergendoller 2010].

The first principle: the need for knowledge, arises from the observation that the students (all people) are unwilling to learn if they do not see the applications or they do not believe in the possibility of application. This is particularly evident in the teaching of financial mathematics in business studies. Students motivation, one can specify as zero: “I learn it because I need to pass it”. A bit of help comes from examples, but they are usually artificial and motivate only briefly. Theoretical aspects of capital changes in time or annuities, students take with a lack of enthusiasm. They do not have the natural motivation to acquire this knowledge. The ability to apply the knowledge seems to them so distant (financial mathematics is taught in the first year), that it is not worth the bother. Forcing them to deal with the actual financial instruments changes this situation, because everyone draws their attention to the loans and deposits, if only because of the widespread publicity of banks.

The proposed project: an independent analysis or comparison of financial instruments, which are seen just in advertising changes their approach to theoretical knowledge. There are tools that they can use in real life (outside university). The analysing of “low-cost” loans or “superb” deposits offered by the banks and comparing the results of these studies with the advertising announcements is a very profound lesson in financial mathematics.

In accordance with the principles of PBL, the leading question specifies an open problem that has to be provocative, abstract or concrete, but it is always closely linked to the material that is to be acquired by students. In the case of our Small Project, we give up on such a problem. In fact, it cannot be regarded as an open problem when comparing two deposits in a bank or the calculation of an annual percentage rate on a loan. The question posed to students does not meet the objectives of a general PBL method, but it is not a simple exercise. Prior to the implementation of the project, students know the rules and formulas but they have to use them in other terms. The formulation of the problem and later the selection of financial instruments for the analysis does not include guidance on how to per-

form the calculations, or even whether you need any calculation. Students must decide in which direction they should analyse, choose the tools in the form of ready-made patterns (we do not expect that they explore them) and use them.

This seems like not a very difficult task, but in practice it turns out that such decisions cause a lot of trouble for students. This is usually due to the different formulation of the principles of financial instruments subject to bank advertising brochures in the analysis (which is the material for the realisation of the project) rather than the formulation in the classroom or in the textbooks of financial mathematics.

A very important element of PBL is the students' engagement in the formulation of the project which then will be implemented. In our Small Project method, this principle is satisfied completely. The students themselves decide what they will do with a single instrument analysis or by the comparison of a few of them. They also choose the financial instruments for analysing and searching the data on them. The only limitation is that they have to be easily accessible financial instruments currently offered on the Polish financial market.

Each project ends with a report, which must be a paper of several pages on the analysed products, showing the principles of calculation and the conclusions of the analysis. The report is the joint work of individuals pursuing the project (two-three students). One of the requirements is the form of this document: it must be a properly formatted document prepared with a text editor with calculations inserted. This requirement forces the students to use computers in the implementation of the project. The practice shows that computers are used not only for the preparation of the report, but above all for the implementation of the necessary calculations, and often to find a selected financial instrument. Therefore the method complies with the requirements for the acquisition of skills for the 21st century: the use of the computer and work in a team.

PBL assumes that the time the student spends working on the project should be counted in days rather than hours. Therefore one can program several iterations in the building of an answer to the leading question, multiple check the results and correct them, increase the involvement of the teacher who then indicates the possible directions of further work. In the Small Project method, there is no time for such a powerful response generation. The project should take a maximum of a few hours of work for each team. Of course it is possible to consult with the teacher, but the students are expected to implement the project independently in two steps: first, select

the instruments for research and make decisions as to how they study them and the second (after gathering relevant information), the main analysis and formulation of the report. The scale of the project determines that there is no place for iterative investigations, although it does not eliminate completely the discussions on the implementation of the project among the implementing team.

The last key element of the PBL method is the public presentation of the results achieved or the product obtained. In the case of Small Project, the final product is a report and conclusions on a comparison of the financial instruments or ways of calculating the specific conditions of use of the instrument and the results of the calculations (often surprising). We kept the need for presentation because this is an additional motivation for the deeper thoughts of the student work. It is known that students attach greater importance to the work that they have to present in the broader group, even if it is their classmates, than when they know that the work will be seen only by the teacher. Unfortunately, the small number of hours prevents the presentation of all reports. Classes with presentations are organised so that each team had to prepare a demonstration: students do not know which teams will show their results.

The projects are assessed on the basis of reports and presentations. Individual students receive the marks, not the teams, in accordance with the principles of the PBL method. The marks form a significant, but not the largest, part of the final assessment.

4. Process of assessment

Small Project appears in the middle of the semester in which Financial Mathematics is provided, in the form of homework that the students have to develop in small (two, three persons) groups for the next classes. Limiting the time for preparing to one week (Financial Mathematics, as other courses, has a weekly schedule) immediately identifies the small scale of the project. The task is formulated as follows.

Describe, freely chosen, a financial instrument currently offered by any bank in Poland. Use a technical device (financial calculator or a computer with a spreadsheet) to make calculations. The result is to be presented in the form of a few pages long report. The work will be presented by the authors during the next class.

Students can see some reports from the previous courses as well. There are no more requirements, hints and limitations. The teacher will accept neither the chosen instruments nor the contents nor even the titles of the reports.

The organisation of the following classes is dedicated to the presentation of the projects. As a rule, five minutes is allocated for each project, but practice shows that along with the questions, necessary comments and follow-ups of the teacher, the presentations last on average ten minutes. Unfortunately, there is no time for presentations of all the work (a group usually consists of 20-30 students, which means about 10-12 projects; the duration of standard classes is 90 minutes), but the principle (known before) of the random selection of the reports for presentations, forces each team to prepare their speech.

The reports are marked in a rating scale of 0-3 points, but particularly interesting projects (description of an unusual financial instrument e.g. lease, original approach to the analysis, etc.) may receive additional points. Subject to the assessment, first of all just for the work and for less substantive value (though serious errors are not accepted – the report goes back to be corrected). The assessment for the project is up to 40% of the final mark, but may not determine the successful completion of the course. The earned point only increases the final mark.

The quality of the prepared presentations and interest in the work of other teams at the time of the presentation, demonstrates the considerable involvement of the students in the implementation of projects, and thus in learning the rules of financial arithmetic. It can therefore be concluded that the method works well.

The following examples of titles of some reports submitted by students in the academic year 2014/2015 are provided.

A typical topic, a comparison of a few financial products of the same kind offered by various banks: *Mortgage bank PBS, BZW BK and PEKAO.*

Another typical topic, analysis of a single financial instrument (here the conclusions clearly point to a very high annual percentage rate): *Analysis of short-term loans: The Wonga Company.*

A more ambitious project, beyond the content of the course (there is no stock investment analysis in the syllabus): *Comparison of three different ways to invest capital. Two deposits and investment trading company.*

5. Summary

The Small Project method proposed in the article, applied in the teaching of financial mathematics, is an analysis of actual financial instruments available on the market. The students select by themselves and examine the instruments in small (two, three persons) teams. This method is based on a general PBL method and draws inspiration from it, but it differs in the scale: the expected time for the implementation of the project is much shorter than in the assumptions of the PBL method and smaller teams are carrying out the projects. The analysis carried out by the students looks like enhanced tasks, but basing them on real bank product offers increases students' commitment. Students must reach for the competent information, properly read it and perform adequate calculations. Usually this is not a simple way (banks provide only figures, rather than the way in which account has been taken of the margin, commissions, credit insurance, etc.) and requires taking many decisions and checking their effectiveness.

The main purpose of this method is to consolidate the knowledge acquired in the classroom, use it in practice and show the students how to operate the mechanisms of financial mathematics in real financial markets. Experience from several years of application of this method suggests that it meets the expectations.

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