Editor Responsável: Prof. Dr. Hermes Moretti Ribeiro da

Recebido: 08/10/2020
Aprovado: 09/10/2020

Project Development in Small and Medium-sized Enterprises: An Opportunity to Improve Teaching and University-business Interaction

José de Souza Rodrigues[1], São Paulo State University, Bauru, São Paulo, Brazil
Aline Martins Schneiders Dalpian[2], São Paulo State University, Jaboticabal, São Paulo, Brazil
Kátia Lívia Zambon[3], São Paulo State University, Bauru, São Paulo, Brazil
Antonio Fernando Crepaldi[4], São Paulo State University, Bauru, São Paulo, Brazil
Walther Azzolini Júnior[5], Sao Paulo University, São Carlos, São Paulo, Brazil

RESUMO

Objetivo: Analisar se desenvolvimento de projetos em pequenas e médias empresas para apoiar o processo ensino-aprendizagem (metodologia PBL - Project Based Learning) é uma solução para superar os desafios de formação de profissionais no século XXI.
Referencial teórico: O desenvolvimento de projetos torna o aluno ativo no processo de ensino-aprendizagem e possibilita o desenvolvimento de competências técnicas e comportamentais e pesquisas com as PME são necessárias porque elas são pouco pesquisadas.
Abordagem metodológica: É uma pesquisa aplicada e a abordagem metodológica utilizada foi o estudo de caso. Os projetos foram desenvolvidos em duas pequenas empresas e foram coletados dados sobre a opinião dos alunos sobre o processo, por meio de observação participante, documentos e entrevistas. Os dados foram obtidos no período de 2016 e 2017 na região de Bauru-SP, Brasil, em parceria com o SEBRAE (Serviço Brasileiro de Apoio às Micro e Pequenas Empresas).
Resultados: A metodologia baseada no desenvolvimento de projetos em pequenas empresas motiva os alunos e desenvolve competências transversais e gera benefícios para as empresas.
Pesquisa, implicações práticas e sociais: Pequenas empresas oferecem a oportunidade de olhar para uma empresa como um todo e interagir com todos os seus membros e aproxima a universidade de sua comunidade.
Originalidade / valor: as pequenas empresas podem contribuir para melhorar o ensino ao permitir o desenvolvimento de projetos colaborativos universidade-empresa.

ABSTRACT

***Purpose**: Analyze whether project development in small and medium-sized companies to support the teaching-learning process (PBL methodology - Project Based Learning) is a solution to overcome the challenges of training professionals in the 21st century.*
***Theoretical framework**: Project development makes the student active in the teaching-learning process and enables the development of technical and behavioral skills and research with SMEs is necessary because they are little researched.*
***Design/methodology/approach**: It is applied research and the methodological approach used was the case study. The projects were developed in two small companies and data were collected on students' opinions about the process, through participant observation, documents and interviews. The data were obtained in the period 2016 and 2017 in the region of Bauru-SP, Brazil, in partnership with SEBRAE (Brazilian Service of Support to Micro and Small Enterprises).*
***Findings**: The methodology based on project development in small enterprises motivates students and develops transversal competences and generates benefits for companies.*
Research, Practical & Social implications: Small businesses offer the opportunity to look at a business as a whole and interact with all your members and bring the university closer to your community.
***Originality/value**: small businesses can contribute to improving education by enabling the development of collaborative university-company projects.*
***Keywords**: PBL, small and medium-sized enterprises, engineering education, production systems.*

1. Av. Engenheiro Luiz Edmundo Carrijo Coube, 14-01. PO BOX 17033-360, Bauru, São Paulo, Brazil, jose.rodrigues@unesp.br, https://orcid.org/0000-0002-3853-787X; 2. professoraaline48@gmail.com, https://orcid.org/0000-0002-1682-2522; 3. katia.zambon@unesp.br, https://orcid.org/0000-0003-3152-0183; 4. antonio.f.crepaldi@unesp.br https://orcid.org/0000-0002-9090-1835; 5. wazzolini@sc.usp.br, https://orcid.org/0000-0002-0387-661X.
RODRIGUES, J.S.; DALPIAN, A.M.S.; ZAMBON, K.L.; CREPALDI, A.F.; AZZOLINI JÚNIOR, W. Project Development in Small and Medium-sized Enterprises: An Opportunity to Improve Teaching and University-business Interaction. **GEPROS. Gestão da Produção, Operações e Sistemas**, v.15, nº 4, p. 189 - 204, 2020.
DOI: http://dx.doi.org/10.15675/gepros.v15i4.2774

1. INTRODUCTION

Increasing population, economic integration, communication systems, and facilities to move capital and materials are making the world more integrated and the problems to be solved more complexes (HAMILTON; MCFARLAND; MIRCHANDANI, 2000; SCOTT, 2015a; SCOTT, 2015b). Taken together, these changes and their consequences have been called Globalization (TEEPLE, 2000). In response to the challenges it produced, Agenda 21 (UN, 1992) is suggested, later updated as Agenda 30 (UN, 2015), that sets out targets and objectives to be pursued by the signatories of these documents. While Agendas 21 and 30 set goals and objectives to make life on the planet sustainable, in the field of educational, the challenge is to equip and prepare new generations to live and solve the problems in the era.

In 2013, the annual UNESCO Pacific Asia Education Research Institutes Network (ERI-Net) adopted the term 'transversal competencies' to refer to all skills, values and attitudes including collaboration, self-discipline, resourcefulness and respect for the environment needed for the integral development of students and to enable them to adapt to a changing world (UNESCO, 2015).

There is a lot of research on what should be taught to new generations and related topics such as employability (WICKRAMASINGHE; PERERA, 2010; GONAZALES-ROMA; GAMBOA; PEIRÓ, 2018; ANDREWS; HIGSON, 2010) skills and expertise (NAKAO et al., 2012, MESQUITA, LIMA, PEREIRA, 2008), curriculum (HAMILTON; MCFARLAND; MIRCHANDANI, 2000; PETROSINO, 2004), teaching/learning methods (ALVES *et al.*, 2016; SEMAN *et al.*, 2018) and assessment (JUWAH, 2004; BURKŠAITIENĖ, 2012) to help teachers, educational institutions, students, the community, governments and organizations to overcome the challenges that the 21st century presents.

Development of skills involves complex issues and is associated with policies and practices (UNESCO, 2015). Policies are given at the level of governments and institutions, while practices are given at the level of operation in the education system. This study is associated at the practice level and consists of analyzing the contributions that small and medium-sized project development can bring to university-business learning and interaction.

The study qualitatively dealt with the data obtained and allowed seeing that project development in small and medium-sized enterprises is interesting from an educational point of view, because it shows the necessity to reinforce the learning about theories in productive

systems, because in both cases analyzed, many informal organizational and operational processes were found, making it difficult to immediately apply analytical techniques and tools. The small size of the operations of these organizations generally allows students to have a systemic view of their processes and activities.

PBL is classified as an active methodology (MATZEMBACHER; GONZALES; NASCIMENTO, 2019; LÓPEZ-FERNÁNDEZ, D. *et al*., 2019) that assists in the development of professional and transversal skills (SANGER; ZIYATDINOVA, 2014; HADINUGRAHANINGSIH; RAHMAWATI; RIDWAN, 2017). This study was carried out to identify contributions to improve the teaching-learning process and university-business interaction with the development of projects in small and medium-sized enterprises.

The results were obtained by analyzing the data collected in 2016 and 2017 during the execution of projects in two small companies, one commercial and one industrial, with part of the activities of two undergraduate disciplines in Production Engineering.

2. THEORETICAL FOUNDATION

Various researches tried to offer solutions to overcome difficulties encountered with the traditional teaching methods, such as a lack of motivation to learn and inability to develop skills other than techniques. It was investigated what practitioners claim to be using in their professional activities (MINOR; ARMAREGO, 2005), what new generations should learn (SCOTT, 2015a) and whether it is possible to teach and learn the skills and abilities pointed out as necessary to solve problems faced by modern world (BESTERFIELD-SACRE; SHUMAN; WOLFE, 2002; MESQUITA *et al*., 2009; UNESCO, 2015).

Learning to learn, learning to do, learning to be, learning to communicate, knowing how to collaborate, develop the critical thinking, teamwork, entrepreneurial skills and creativity are considered important to this new era (SCOTT, 2015a). A survey of the requirements contained in vacancies offered by Portuguese companies in the area of Industrial Engineering (MESQUITA *et al.,* 2009) found that transversal competencies had a higher number of occurrences than professionals.

The gain in the importance of transversal skills is due to the increasing complexity of problems and the need to combine different tools and concepts to solve them.

> The economy of knowledge needs people with the right mix of skills: transversal competencies, e-skills for the digital age, creativity and flexibility, and a solid knowledge of the chosen field (science, technology, engineering, mathematics, etc.) (EUROPEAN COMMISSION, 2011).

Transversal competences are defined as "(...) as attitudes, abilities and skills of the individual that contributes to effective performance in different work situations" (TSANKOV, 2017, pp.199-200). Part of these transversal competencies is related to attitude, behavior or behavioral-related, making learning in the traditional format difficult. Even those that can easily be turned into a subject, such as a second language for business and engineering courses, should not be turned into subjects because this logic leads to courses becoming less focused, causing them to lose their identities due to the number of subjects related to the teaching of transversal competencies (MESQUITA *et al.*, 2009).

The development of technical and transversal skills requires the structuring of an educational environment for this purpose (EUROPEAN COMMISSION, 2019). Methods, techniques, procedures, processes, educational resources, curriculum, educational political project, subjects and evaluation systems should be geared towards the production of the desired transversal and technical competences.

In Europe, the Bologna Process, in addition to allowing student mobility and ensuring quality standards in EU member countries, has helped to establish a quality benchmark for higher education, its ability to equip students "(...) with the knowledge, skills and core transferable competences they need to succeed after graduation" (AALBORG, 2019).

In traditional teaching methods, the student has a passive role in the teaching-learning process (LI, H.; ÖCHSNER; HALL, 2017). Active learning considers that the student should be active in the learning process and takes responsibility for their learning by actively participating in the various learning processes in which they are involved. The implementation of active methodologies occurs in a number of ways. It can be in single subjects, in a set of subjects (UMINHO, 2018), in a course or in an institution, in a country or region (AALBORG, 2019).

The learning methodology Project Based Learning - PBL, can fulfill the task of supporting the learning of both professional and transversal content. There are several ways to implement active learning and one of them is project development, "(...) which has been gaining ground, and being successfully applied in several fields" (ALVES *et al.*, 2016; p.17).

"(...) PBL is an effective, engaging way to teach both core concepts and non-curricular skills" (SCHWALM, TYLEK, 2012, p.2).

Complementary Law 155 of October 27, 2016 (BRAZIL, 2016) classifies small enterprises as those with a revenue between US$ 114,649.68 and US$ 1,528,662.42 (using the US Dollar exchange rate on 10/27/2016, 1US$ = R$3.14). To support these companies, SEBRAE (the Brazilian Micro and Small Enterprise Support Service) was created by Decree 99.570 of April 12, 1990 (BRAZIL, 1990).

Entrepreneurship plays an important role in countries, and the creation of the Global Entrepreneurship Monitor (GEM) is indicative of its importance. It analyzes entrepreneurial activities world-wide, and the 2019/2018 Report shows data from 54 countries, placing Brazil in 48th. position on the impact of innovation and in 47th position in relation to the level of education of new and established entrepreneurs (GLOBAL ENTREPRENEURSHIP MONITOR, 2019). These data indicate that a significant portion of companies started in Brazil, or already established, are not prone to innovation and are created or maintained by entrepreneurs with little scholarity compared to other countries monitored by Global Entrepreneurship Monitor (2019).

Despite efforts by governments and various organizations to spread, encourage and strengthen entrepreneurship, universities and research centers can play an important role in both creating new ventures and maintaining and developing established ones.

Developing projects with undergraduate students can facilitate access to knowledge for small and medium-sized enterprises while providing an opportunity to streamline undergraduate curricula and bring learning closer to practice.

3. METHODOLOGICAL PROCEDURES

The study was conducted from 2016 to 2017 with data obtained from the development of projects in two small enterprises in the region of Bauru-SP, Brazil, one trade and one industry. The first part of the study was carried out as a pilot and involved only three undergraduate students in Production Engineering and was done entirely at the commercial company. The second part was carried out involving two undergraduate subjects in the Production Engineering course (Production Management I and Production Management II) and only involved the industrial company. Data was collected using document analysis,

observation *in loco* and semi-structured questionnaire designed in Google Docs and answered by students in both subjects, student reports, presentations (in the classroom and in the company), technical visits to the company, company documents (including access to data contained in the ERP software). used by the company), documentation generated by participant observation, during project orientation that occurred in the subjects.

Research is qualitative in nature, applied in its purpose and exploratory in its objectives (TOGNETTI, 2008). Regarding the procedure, this is a case study, since "It aims to investigate a specific case, well defined, contextualized in a time and place so that a detailed search for information can be performed" and it can be single or multiple (VENTURA, 2006). The Case Study

> It seems to be appropriate for investigating phenomena when there are a wide variety of factors and relationships that can be directly observed and there are no basic laws to determine which ones are important (VENTURA, 2006, p. 386).

The quantitative data was treated using basic statistics, while the text generated in open-ended questions was treated with word identification and counting software. Participant observation also generated data and inputs to analyze the context in which they were obtained.

4. DEVELOPMENT, DATA ANALYSIS AND RESULTS

In this section are presented the results of research, considering the project development, Project Analysis by Students, Challenges and opportunities with projects and learning in SMEs and University and Small and Medium-sized Enterprise Interaction.

4. 1 Project Development

In 2016, a pilot project was started with a small number of students (3), all belonging to an institutional project called PET Bauru Production Engineering. They worked at a building material trading company and the learning gained guided the measures taken at the industrial company. These lessons include the lack of formalization in these companies, the scarcity of structured data, a lean administrative structure focused on owner ownership, and the predominance of low-educated employees. In this company in particular, no employee had completed higher education, including the owners, agreeing with the data shown in the GEM report (GLOBAL ENTREPRENEURSHIP MONITOR, 2019).

After, in 2017, projects were developed in the industrial company with the participation of 37 students from Production Management I (ADM PROD I), all Brazilian, and 50 students from Production Management II (ADM PROD II), 46 Brazilian students, 2 French and 2 German.

In both subjects the students' task was similar in overall purpose: to visit the company, identify opportunities for improvement, and come up with solutions. ADM PROD I students worked on the same projects as the ADM PROD II class and had access to reports produced by that class.

Since it was a small enterprise and had a low formalization rate, both the management structure and the processes, as observed during the realization of the first project, it was decided to indicate the areas in which the projects would be developed, as follows: a) Inventory management; b) Communication and IT support (Information Technology) to operations and management process; c) Study of processes; d) Production Execution and Control; e) Organizational structure; f) Production layout and g) Production Planning and Scheduling. To support project development activities a guide (BAARS, 2006) was used.

The project was developed while the company's operations were running, and it was necessary to warn students to cause as little interference as possible to the company's operations while they were performing the project activities.

Project development documentation consists of final student reports, presentations (in the classroom and at the company), technical visits to the company, company documents (including access to data contained in the ERP software used by the company), documentation generated by participant observation and the orientation of projects during the academic year were used for analysis, as well as the application of a questionnaire to the students, as follows.

4.2 Project Analysis by Students

After completing the projects in the industrial company, a semi-structured questionnaire was applied. The data obtained through the questionnaire was generated from a population composed of 37 students from Production Management I (ADM PROD I), all Brazilian, and 50 students from Production Management II (ADM PROD II), 46 Brazilian students, 2 French and 2 Germans. Only Brazilians completed the questionnaires. In total, 24 ADM PROD I students and 39 ADM PROD II students answered the questionnaire, representing 75.9% of the population.

Of all the questions contained in the questionnaire, only the students' view of project development will be presented here, with its justification (In their opinion, should project development continue as part of this subject? Justify) and what demonstrates competencies and skills, for which students should indicate the following options: “Not stimulated”; “Encouraged to use”; “Stimulated to develop”; “Encouraged to develop and use”.

This selection was chosen to limit the scope of the paper and to present the PBL as an opportunity to bring together companies and universities, especially small and micro enterprises, and for students to develop skills.

In the next two (sub)sections that follow, the analysis of student replies to both questions are shown here.

4.2.1 Motivation to Develop the Project: Learn and Practice

Regarding the first question, from the respondents, 39 ADM PROD II students (97.5%) and 24 ADM PROD I students (100%) stated the alternative that project development should continue in the subject. Then the students justified their opinion in an open-ended response field. Since it is text, the answers were exported to an Excel spreadsheet and the answers column was extracted. FineCount software was used to identify the words used and to count them. The following words were found (in parentheses is the number of times the word was quoted): Practice (35), student or students (35), Project development (21), subject or subjects (19), classroom (15), work (12), important (11), theory (11), and learning (10). Looking at the contexts in which the words were used, the word ‘learning’, for example, appears as follows: “The opportunity to be able to deal directly with a real company provides greater learning (...)”; “Practice is one of the best ways to get learning (...)”, “I believe learning in practice is one of the main ways to learn (...),“ By getting involved with a project, the student can see the applicability of theoretical learning (motivating) (...)”. Without presenting all the sentences found (10 in total), also note that the activities performed by the students were sufficient to establish a positive relationship between “learning” and “practice”, one of which adds “motivation” to the context of project development involving real problems. Based on the opinion of the students, there is evidence that the improvement of learning through the use of PBL, as reported in the literature consulted, is confirmed, because most, almost all of the sample (97.5% of one class and 100% on the other) of the respondents (63 students representing 74.1% of the total 83) stated that project development should

continue in the subject. The justifications presented for the given opinion also confirm that the experience with project development was positive and helped learning the concepts associated with the activities performed.

4.2.2 Development of Competencies and Skills

Finally, students were presented with a set of competencies and skills for which they should select from "Unstimulated"; "Encouraged to use"; "Stimulated to develop"; "Encouraged to develop and use" for the following skills and competencies: make public presentations; written expression; locate a scientific paper; formulate a problem in loose-knit environments; think about the implementation of the proposed solution; consider human factors when proposing a solution; have a mental model of a production system; use computer resources; use previously viewed content; improve oral expression; use scientific writing; formulate solutions; think of a solution from the user; speak in English; autonomy and responsibility for learning; reading in English; writing in English.

The competencies and skills that most challenged students (stimulated to develop and use) were, in this order: (i) Think about implementing the proposed solution (17 ADM PROD II, 18 ADM PROD I); and (ii) Think of the solution from the user (17 ADM PROD II, 18 ADM PROD I). The lowest frequencies for the "non-stimulated" option in this order were "Speak in English" (19 ADM PRODI, 0 ADM PROD II), "Write in English" (16 ADM PRODI, 1 ADM PROD II) and "Read in English" (19 ADM PRODI, 2 ADM PROD II).

The above items show how project development changes the dynamics of the learning environment, interfering with student learning. In the first two cases, "think about implementing the proposed solution" and "think about the solution from the user", basic demands of project development, in general, traditional classes do not encourage the student to think about it, because the focus is on in teaching the student how to use a method or technique. In cases related to a foreign language (English), the almost opposite answers in both classes are related to the dynamics implemented in the class. The ADM PROD II class, due to the participation of foreign students in the course, had to present in English (oral and written, involving debate about what was presented). As for the other class, ADM PROD I, which had no foreign students, they were presented in Portuguese, justifying, for this class, the answer that this was the least stimulated item for them. It is proof that the learning that

takes place in class depends on the dynamics that are implemented (which elements constitute it and which challenges are presented to the students).

Thus, it can be said that there is strong evidence that project development has contributed to the development of transversal competences, including those that complement the technical competences, since the items that presented the most frequency in relation to "stimulated to develop and use", indicating that they are competencies and skills that need to be developed to be used, not technical, although they may be somehow embedded in project development techniques.

4.3 Challenges and opportunities with projects and learning in SMEs

Among the main challenges encountered is the informality of processes. In the first company, the integrated management system was very simple, practically a cash/sales system with associated inventory control, and almost all non-formal procedures were informal or poorly formalized (there was no formal process to follow, there was no a description of the activities that made up the processes, nor of the sequence and constraints to which they were subjected). As a result of the lack of formalization of processes, the differences can be pointed out between the physical stocks and those pointed out in the system (problem found in both companies). In the trading company, at the owner's request, inventory was recounted, and physical inventory data was aligned with that of the ERP, despite the researchers' warnings that processes had to be improved and standardized before inventory alignment. Three months later, the data was inconsistent again. In analyzing the possible causes, some of the findings were: a) there was no standard procedure for changing materials, b) the responsibilities for stock movement were distributed among several people and there were no formal controls over what each was doing in relation to inventory. Similarly, in the second company, almost all processes were informal, meaning there was no documentation about them. Although the ERP system is more comprehensive, not all modules were deployed. As an industry, the challenges of the entry, transformation, and exit cycle are greatest. While in the first company the most common problems are lack of material for sale and excess inventory, in the second company it is difficult to meet deadlines, control inventories and production processes.

It was found in both companies that part of the problems they faced could be solved with basic knowledge of the area of Production Engineering and, therefore, represent great opportunities for project development. For students the big challenge was informality,

because the data needed to apply them was not always available, or had the required reliability, and processes were not always visible. This should serve more as a warning for those who want to introduce the development of practical projects in undergraduate partnership with small and medium-sized enterprises, rather than as a data that points to the unfeasibility of this type of proposal. It is concluded that it is exactly this fact that makes the development of projects in these companies so important, as they offer a type of challenge that is not normally found in large companies, as they already have a significant degree of formalization and process structuring. Small and medium-sized enterprises also offer unique opportunities in terms of seeing the enterprise system in action as a whole. It is often easy for the student to have access to almost all company employees, including managers and owners, and can visit company facilities (administrative and operational area), have access to management systems and controls.

4.4 University and Small and Medium-sized Enterprise Interaction

Regarding the university-company approach, it should be noted that both companies did not have an internship agreement with the Faculty of Engineering to which the undergraduate degree is linked and, therefore, no student had an internship in them. One company did not even know there was this possibility. In the first company (the commercial one), the intern was proposed to continue the activities that had been started with the PET group and, in the second, to be the connection between the company and the classroom.

Note that student activities were not restricted to visiting companies and collecting data, there was interaction with company employees and owners. Regarding this initiative, it is expected that, over time, the development of projects in companies will make the university better known to their community and stimulate the reverse process, companies will look to the university to present project proposals and partnerships. This process has already been observed at the University of Minho in Portugal, during a visit to that institution in 2019.

In 2018, one of the trading company owners contacted us to propose an energy saving project in another venture he started. The owner of the industrial company with contact with students and professors is proposing several projects for other professors and university departments, stating that the purpose of the research, which started this paper, to associate PBL with the university-company interaction and process improvement. teaching-learning was confirmed by the observed reality.

5. CONCLUSIONS

Both projects involved small businesses. It was observed that they did not know how the university could contribute to become more competitive and improve their processes, formalization and controls, allowing their managers to be more involved in managerial activities and less in operational ones. Therefore, university-business cooperation needs some effort to bring them together, which allows the university to get involved in real problems within companies, as well as for them to benefit from the existing knowledge at the university.

Improvements made in companies, as well as those suggested, showed managers the need to focus efforts on management, but for this to be possible, improvements in the processes and controls of companies would be necessary to streamline the decision-making process and make data more reliable, facilitating the process of decentralization of activities and functions. If managers focuses their energies on managing the company, they can devote more effort to improving business focus and adopting new competitive strategies or improving current ones.

Both companies are still protected by the locality issue and do not compete directly with better-structured companies, which may explain, at least in part, the university's “lack of knowledge”. It can be said that, being protected by the locality, the two companies are under little pressure to improve their management systems, controls and processes, especially because they operate in traditional branches, civil construction and agricultural equipment. However, their growth process must push them in this direction, or it will become unfeasible.

The university-company interaction brings positive results to students, as it brings theory closer to practice and allows them to put into practice what they have learned. This is evidence that small business project development can help improve graduation by creating opportunities for students to develop hands-on projects within subjects. The research also showed that students were more motivated with the development of projects and that they were encouraged to develop or improve various transversal skills (using English in oral and written form, working in teams, dealing with real problems, developing projects, among others).

Both companies in which the projects were developed proved to be fertile ground for developing undergraduate level projects, especially in the area of Production Engineering, as

many of the challenges to be faced relate to basic problems in this area. The most common challenges are structuring inventory control and management, designing the administrative structure of the company and its roles and functions, controlling production processes, defining purchasing and lending logics, in short, it consists of structuring and aligning product, process, people and the organization.

The companies were selected by SEBRAE/Bauru based on the actions of the Local Innovation Agents Program (SEBRAE). It is likely that the initial work done by SEBRAE may have facilitated project development, influencing the results of this study regarding the challenges to be faced at the interfaces of university-business collaboration, especially due to the need to deal with many students, many sometimes repeating questions already answered, however careful to alert them and prepare them to avoid such occurrences. Based on the experience of developing projects in the companies and information exchanged with SEBRAE, there is evidence that the university-company interaction process depends on the interest and sense of need, both on the part of the manager and the university.

ACKNOWLEDGEMENTS: We thank SEBRAE-Bauru, specially Mr. Clemilton Basseto, who played an important part in the successful collaboration between companies and the university, as well as the owners of the companies in which the projects were developed. Without the collaboration of them this research would not have been successful.

References

AALBORG, **Problem Based Learning at Aalborg University.** Available in: http://www.en.aau.dk/about-aau/aalborg-model-problem-based-learning/. Access: 28 mar. 2018.

ALVES et al., Managing PBL Difficulties in an Industrial Engineering and Management Program. **Journal of Industrial Engineering and Management**, v. 9, n.3, p. 586-611, 2016, Available in: http://dx.doi.org/10.3926/jiem.1816.

ANDREWS, J. HIGSON, H., **Graduate Employability, 'Soft Skills' Versus 'Hard' Business Knowledge:** A European Study. Pages 411-422 | Published online: 14 Sep 2010, Available in: https://doi.org/10.1080/03797720802522627. Access: 14 oct 2019.

BAARS, W., **Project Management Handbook**, Version 1.1 - July 2006. San Francisco:Creative Commons, 2006.

BESTERFIELD-SACRE, M., SHUMAN, L. J, WOLFE, H., Modeling Undergraduate Engineering Outcomes. **Int. J. Engng, v.** 18, n. 2, p. 128–139, 2002.

BRAZIL, **Decreto No 99.570**, de 9 de outubro de 1990. Available in: http://www.planalto.gov.br/ccivil_03/decreto/d99570.htm. Access: 01 mar 2018.

BRAZIL, **Lei complementar 155** de 27 de outubro de 2016. Available in: http://www.planalto.gov.br/CCivil_03/leis/LCP/Lcp155.htm#art1. Access: 01 mar. 2018.

BURKŠAITIENĖ, N., Promoting student learning through feedback in higher education. **Societal Studies, v.** 4, n.1, p. 33–46, 2012.

EUROPEAN COMMISSION Relevant and high-quality higher education equips students with the knowledge and transferable core skills required to succeed after graduation, Education **and training.** Available in: http://ec.europa.eu/education/policy/higher-education/quality-relevance_en. Access: 28 mar 2019.

EUROPEAN COMMISSION, **Supporting growth and jobs - An agenda for modernizing Europe's higher education systems**. Commission communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Brussels: European Commission, COM (2011), 567 final, 2011. Available in: http://eur-lex.europa.eu/legal-content/PT/TXT/PDF/?uri=CELEX:52011DC0567&from=EN, Access: 28 mar. 2018.

GLOBAL ENTREPRENEURSHIP MONITOR – GEM. 2018/2019 **Global Report**. Available in: https://www.gemconsortium.org/. Access: 22 nov 2019.

GONZALEZ-ROMA, V., GAMBOA, J.P., PEIRÓ, J. M., University Graduates' Employability, Employment Status, and Job Quality. **Journal of Career Development**, v. 45, n.2, p.132-149, 2018.

HADINUGRAHANINGSIH, T., RAHMAWATI, Y., RIDWAN, A., Developing 21st century skills in chemistry classrooms: Opportunities and challenges of STEAM integration. Avalilable in: https://aip.scitation.org/doi/abs/10.1063/1.4995107. **AIP Conference Proceedings**, Published Online: 04 August 2017. Access in: 17 jul. 2019.

HAMILTON, D., MCFARLAND, D., MIRCHANDANI, D, A decision model for integration across the business curriculum in the 21 st century**. Journal of Management Education**, n. 02, 2000.

JUWAH, C. et al. Enhancing student learning through effective formative feedback. **The Higher Education Academy,** 2004.

LI, H., ÖCHSNER, A., HALL, W., student engagement and experience in a mechanical engineering course. **European Journal of Engineering Education**, p. 283-29, 2017.

LÓPEZ-FERNÁNDEZ, D. et al., Motivation of Computer Science Students at Universities Organized around Small Groups. In: GLOBAL ENGINEERING EDUCATION CONFERENCE, 2019. **Anais**… IEEE (EDUCON), p. 1120–27, 2019. https://doi.org/10.1109/EDUCON.2019.8725074.

MATZEMBACHER, D.E., GONZALES, R.L., NASCIMENTO, L.F.M. From informing to practicing: Students' engagement through practice-based learning methodology and community services. **International Journal of Management Education**, v. 17, n. 2, p. 191-200, 2019.

MESQUITA et al. The Connection between Project Learning Approaches and the Industrial Demand for Transversal Competencies. In: INTERNATIONAL RESEARCH SYMPOSIUM. **Anais**…ON PBL - IRSPBL'09, 2009.

MESQUITA, D., LIMA, R.M.; PEREIRA, G., Engineering and industrial management in Portugal: a view of professional demand. In: LUSO-MOZAMBICAN ENGINEERING CONGRESS (CLME'2008), 5., 2008. **Anais**… Moçambique: Maputo, 2008.

MINOR, O., ARMAREGO, J., Requirements Engineering: A Close Look At Industry Needs And Model Curricula. **Australian Journal of Information Systems, v.** 13, n.1, 2005. Available in: https://journal.acs.org.au/index.php/ajis/article/view/71/54. Access: 14 oct 2019.

NAKAO et al., Competency mapping of trainees at USP Polytechnic School. **Engineering Education Review**, v. 31, n. 1, p. 31-39, 2012.

PETROSINO, A. J. Integrating Curriculum, Instruction, and Assessment in Project-Based Instruction: A Case Study of an Experienced Teacher. **Journal of Science Education and Technology**, v. 13, n. 4, 2004.

SANGER,P. A., ZIYATDINOVA, J., Project Based Learning: Real World Experiential Projects Creating the 21st Century Engineer. In: INTERNATIONAL CONFERENCE ON INTERACTIVE COLLABORATIVE LEARNING (ICL), 03-06 December 2014**. Anais…,** Dubai, UAE 2014, Available in: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7017830&tag=1. Access: 17 jul. 2019.

SCHWALM, J.; TYLEK, K. S., Systemwide Implementation of Project-Based Learning: The Philadelphia Approach. **Afterschool Matters,** n.15 p. 1 -8, 2012.

SCOTT, C.L., **The futures of learning 2:** What kind of learning for the 21st century? UNESCO Education Research and Foresight, Paris. [ERF Working Papers Series, n. 14], 2015a.

SCOTT, C.L., **The futures of learning 3:** what kind of learning for the 21st century? UNESCO Education Research and Foresight, Paris. [ERF Working Papers Series, n.. 15], 2015b.

SEMAN, L.O. et al., On the students' perceptions of the knowledge formation when submitted to a Project-Based Learning environment using web applications**. Computers & Education**, v.117, p. 16–30, 2018.

.

TEEPLE, G., **What is Globalization?** In Globalization and its Discontents, S. McBride et al. (eds.), Palgrave Macmillan, a division of Macmillan Publishers Limited, 2000, Available in: https://link.springer.com/chapter/10.1057/9780333981610_2. Access: 28 feb. 2018.

TOGNETTI, M.A.R., **Metodologia da pesquisa científica.** Slides. Available in: http://http://sbi-web.if.sc.usp.br/metodologia_pesquisa_cientifica.pdf. Access: 06 dez. 2008.

TSANKOV, N., Development of Transversal Competences In School Education (A Didactic Interpretation). **International Journal of Cognitive Research in Science, Engineering and Education,** v. 5, n. 2, 2017.

UMINHO, **Integrated Master in Engineering and Industrial Management - MIEGI**, Available in: https://www.uminho.pt/pt/ensino/oferta-educativa/_layouts/15/uminho.portalum.ui/pages/catalogocursodetail.aspx?itemid=2818&catid=8. Access: 20 Aug. 2018.

UN, **Transforming our world:** the 2030 Agenda for Sustainable Development (A/RES/70/1). Available in: https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf. Access: 28 feb 2018, 2015.

UN, **United Nations Conference on Environment and Development**. Rio de Janeiro, 1992. United Nations Conference on Environment and Development: according to Resolution no. 44/228 of the UN General Assembly, 12/22/89, establishes a balanced and integrated approach to issues related to the environment and development: Agenda 21. Brasília: Chamber of Deputies, Coordination of Publications, 1995. Available in: http://www.onu.org.br/rio20/img/2012/01/agenda21.pdf. Access: 28 feb. 2018.

UNESCO 2013 Asia-Pacific Education Research Institutes Network (ERI-Net) Regional Study on Regional Synthesis Report, **Transversal Competencies In Education Policy & Practice (Phase I).** Regional Synthesis Report. UNESCO, Bangkok, 2015.

VENTURA, M.M., The Case Study as a Research Modality. **Rev SOCERJ**, v. 20, n. 5, p. 383-386, 2007.

WICKRAMASINGHE, V. PERERA, L., "Graduates', university lecturers' and employers' perceptions towards employability skills", **Education + Training**, v. 52, n. 3, p.226-244, 2010. Available in: https://doi.org/10.1108/00400911011037355. Access: 06 mar 2018.