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The Perceptions of Engineering Teachers on a "Practice What You Preach" PLE Training Program

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Resumo

Este estudo pretende ser contribuição aos fundamentos teóricos e aplicações práticas da metodologia PLE (Project-Led Education), que é ainda muito incipiente e requer muita discussão sobre como e com que resultados tem sido utilizado em programas de Engenharia em todo o mundo. O objetivo deste trabalho é apresentar um modelo conceitual das competências necessárias dos professores em PLE desenvolvido por oito professores da dentre essas três Universidades estudadas por Tavares Campos (2013), que decidiu se preparar para a metodologia PLE novas funções de ensino, através de um programa de treinamento, projetado com base em metodologia PLE em si, que lhes permitam experimentar a metodologia PLE na perspectiva dos seus alunos de Engenharia. Uma síntese das percepções dos professores sobre o programa de formação, obtidos através de um questionário de escala de Likert, e confirmada através de observações e entrevistas não estruturadas, indicou que a formação dos professores baseada na PLE metodologia pode ser uma maneira eficaz de as universidades os ajudarem a compreenderem seus papéis e de seus alunos nesta nova metodologia educacional.

Palavras-chave: Educação em Engenharia; Metodologia Ativas; Aprendizagem Baseada em Problemas; Aprendizagem Baseada em Projetos; Formação de Professores.

Abstract

This study is meant as contribution to the theoretical foundations and practical applications of the PLE (Project-Led Education) methodology, which is still very incipient, and requires much discussion about how and with what results it has been being used in Engineering programs throughout the world. The purpose of this paper is to present a conceptual model of Engineering teachers' necessary competencies in PLE developed by eight teachers from one of those three Universities studied by Tavares Campos (2013), who decided to prepare themselves for the PLE methodology new teaching roles, through a training program designed on the basis of PLE methodology itself, which would allow them to experience the PLE methodology from their students' perspective. A synthesis on the teachers' perceptions about the training program, obtained through a Likert scale questionnaire, and confirmed through observation and unstructured interviews, indicated that a teachers training based on the PLE methodology can be an effective way for Universities to help them understand students' and teachers' roles in this new educational methodology.
Keywords: Engineering Teaching; Engineering Learning; Problem-Based Learning; Project-Led Education; Teachers Training.

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Resumen

Este estudio pretende ser una contribución a los fundamentos teóricos y aplicaciones prácticas de la metodología PLE (Project-Led Education), que todavía es muy incipiente y requiere mucha discusión sobre cómo y con qué resultados se ha utilizado en programas de Ingeniería en todo el mundo. El objetivo de este trabajo es presentar un modelo conceptual de las habilidades necesarias de los profesores en PLE desarrollado por ocho profesores dentro de las tres Universidades estudiadas por Tavares y Campos (2013), que decidieron prepararse para la metodología PLE en sus nuevas funciones de enseñanza, a través de un programa de capacitación, diseñado sobre la base de la misma metodología PLE, que les permita experimentar la metodología PLE desde la perspectiva de sus estudiantes de Ingeniería. Una síntesis sobre las percepciones de los profesores sobre el programa de formación, obtenida a través de un cuestionario de escala de Likert y confirmada por medio de observaciones y entrevistas no estructuradas, indicó que la formación de los profesores a través de la metodología PLE puede ser una forma eficaz de las Universidades ayudarlos a comprender sus funciones y la de sus estudiantes en esta nueva metodología educacional.

Palabras claves: Engineering Teaching; Engineering Learning; Problem-Based Learning; Project-Led Education; Teachers Training.

1. Introduction

In recent years, the expansion of higher education and the growing pressure from the productive sectors for qualified people have increased the demand for a University that facilitates social and economic progress through knowledge generation and dissemination.

On the one hand, a growing number of students from ever more diverse social classes come to the University seeking to identify and develop skills that enable them to fulfil themselves and to improve the quality of their lives and of the groups they belong to.

On the other hand, as economies demand the improvement of products and services, their societies expect higher education to champion technical and scientific development, and to ensure its harmonious integration to the political and cultural fabric.

Thus, the issue of the unitary school, which seeks to join professional education (the preparation of skilled labor to the market) with humanistic education (the formation of critical and conscious citizens), finally knocks at the gates of the University, which now needs to face the challenge of meeting a technological demand – to advance culture in order to fuel economic development – and an ethical requirement – to make sure that knowledge becomes an instrument against social injustices.

As a consequence of this, slowly but steadily gaining awareness that modern human action is less and less related to doings (memorization and reproduction) and more and more connected to interventions (prediction and facing of the unknown), the University has been reviewing its relationship with knowledge.

Specifically in Engineering, which now requires innovation through the creative adaption of old knowledge to new contexts, it is becoming clear that the mere recollection of solved problems and the direct transfer of previously implemented procedures and solutions are not enough to cope with the ever challenging world.

Modern Engineering professionals are faced with ever more uncertainty, with partial information and competing demands from companies' stakeholders, forcing them to acquire and develop not only technical skills but human relations competence as well.

So, abandoning the unidirectional and linear transmission of fragmented content, the PBL (Problem-Based Learning) and the PLE (Project-Led Education) methodologies are Engineering programs' attempts to enable students to look for solutions to daily problems by means of a contextualized, dynamic and critical connection between theory and practice.

The PBL methodology has been used to help learners adapt underlying theories to their individual cognitive structures through contextualized questions carefully designed to stimulate the students' critical and committed participation in finding explanations to authentic situations of the real world [1]. In this

methodology (Table 1), inductive (from practice to theory) non-linear (simultaneous access to multiple knowledge) teaching and active (doing more than just seeing and repeating) learning have reportedly allowed students to tap into interdisciplinary knowledge [2].

Table 1. PBL main aspects – Tavares and Campos (2013).

aspects	PBL - Problem-Based Learning
expected deliverables	students are expected to provide explanations or suggestions to authentic situations of the real world
educational approach	built as a research model, with emphasis on diagnosis which helps contextualize interdisciplinary knowledge
educational curriculum	educational curriculum is organized around a question, with educational focus being on the process
educational design	after question is presented, large groups of more than 10 students look for an answer for 1 or 2 weeks
theory-pratice integration	students look for missing information to share a hypothesis or solution in class, when theory is finally elaborated
teachers' role	act as facilitators of students' quests and as specialists in classes
studens' role	analyse, discuss and generate questions/learning tasks from the open case

Going beyond the case problems, with small tasks and known answers to known difficulties, that characterize the PBL methodology the who focuses on creating products, with big tasks and multiple innovative solutions to challenging unknown questions [3], and adopts (Table 2) an even more hands-on educational approach, whereby students, while creating materials, artifacts, processes and systems closely related to their future professional situations, identify, analyze and apply the most suitable theories to develop and manage their projects [4].

Table 2. PLE main aspects – Tavares and Campos (2013).

aspects	PBL - Problem-Based Learning
expected deliverables	students are expected to develop new materials, artifacts, processes and systems to the changing world
educational approach	built as a production model, with emphasis on practice which mimics the real world professional environment
educational curriculum	educational curriculum is organized around a solution, with educational focus being on the product
educational design	after theme is presented, small groups of up to 8 students plan and develop their projects for 10 or more weeks
theory-pratice integration	while elaborating on theories in classes, students develop a project, looking for information and managing resources
teachers' role	act as supervisors of students' projects and as specialists in classes
studens' role	analyse, discuss and generate questions/learning tasks from the open theme and manage product development

However, although very promising, the theoretical foundations and practical applications of both methodologies are still very incipient and require much discussion about how and with what results they have been being used in Engineering programs throughout the world.

Tavares and Campos (2013) investigated how the PBL and the PLE methodologies have been being implemented in the Engineering programs of three Brazilian Universities whose advertisements mention an

investment in modern educational methodologies, aiming to contribute to the consolidation of a scientific basis. They found out that while teachers believed their actions were in right path to adequately implementing their Universities' attempts to revamp their educational methodologies by means of the PBL and the PLE, their students hardly perceived their Universities' intended proposals.

Informal talks with many of the teachers who took part in the research indicated that they (almost secretly) felt unable to adequately implement the PBL and PLE methodologies' theory and practice in their classes, and, among the possible reasons for this, it stood out their perception that it was because they had been taught in the traditional way.

Exploring this point a little further, it was common ground that, as students, they had not been stimulated to comprehensively acquire Knowledge; that they had always worked alone or in ill-formed groups; and that they lacked the experience of critical thinking and problem solving, together with sharing common objectives and results (as it is required in the PBL and PLE methodologies), and so, as teachers, the concept of tutoring (supporting students' cognitive and social skills development) was almost alien to them.

This led the authors to the idea of creating an opportunity where some of those teachers could practice what they were preaching in their classrooms, and to experience the PBL/PLE proposal as students, so that they could become aware of the opportunities and difficulties of intense team work, strict timelines, real life problems and interdisciplinary knowledge.

As the PLE methodology, with its concept of project management and product delivery, is more akin to the Engineering profession and academics than the PBL methodology [5], which itself is part of the PLE methodology [6] (Figure 1), a practical PLE methodology training program was devised.

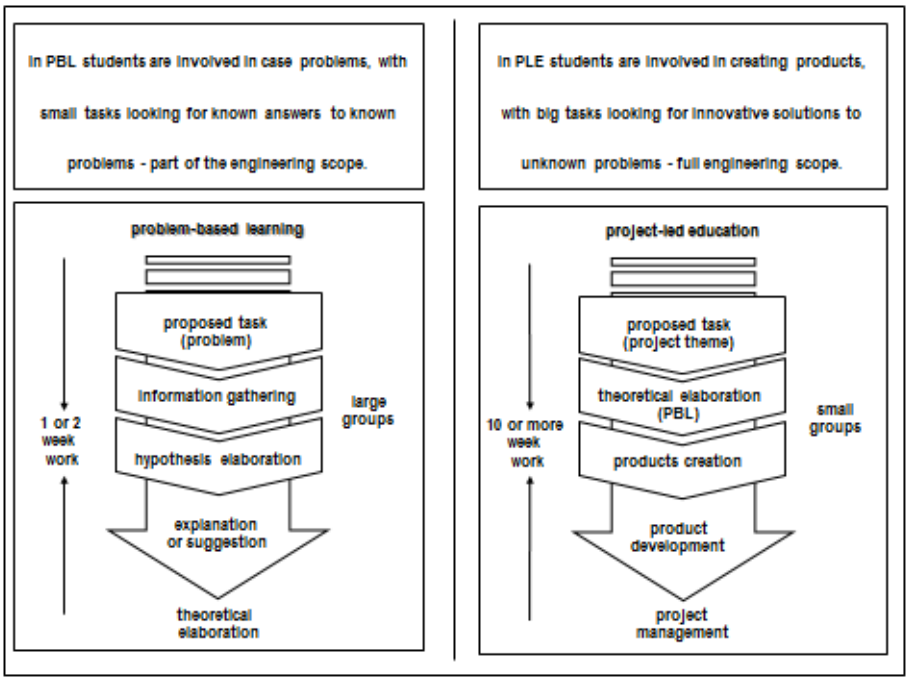


Figure 1. PBL and PLE in Engineering courses – Tavares and Campos (2013).

The purpose of this paper is to report the experience of preparing eight teachers from one of the three Universities studied by Tavares and Campos (2013) to take on their new roles in the PLE methodology, through a training program designed on the basis of the PLE methodology itself, in order to provide them with the experience of practicing what they preach.

The main research question was "Can a teachers training program based on the PLE methodology be an effective way for Universities to help them understand students' and teachers' roles in this new educational methodology?"

2. Methods

As method of approach (the more abstract and broader methodological behavior for investigating events) [7], this study was developed under the inductive method, which constructs or evaluates general propositions that are derived from specific examples [8].

As method of procedure (the methodological behavior adopted in the more concrete phases of a study) [9] this investigation embraced the monographic method, which is an in-depth study of certain individuals, professions, policies, institutions, groups and communities, in order to obtain generalizations [8].

As method of investigation – the methodological behavior regarding the way the researcher intervenes in reality [10] – this research adopted the case study, which constitutes an account of an activity, event or problem that contains a real or hypothetical situation, used to help you see how the complexities of real life influence decisions [8].

From among the different techniques for data collection, this study relied on observation, unstructured interviews and a Likert scale closed-question questionnaire [11]; and, with regard to the techniques for data analysis, mainly the quantitative (the objective numerically expressed analysis of observed phenomena) [12] treatment was applied.

Once this study endeavored to stimulate the development of educational models that bring less domination and exclusion, and because it rejected unilateral views and oppressive actions, perceived as useless in today's world, it adopted a critical orientation to teaching and learning [13].

For the organization of the training program Weenk and friends' principles [14] were followed, since they provide Engineering teachers with the opportunity of experiencing PLE learning from their students' viewpoint: in a five session course participants underwent teamwork project development and management, whose final deliverable was the presentation of a conceptual model of Engineering teachers' necessary competencies in PLE.

3. Results

This section presents the organization of the training program, the conceptual model produced by the participants and their perception on the task they performed.

3.1. Organization of the Training Program

Based on Weenk and friends' principles [14], Tavares acted as the tutor of eight Engineering teachers who took part in Tavares and Campos's investigation (2013) on how the PBL and the PLE methodologies were being implemented in the Engineering programs of three Brazilian Universities.

The training program was carried out in five two-hour sessions from June 17 to June 21, 2013.

In the first session, participants received from their tutor the project they had to complete working as a team – the development of a conceptual model of Engineering teachers' necessary competencies in PLE – and started to share ideas and concepts for the development of the task due at the end of the week.

In the second, third and fourth sessions, participants worked in a pattern similar to what they require from their students in their classrooms, feeling the pressure to make decisions within a limited time frame, without the opportunity to discuss different points of view for extensive periods of time.

In the fifth session, participants, after presenting the most important features of their conceptual model and discussing their proposal both in theoretical and practical terms, talked freely about their experience as PLE students, and answered a Likert scale closed questionnaire handed out by their tutor.

3.2. Conceptual Model Produced by the Participants

Following the PLE methodology – characterized by mutual cognitive and social interaction – participants, after collecting and analyzing data and information that could lead to the development of a conceptual model of Engineering teachers' necessary competencies in PLE, arrived to the idea expressed in Figure 2.

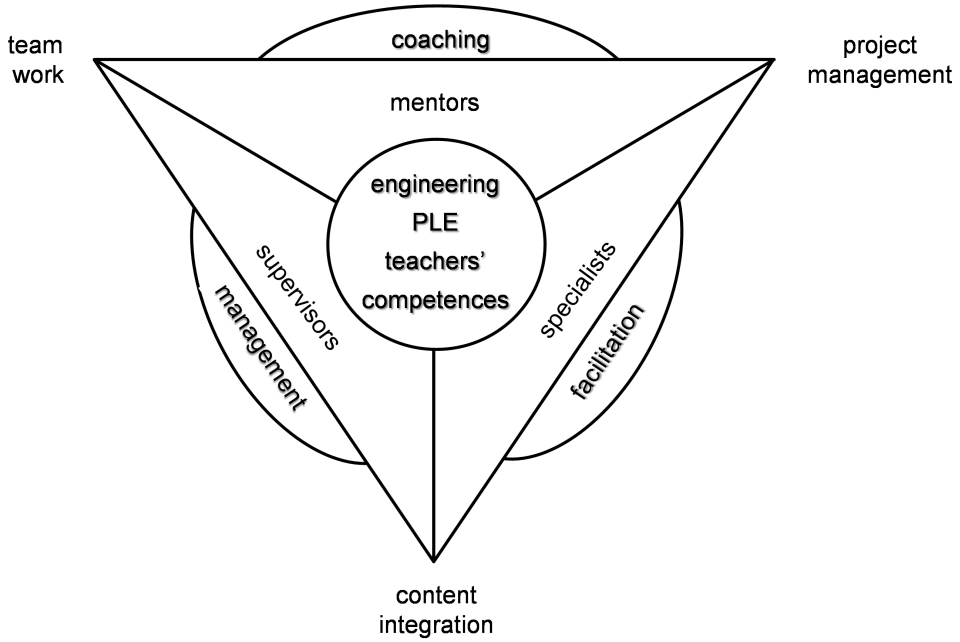


Figure 2. Engineering teachers' necessary competencies in PLE.

The conceptual model starts with the three basic tasks PLE Engineering students are expected to perform:

- content integration, in which students, instead of being told exactly what they should learn and in what sequence, are helped to determine such things independently, finding out, learning and integrating whatever knowledge is necessary to complete their projects [15];

- project management, in which students are exposed to Engineering projects planning, organization, direction and control, and guided on how to engage in and oversee their own works, in order to ensure they meet their goals, time lines and budget expectations [16];

- teamwork, in which students are encouraged to work cooperatively, and supported in the development and improvement of their interpersonal skills, while monitoring and adjusting their own, their peers' and their group's learning processes and performance [17].

From those, it defines the three basic tasks Engineering teachers are expected to perform in PLE, based on which their necessary competences are identified:

- specialists, the competence of providing support to students' content integration and project management tasks, based on their academic and professional technical experience, in such a way that they act as facilitators of students' learning;

- supervisors, the competence of evaluating students' content integration and teamwork tasks, based on their academic and professional administrative experience, in such a way that they act as a managers of students' performance;

- mentors, the competence of guiding students' teamwork and project management tasks, based on their academic and professional interpersonal experience, in such a way that they act as coaches for students' cooperation.

3.3. Participants' Perception on the Training Program

While discussing and negotiating roles and approaches concerning the development of a conceptual model of Engineering teachers' necessary competencies in PLE, participants collected and analyzed data and information on the subject in a process which demanded cooperation and collaboration for the gradual construction of knowledge.

In order to better understand how this research's participants perceived this training experience, they were asked to answer a Likert scale closed-question questionnaire (Table 3), which was complemented by observation and unstructured interviews by the authors of this paper.

Table 3. Structure of the closed-question questionnaire

1 = I totally disagree/ 2 = I partially disagree/ 3 = I partially agree/ 4 = I totally agree		1	2	3	4
Content Integraton	Q01. In this training program, we had to search for, apply and integrate knowledge into our end product.				
	Q02. In this training program, we felt the need to take more responsibility for our learning.				
	Q03. In this training program, we were engaged in active learning, primarily self-directed.				
Project Management	Q04. In this training program, we had to plan, organize, direct and control our project.				
	Q05. In this training, we fel the pressure to meet goals, time lines and budget expectations.				
	Q06. In this training program, we had to deal with interpersonal communication and conflict management.				
Teamwork	Q07. In this training program, we had to exercise the communication skills of listening and speaking.				
	Q08. In this training program, we ha to work cooperatively and exercise collaborative skills.				
	Q09. In this training program, we had to manage our own as well as our peers' performance				
Tutoring Competences	Q10. In this training program, coaching competencies had to be exercised by the tutor.				
	Q11. In this training program, facilitation competencies had to be exercised by the tutor.				
	Q12. In this training program, management competencies had to be exercised by the tutor.				
Training Program Effectiveness	Q13. In this training program, we had the opportunity to experience engineering students' reality in PLE.				
	Q14. In this training program, we had the opportunity to visualize engineering teachers' challenges in PLE.				
	Q15. This training program incrieased our leel of confidence to effectively implement methodology.				

The questionnaire was structured in three parts in order to evaluate participants' perceptions on 1) the adequacy of the training course to the PLE methodology (which seeks to ensure content integration by means of project management carried out in teamwork) (questions 01 to 09); 2) the tutor's need to apply the competencies participants devised in their conceptual model of Engineering teachers' necessary competencies in PLE (questions 10 to 12) ; and 3) the effectiveness of a training course based on the PLE methodology in helping teachers understand students' and teachers' roles in this new educational methodology (questions 13 to 15).

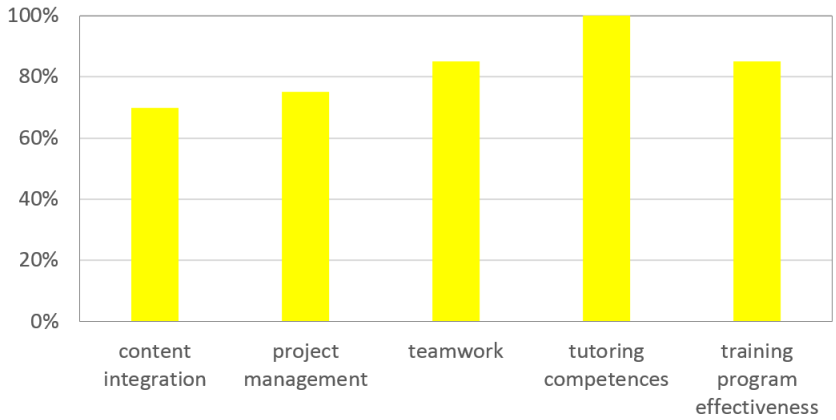
In order to stimulate participants to talk freely about their experience as PLE students, 3 questions (Table 4) were proposed as general guiding lines:

Table 4. Unstructured interviews general guidelines

1	The most positive aspect(s) of the educational approach adopted by the training course to the PLE methodology is(are):
2	The least positive aspect(s) of the educational approach adopted by the training course to the PLE methodology is(are):
3	My suggestion(s) for improving the educational approach adopted by the training course to the PLE methodology is(are):

4. Analysis

Results of the answers provided by the participants in the Likert scale closed-question questionnaire are showed in Graph 1:



Graph 1. Participants' perception on the task they performed.

Analysis of the answers provided by the participants in Graph 1 revealed that:

- 70% of the participants totally agreed that the training program was designed to ensure content integration (questions 1, 2, 3);

- 75% of the participants totally agreed that the training program was guided by the project management methodology (questions 4, 5, 6);

- 85% of the participants totally agreed that teamwork was an essential part of the training program (questions 7, 8, 9);

- 100% of the participants totally agreed that the tutor had to exercise the competences of coaching, facilitation and management in the training program (questions 10, 11, 12);

- 85% of the participants totally agreed that the training program was an effective way to understand learning and teaching in the PLE methodology (questions 13, 14, 15).

Participants' main ideas collected in the unstructured interviews general guidelines are:

- class time devoted to application of concepts by the participants and more time for one-on-one teacher-participant interaction are the most positive aspect(s) of the educational approach adopted by the training course to the PLE methodology;

- limited time frame for the scale of the task is the least positive aspect(s) of the educational approach adopted by the training course to the PLE methodology;

- adjustment of time frame to the scale of the task is a suggestion for improving the educational approach adopted by the training course to the PLE methodology.

5. Conclusion

This paper reported the experience of preparing eight Engineering teachers to take on their new roles in the PLE methodology, through a training program designed on the basis of this same methodology, in order to provide them with the experience of practicing what they preach.

In face of the collected data, it is possible to infer that the answer to this research's main question is yes, a teachers training based on the PLE methodology can be an effective way for Universities to help them understand students' and teachers' roles in this new educational methodology.

As expected, adjusting time frame to the complexity of the task is a main concern, which has to be taken into careful consideration when implementing the PLE Methodology.

This is an exploratory case study, and so, additional studies are needed in order to better understand – and, eventually, disseminate – this throughout the Engineering teaching and learning community.

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