Graphical Abstract

Practice shows the way

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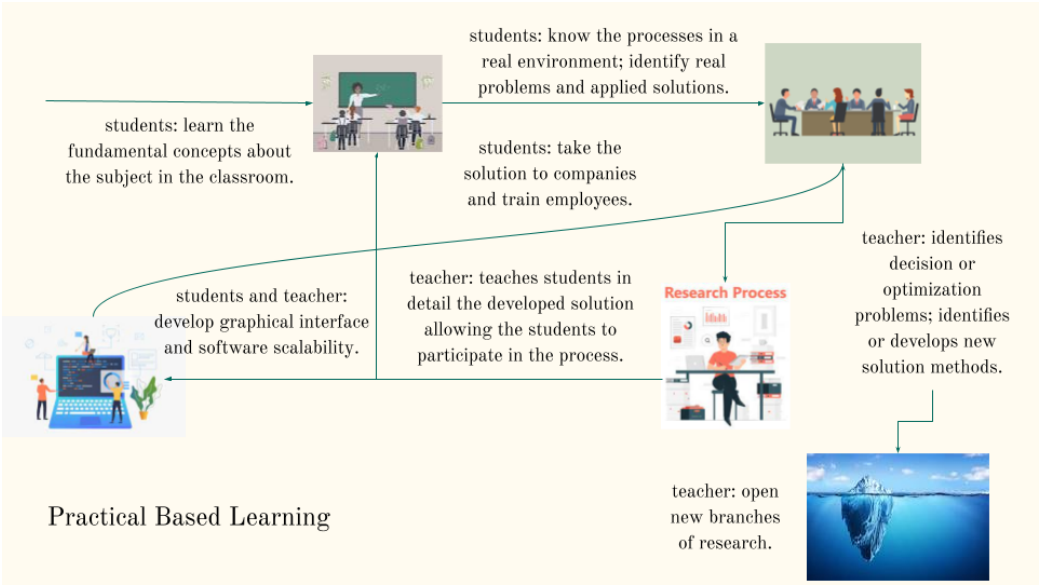

Highlights

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- This paper presents a strategy for teaching undergraduate students based on practical experience
- This strategy is strongly associated with the inseparability between teaching, research, extension and technological development
- This paper also recommends some important resources that can be used to develop group work
- And it discusses a solution to the impasse between transparency and guaranteeing the authenticity of the work, already widely used for software development but not in the development of research works

Practice shows the way

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Abstract

This paper presents a university teaching strategy, grounded on a practice-based learning approach.

Keywords: practical-based learning

1. Introduction

Problem-based learning (PBL) is a pedagogical approach applied worldwide, especially in nursing and medicine courses.

2.

A estratégia de apredizado baseado na prática começa com os alunos aprendendo os conceitos básicos sobre alguma ciência em sala de aula. Concomitamente ou após esse primeiro aprendizado, os alunos realizam visitas a uma organização, através das quais eles poderão compreender os processos organizacionais, identificando aspectos do processo que precisam ser melhor gerenciados. Os alunos então elaboram um relatório da visita, descrevendo detalhadamente o processo estudado e os problemas reais identificados. Posteriormente essas informações são levadas ao professor facilitador. Através de discussões entre professor e os alunos envolvidos, os problemas reais, ou seja, os aspectos do processo estudado que precisam ser melhorados, são formatados como problemas de decisão ou problemas de otimização. E então é feito um levantamento bibliográfico sobre problemas próximos aos problemas de decisão / otimização identificados e sobre metodologias que são aplicadas na solução destes problemas. O professor pesquisador modela tais problemas e desenvolve algoritmos de solução para os modelos desenvolvidos. Todo o conhecimento em desenvolvimento é então passado para os alunos que, por

sua vez, serão motivados a participar do processo de modelagem e solução dos problemas identificados.

Mathematical Modeling and Optimization are extremely relevant sciences for students in production engineering. Especially when we experience the expansion of Industry 4.0 (Ram, 2021). Through Mathematical Modeling it is possible to accurately understand any industrial or organizational problems in which process optimization is sought and, once a model is built, in order to find the desired answer to the problem, or at least a somewhat close answer, Optimization, and so Programming, simply becomes indispensable. Through my experiences at the university where I work, I developed the following strategy for joint teaching of Mathematical Modeling, Programming and Optimization, combining teaching, extension, research and technology:

Teaching: the fundamentals of mathematical modeling and optimization can be taught to students in two different subjects: 1) Mathematical programming; and 2) Mathematical Modeling. In the first course, modeling mathematical programming problems is taught along with mathematical methods of solution. Modeling problems close to real problems can and should be motivated through case modeling exercises such as those proposed by Hillier and Lieberman (2010). In the second course, students should learn how to model standard optimization problems (e.g. allocation problems; balancing problems; routing problems; and scheduling problems) in addition to some heuristics used to solve such problems. In both courses, students must be motivated to understand and present scientific papers with the modeling of real problems. Extension: the extension applies in four moments: 1) students look for a company to develop their work, know the company, understand the company's operating process, and help to identify optimization problems within the company; 2) an Applied Programming course is offered to students, through which students learn object-oriented programming; 3) the students work with the company in the search for ideas and the refinement of the proposed solution; 4) students take the solution developed for different companies, conducting data collections and testing the solver. Research: once a real problem is identified; it is necessary to carry out a vast bibliographic survey, identifying mathematical models and proposed solution approaches for problems close to the one studied, and it is necessary to develop new solution algorithms, through the adaptation of solutions proposed in the literature. The research must be carried out through research projects, and possibly in parallel with the development of course conclusion works and scientific and technological initiation projects. Technological: once the so-

lution is developed and tested, it is recommended to develop a solver, with a good graphical interface, that can be easily used by company employees. This step can be carried out through technological projects, developed in parallel with graduation projects for students in the technological area, and projects of technological initiation. At this stage, it is also possible to develop partnerships with startup companies, and acquire financial resources to support research and innovation developed within the university. The four lines of action are related as follows: through teaching, students acquire the basic knowledge necessary for the development of research and extension activities; through the extension, students deepen their knowledge of programming, help identify new optimization problem and approaches applied by the company to solve these problems and test the solutions developed, also qualifying company employees; through research, students participate in the development of solutions to identified problems; and through technological projects, students can participate in software development. Both research and extension works contribute to teaching, as they allow students to understand and expand all the content presented in the classroom, through practice. It is important to emphasize that throughout the process, students must work together with teachers who have extensive knowledge and practice regarding the subjects covered. So, the teachers involved also deepen their knowledge, which significantly improves the quality of teaching.

References