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TEACHING LINEAR PROGRAMMING THROUGH REAL CONSTRUCTION OPTIMIZATION CASES

Ion Mierlus Mazilu[1,*]

[1] *Technical University of Civil Engineering Bucharest, Romania*

ABSTRACT

The teaching of Operations Research, and specifically Linear Programming, within engineering mathematics curricula has traditionally relied on abstract problem formulations and textbook exercises that bear little resemblance to the complex, multi-variable challenges encountered in real professional practice. While students are able to reproduce algorithmic procedures such as the Simplex method under examination conditions, they frequently struggle to recognize the applicability of these tools in authentic engineering contexts. This disconnect between mathematical formalism and practical relevance represents one of the most persistent challenges in applied mathematics education at technical universities, contributing to reduced student motivation, surface-level learning, and limited transfer of knowledge to professional settings. This paper presents the design and implementation of a case-based teaching approach for Linear Programming, developed and tested within the Applied Mathematics curriculum at the Technical University of Civil Engineering Bucharest (UTCB). The central pedagogical proposition is that real construction optimization cases can serve as powerful teaching vehicles, simultaneously anchoring abstract mathematical concepts in recognizable engineering scenarios and stimulating active student engagement. By situating the Simplex method and linear optimization within problems drawn directly from civil engineering practice, students are encouraged to move beyond procedural competency toward conceptual understanding and applied mathematical reasoning. The study introduces three carefully designed construction cases used as the primary teaching medium. The first case addresses the optimal allocation of construction materials across multiple building sites under budget and supply constraints, requiring students to formulate and solve a multi-variable linear programming problem reflecting realistic procurement conditions. The second case involves the minimization of transportation costs for raw materials delivered to construction sites, modeled as a classical transportation problem and solved using both the Simplex method and the Northwest Corner method. The third case focuses on the optimal scheduling of workforce allocation across concurrent project phases, incorporating resource availability constraints and deadline requirements typical of civil engineering project management. Each case is accompanied by full mathematical formulation, step-by-step solution procedures, and a discussion of how variations in real-world parameters affect the optimal solution, thereby reinforcing sensitivity analysis as an essential component of applied linear programming. The implementation was carried out with two parallel student cohorts enrolled in the Operations Research course at UTCB. One cohort followed the traditional instruction model based on standard textbook exercises, while the second cohort engaged exclusively with the real construction cases described above. Student performance was evaluated through a common mid-semester assessment covering problem formulation, solution procedure, and interpretation of results. In addition, a structured feedback questionnaire employing a five-point Likert scale was administered to measure student perceptions of relevance, motivation, and confidence in applying linear programming to engineering problems. Attendance rates across the intervention period were also recorded as a secondary indicator of engagement. The results indicate that students exposed to real construction cases demonstrated measurably stronger performance in problem formulation and solution interpretation, while reporting

[*] *Corresponding Author's E-mail: ion.mierlusmazilu@utcb.ro*

significantly higher levels of motivation and perceived relevance compared to the control cohort. Notably, the case-based group exhibited greater ability to adapt the mathematical model when problem parameters were modified, suggesting deeper conceptual understanding rather than procedural imitation. These findings support the integration of authentic engineering cases as a core pedagogical strategy in Operations Research teaching at technical universities. The paper concludes with recommendations for curriculum designers and mathematics educators seeking to embed real-world optimization problems into Linear Programming courses, and discusses the conditions under which case-based teaching is most effective. Limitations of the study and directions for future research, including the extension of this approach to integer programming and multi-objective optimization, are also addressed.

***K*eywords** linear programming · operations research · case-based teaching · engineering mathematics · Simplex method · construction optimization · active learning

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