

Social Skills: A Key Factor for Engineering Students to Develop Interpersonal Skills*

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The development of interpersonal skills during a student’s undergraduate course is critical because the more developed the social skills the more chances to satisfactorily deal with the demands of different environments and interlocutors. That being the case the university should include interpersonal development as part of its academic goals. Some universities try to achieve those objectives through “junior” enterprises, continuing education programs, university-industry outreach programs and so on. Therefore, this paper describes a successful experience conducted in the university for developing engineering students’ interpersonal skills. Two different strategies were adopted to promote the Engineering students’ development of interpersonal skills: the PRODIP (Interpersonal Professional Development Program) and academic disciplines focusing on social skills and leadership. The PRODIP program had the participation of 41 engineering students in one of its four consecutive annual editions. The students’ social skills were assessed before, during, and after the end of the program, and also three months after (follow-up). The program, which lasted four months, was composed of 15 weekly sessions that included intervention and theoretical aspects related to the practical training of successful social interactions. The participants in PRODIP improved their social skills after the program was implemented and this improvement continued over time (follow-up). The social skills course was applied in two ways, the first one, a brief format, was offered to 29 students, with three four-hour meetings each and addressed topics such as communication, assertiveness and working skills. The second one in a larger format, was offered to 40 students, it consisted of 15 lessons of two hours each. The participants reported the importance of social skills as a prerequisite for teamwork and internship programs, which constitutes the transition from student to the professional workplace. The need to plan strategies in order to promote the students’ interpersonal development is discussed.

Keywords: engineering education; interpersonal development; leadership; social skills

1. Introduction

In addition to technical skills, competencies such as teamwork, public speaking, solving problems, making decisions, communicating empathetically and assertively, and other skills, are fundamental for students to adapt to the new reality of the work market and are prerequisites for leadership skills. This reality imposes new requirements to the University in terms of reviewing its career curricula.

Recently, the Engineers’ Leadership Foundation carried out a survey with senior engineering man-

agers and leaders [1]. They were asked to point out non-traditional or non-engineering courses and activities that make or could make a difference in their professional lives for attaining a senior-management or leadership position more quickly than otherwise. In its report, the Engineers’ Leadership Foundation recommends that technical education is extremely important for engineers, and this should continue throughout their professional life. However, becoming a leader means developing ‘people skills’, that is, the ability to relate well to other people, and especially to communicate effec-

tively, in writing and orally. Several non-technical courses and activities were cited in this report, such as: public speaking, Psychology, History, Ethics, fraternity, music, internship, theater, public speaking, public relations, social relations, people skills, debating club, drama club, among others.

Newport and Elms [2] carried out a study that observed engineers in the workplace in order to determine which qualities make some engineers more effective than others. The results indicated that engineering educators have to address more areas than simply technical competence if they are to produce highly effective engineers. Characteristics of an effective engineer include, among others, leadership skills and judgment, the ability to handle pressure, keeping calm in crises, high self-esteem, motivation, proactivity, and interpersonal abilities (respect for others' opinions, team working skills, enthusiasm, extraversion, optimism, sense of humor and an open mind). An interesting finding of this research attests that there is not significant correlation between effectiveness and academic performance, that is, effective engineers are not necessarily good academic performers [2]. The authors conclude that many of the characteristics of an effective engineer are learnable, and could be taught within an educational program [2]. Other authors, however, argue that despite the significance of social and emotional skills and several recommendations to include them in the curriculum, universities believe this idea is difficult to implement. One major barrier is the lack of an evaluation model for such skills, which are far more complex than those based on acquiring knowledge [3].

Thus, the university is being called upon to assume a new role to educate and prepare professionals to meet the ever changing demands of the work market [4–8]. The preparation that goes beyond theoretical and technical skills that every profession requires is essential to achieve professional success and to ensure quality of life. Moreover, it is related to lower involvement in risky behaviors such as drugs and alcohol abuse [9]. Undergraduate students, during their courses or future employment, need to know how to deal with the most diverse types of interpersonal situations. Thus, the undergraduate students need to have different social skills because the more developed their social skills the more likely he or she will satisfactorily deal with the demands of different environments and interlocutors.

An alternative for developing interpersonal skills is the Social Skills Training (SST), as inserted in the theoretical-practicum field of Social Skills, which contributes to understanding interpersonal development and to developing strategies for interven-

tion. In this theoretical-practicum field two concepts are crucial: the social skills and social competence. Social skills are understood as classes of social behaviors that have a high probability of generating positive consequences for the professionals (individually or in groups), and social competence is related to the functionality of the behavior regarding positive consequences for themselves and the interlocutors involved in the interaction (instrumental dimension) and to the quality and stability of relationships with others, ensuring greater balance in interpersonal reinforcers (ethical dimension) [10–12]. More specifically in the work context, it can be understood that the professional's social skills are "those that meet the different interpersonal demands in the workplace in order to achieve the goals, preserve the well-being of the staff and respect the rights of each other" [13, p. 89]. For some professions, such as for instance engineers, social skills are associated with better ratings for professional leadership, professional success and greater professional achievement. Regardless of the profession, social skills are associated with higher quality of life, better physical and mental health [13].

In a survey about managerial attributes (traditional intelligence, personality, communication based on emotional intelligence), managers and subordinates from different areas were evaluated regarding their perceived results [6] and the results were that: (i) emotive communication was positively correlated with subordinate satisfaction, and also that communication was a more effective predictor of subordinate satisfaction than the logical-mathematical test, (ii) the logical-mathematical intelligence was correlated negatively with subordinate satisfaction ratings, (iii) self-report level of optimism correlated with subordinate satisfaction, (iv) level of a manager's sociability correlated positively with the overall impression of his/her communication ability. In order to identify a set of relevant skills for Industrial engineers in Brazil, a survey was carried out with company managers and the authors concluded that Industrial engineers are less qualified with regards to the companies' expectations because, according to the managers, the more relevant aspects were the communication and interpersonal skills, considered an essential complement to technical knowledge [14].

The work market requires social skills and social competencies from its professionals, with personal attributes and behaviors increasingly becoming decisive hiring factors and also important for the career [6]. Consequently, a multidisciplinary approach has become even more relevant in higher education as the technical and non-technical fields become increasingly interdependent in society [7].

because they expose students and faculty to ideas, values, and perspectives outside of their own discipline. It is argued that curricula designed with an understanding of multidisciplinary groups, their interactions, and educational effectiveness in groups will be required, in addition to the current curricula focusing on individual performance [7]. It is therefore essential that universities include a broader education for students, covering interpersonal development and capacitating more than just technical skills.

In Brazil, the literature presents some successful experiences of Social Skills Training (SST) of students from different undergraduate courses such as Psychology [15–17], Exact Sciences [18], undergraduate nursing [19] and also students from many other undergraduate courses [20–22]. In general, the results of these studies showed increased social skills after SST and its effect on social relations in different contexts.

A study of the “profile of an engineer” describes the important roles performed by engineers and the key behaviors observed, which are associated with the effective performance of these roles. These “profiles” could assist the university “to clarify practices in their disciplines, design appropriate educational and instruction materials, and associate other disciplines to their own” [23, p. 439]. The results indicated a profile consisting of ten role definitions: analytic, problem-solver, designer, researcher, communicator, collaborator, leader, self-grower, achiever, practitioner [23]. Each role was defined by five professional behaviors. Studies like this can provide the university with tools to restructure the curricula of their engineering courses [23].

Some universities have shown interest in restructuring their undergraduate courses in order to ensure the undergraduate’s social competence [24, 25]. A study [24] proposed restructuring the engineering curricula of the University of Pretoria (South Africa) to meet the changing market demands, illustrating a successful experience to include curricular activities based on a multidisciplinary approach, teamwork and on the improvement of social skills. Another study [6] suggests a methodology to incorporate the subject of social-emotional skills and social competence into undergraduate engineering courses which includes teacher training in social competence and in student-centered learning through peer assistance, support, and mentoring. Others authors [26] studied the impact of a peer tutoring program on the cognitive and metacognitive learning strategies and on the social skills of the mentors of students in their last school year or those in a postgraduate program at the University of Granada (Spain). The results

showed differences that favored the treatment group (in contrast with the control group) on grade point average, performance rate, success rate and learning strategies and, also, statistically significant pre-post differences for the tutors on learning strategies and social skills.

It is observed that universities (specifically engineering schools) have faced difficulties to incorporate the teaching of social skills and social competence to ensure the students develop better skills to deal with the new work market demands, and also to insert social skills in the curriculum of undergraduate courses that involve leadership. Consequently, investigating effective strategies that enable integrating this content into the curriculum has become even more necessary. Therefore, this paper describes two successful experiences of interpersonal development that occurred within the Sao Carlos School of Engineering at the University of Sao Paulo for engineering students: the PRODIP (Interpersonal Professional Development Program) and the academic discipline of social skills and leadership.

2. Interpersonal development for engineering students

In this paper two alternatives are presented: the PRODIP and two formats of academic disciplines. They are briefly described as follows.

2.1 PRODIP

The PRODIP was developed, implemented and evaluated by [8, 15] as a strategy to develop human resources given the demands of the workplace, focused on developing the social competence of professionals. The PRODIP can be applied to different populations such as employees and managers, teachers, community groups, as well as to students in transition from university to the work market [8]. The program is empirically grounded in the theoretical and practical field called Social Skills Training (SST) and uses a specific experiential method [9], characterized by interactive activities, structured in an analog or symbolic format, related to the individuals living in the natural environment [1]. With this method the participants are introduced to interactive situations which are structured to mobilize actions, feelings and thoughts, so that they are required to demonstrate and to improve their behaviors and skills in order to effectively deal with those situations [13]. The PRODIP assumes that people with good interpersonal skills and socially competent are more productive at work, as well as more prepared to contribute towards the improvement of the work environment and the

quality of relationships with bosses, colleagues, suppliers and customers [12].

Social skills can be learned and that is why they can be taught in programs such as PRODIP. According to Del Prette and Del Prette [10, p. 2], the PRODIP aims to: “(a) increase the frequency and/or improve the proficiency of social skills, (b) teach new social skills, (c) reduce or extinguish behaviors that compete with these skills”.

In the university setting, where PRODIP was applied to engineering students, the objective was to complement the training of future professionals, preparing them for the work market. PRODIP was part of the activities related to The Leadership Development Program in Engineering (PROLIDER) offered in last college year to students of two public universities in the state of São Paulo. PROLIDER is a one-year program that includes different courses and activities for the first six months, followed by six additional months of practical professional training in a private company [27].

PRODIP was part of PROLIDER for four consecutive years (2009–2012), administered to four groups of undergraduate engineering courses. Table 1 describes the participants of each PRODIP.

Before applying PRODIP, the social skills of the undergraduate students were evaluated with the Social Skills Inventory (SSI-Del-Prette) [28, 29], which is a self-report instrument consisting of 38 items. This inventory assesses the social skills repertoire by presenting a situation and a possible reaction (socially skilled or not) within different interpersonal contexts (work, leisure and family) with different interlocutors (family, friends, authority, strangers). This instrument is validated and has satisfactory psychometric indicators (internal consistency: $\alpha = 0.75$, test-retest reliability: $r = 0.90$, $p = 0.00$; concurrent validity with Ratus of PRODIP and three months after the end of the PRODIP. This follow-up assessment was not conducted only for the participants of Group 1 (year 2009).

The social skills selected to compose the PRODIP were chosen considering the deficits presented by each student and by each group as evaluated by the SSI-Del-Prette. Some additional social skills were included because they are pre-requisite to more

complex ones (such as assertion and leadership skills) and because they are important skills for further interpersonal development, such as: to observe, to describe, to record, to relate previous behaviors and consequences, to identify links between behavior, thoughts and feelings, and so on.

More specifically, the classes and subclasses of social skills taught in PRODIP included: self-monitoring; demonstrating attention; nonverbal performance; asking and answering questions; starting, sustaining and ending conversation with known and unknown people; gratifying/praising; giving and requesting feedback; introducing yourself; thanking; saying goodbye; talking about yourself; reflecting feelings; expressing support; manifesting one's opinion; agreeing; disagreeing; asking, accepting and refusing requests; apologizing; expressing positive and negative feelings; requesting behavioral changes and dealing with criticism; interacting with authority; talking in public; working in teams; coordinating groups; solving problems; making decisions; mediating conflicts; making friends; expressing solidarity and cultivating love. Each of these social skills was trained in its functional (effectiveness) and topographic dimensions (molecular components such as eye contact, facial expression, gestures, vocal modulation and so on).

The sessions included theoretical and practical activities. The theoretical sessions were carried out using oral presentations, content projections in power-point and video presentations, complemented with spontaneous participation and/or dialoguing with the whole group. The practical activities were composed of analogous or symbolic experiential situations, some of them adapted considering the specific group of participants and the emphasis on the work context. The practical activities also included role-playing situations likely to occur in the workplace. All the sessions were supported by cognitive and behavioral techniques such as modeling, shaping, differential reinforcement, instruction, oral feedback, video feedback and homework. Throughout the years of the program, PRODIP was conducted by the same psychologist experienced in training groups with social skills.

2.2 Academic discipline of social skills and leadership

After the success of PRODIP with its effect on the participants of PROLIDER, the coordination of the Industrial Engineering course requested the scope of the program be extended to all students, not just the participants of PROLIDER. Initially, the proposal of a short course was tested, this consisted of three four-hour meetings, totaling 12 hours, which covered topics that included social communication, assertiveness and working skills.

Table 1. Description of participants in each PRODIP

Group (year)	Number of students	Mean Age	Sex
Group 1 (2009)	16	22.81	3 F and 13 M
Group 2 (2010)	9	23.44	4 F and 5 M
Group 3 (2011)	7	22.28	5 F and 2 M
Group 4 (2012)	8	23	1 F and 6 M

Note. F = Female; M = Male.

Nineteen 2nd to 5th year undergraduate students of the Industrial Engineering course participated in this course and at the end of the course they received a certificate of participation.

After the positive evaluation of the students who participated in the short course, the inclusion of an elective course was tested in the Industrial Engineering curriculum, focusing on thematic interpersonal relationships, this consisted of 15 lessons and included the following topics: learning, behavior and environment, interpersonal relationships in the work context, concepts and social skills learning, self-monitoring, social skills components (non-verbal, paralinguistic and verbal), communication social skills (demonstrating attention; nonverbal performance; asking and answering questions; starting, sustaining and ending conversation with known and unknown people; gratifying/praising; giving and requesting feedback), social skills of civility (introducing yourself; excusing, asking by saying please; thanking; greeting; saying goodbye); social skills to express positive feelings (making friends; expressing solidarity and cultivating love), empathetic social skills (paraphrasing; reflecting feelings; expressing support). The course also focused on a long list of more rigorous working skills, such as manifesting one's opinion; agreeing; disagreeing; asking, accepting and refusing requests; apologizing; expressing positive and negative feelings; requesting behavioral changes and dealing with criticism; interacting with authority, talking in public; working in teams; coordinating groups; solving problems; making decisions; mediating conflicts, managing interpersonal conflicts, stress and work, and also leadership.

In each class, theoretical aspects were articulated to practical training in social interactions such as teamwork, role-play, experiential situations and interpersonal homework. In addition, several videos and film clips were used to illustrate the appropriate and inappropriate performance in social interactions. The academic discipline had the participation of 29 2nd to 5th year Industrial Engineering undergraduate students, mostly 2nd year students. With regards to the discipline, the

students were continuously evaluated by means of academic home works, by group and/or single activities in the class and, at the end of the discipline the students were evaluated by their analysis of a film relating to the work context.

3. Main results

3.1 PRODIP

Concerning the PRODIP results, simple analysis of variance (ANOVA) was conducted to compare the groups in relation to their pre-test scores. This analysis indicated that there was no difference in the groups' pre-test scores. Given this, the students of the four groups were combined into a single group to perform statistical analyzes to compare their evaluations by analysis of variance (ANOVA) for repeated measures with Bonferroni post hoc tests. Table 2 describes the descriptive data in each evaluation using the SSI-Del-Prette.

The results showed that the differences between the conditions are not due only to sampling error, but are from the PRODIP intervention, such as in *Total score* ($F_{(2,69)} = 9.92; p = 0.000$) with differences between pretest and post-test ($p = 0.001$). Also, there were differences between evaluations in the indicator called *Coping and self-assertion with risk* ($F_{(2,69)} = 7.12; p = 0.002$) between pretest and post-test ($p = 0.006$); in *Conversation and social confidence* ($F_{(2,73)} = 3.61; p = 0.034$) between pretest and post-test ($p = 0.05$) and in *Self-exposure to unknown people and new situations* ($F_{(2,68)} = 8.56; p = 0.001$) in pretest and post-test ($p = 0.002$).

In all years, PRODIP was positively assessed by the undergraduate students, with a high level of satisfaction and impact on their professional and personal lives. In a final assessment performed by the undergraduate students, all of them reported higher grades.

3.2 Academic discipline of social skills and leadership

Regarding the short social skills course, at the end of the course the students evaluated it with the follow-

Table 2. Descriptive data (mean and standard deviation) of undergraduate students on pre-test, intermediate, post-test and follow-up evaluations using the SSI-Del-Prette

Indicator	Variation	Pre-test \bar{X} (SD)	Inter-test \bar{X} (SD)	Post-test \bar{X} (SD)	Follow-up \bar{X} (SD)
Total Score	0-137	99 (17.64)	105.3 (14.89)	109.5 (13.08)	116.5 (14.10)
F1—Coping and self-assertion with risk	0-18.2	11 (2.69)	11.8 (2.53)	12.3 (2.22)	13.2 (2.04)
F2—Self-assertion in the expression of positive affect	0-11.7	8.5 (1.81)	8.8 (1.52)	9.1 (1.44)	9.6 (1.40)
F3—Conversation and social confidence	0-9.62	7 (1.54)	7.6 (1.04)	7.7 (1.04)	8.2 (1.21)
F4—Self-exposure to unknown people and new situations	0-5.82	4.2 (1.28)	4.6 (0.88)	4.8 (0.73)	4.8 (0.82)
F5—Self-control of aggressiveness	0-2.53	1.2 (0.64)	1.3 (0.44)	1.3 (0.55)	1.2 (0.47)

Notes \bar{X} = Mean; SD = Standard deviation.

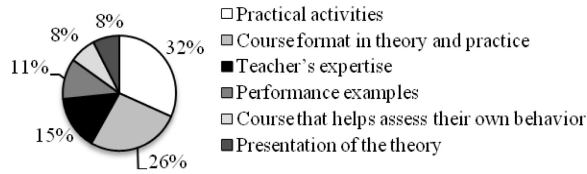


Fig. 1. Main strengths reported by students of the short social skills course.

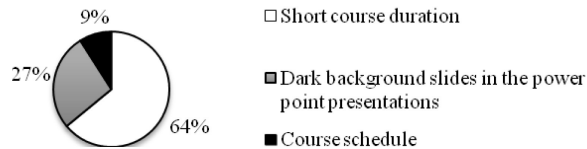


Fig. 2. Weaknesses reported by students of the short social skills course.

ing questions: (i) how much they had enjoyed the content, (ii) how much they had enjoyed the teaching strategies, (iii) how much they had enjoyed the resources (videos, power-point, activities in class, quantity and quality of the texts, readings), (iv) expertise, (v) their own performance, and (vi) the main strengths and weaknesses of the course. For questions (i) to (iv), the students responded according to a scale with the following response options: excellent, good, fair, bad and very bad. The questions (v) and (vi) allowed free responses.

Concerning the content of the course, the students responses ranged from excellent (58%) to good (42%). The evaluation of teaching strategies was excellent (84%) and good (16%). The students evaluated the resources as excellent (32%), good (58%) and regular (10%). Regarding expertise, 84% evaluated this as excellent and 16% as good. About their own performance, all students reported that they could have been better. The strengths reported (for more than two students) by the students of the course are in Fig. 1 and the answers about the weaknesses are in Fig. 2.

Regarding academic discipline, primarily in relation to the students' academic evaluation through activities and final evaluation grades, it is emphasized that no students received below average grades. At the end of the course an assessment was also carried out to identify: (i) how much they had enjoyed the content, (ii) how much they had enjoyed the teaching strategies, (iii) how much they had enjoyed the resources (videos, power-point, activities in class, quantity and quality of the texts, readings, home works), (iv) expertise, (v) the importance of the discipline in the course grade, (vi) evaluation of their own performance, and (vii) the main strengths and weaknesses of the course. Similarly to the evaluation of the short course, in relation to questions (i) to (iv), students responded accord-

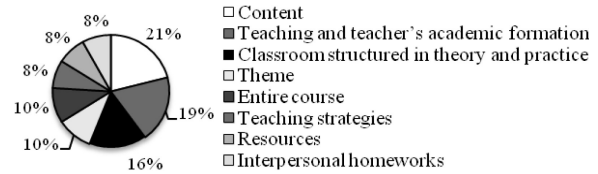


Fig. 3. Main strengths reported by students of academic discipline.

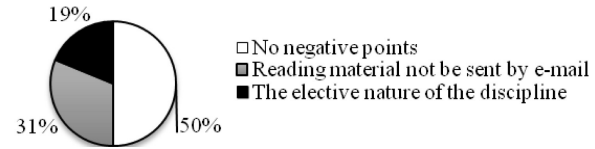


Fig. 4. Weaknesses reported by students of academic discipline.

ing to a scale with the following response options: excellent, good, fair, bad and very bad. Item (v) had a scale with the With regards to the students' evaluation of the content of the discipline, the answers ranged from excellent (72%) to good (28%). Regarding teaching strategies the responses were excellent (71%) and good (29%). On resources, students evaluated these as excellent (73%) and good (27%). About the expertise, the answers ranged from excellent (84%) to good (16%). Regarding the importance of the discipline the answers ranged from very important (46%), essential (43%) to important (11%). About their own performance, all students reported that they could have been better. The strengths reported for the discipline are illustrated in Fig. 3 and the answers about the weaknesses are in Fig. 4.

4. Discussion and future issues

The results of PRODIP indicated that there was an improvement in the *Total score* after the intervention and in three indicators of SSI-Del-Prete, specifically in skills that require assertion and defense of rights and self-esteem, communication skills, and self-exposure to strangers or new situations. The improvement, therefore, involved communication skills, assertiveness and anxiety control, all them important to deal with the current demands of the workplace [6, 14, 23, 24, 30]. Another important result in this case was maintaining these acquisitions in the follow-up evaluation, some even improving a little more. This kind of data represents very important indicators regarding the effectiveness of the program [31].

The academic discipline for social skills was not only positively evaluated for its content on interpersonal relationships, but also because its format joined theoretical and practical activities. Such a

format, besides appreciated by the students, also enables the students to learn other behaviors through the analysis of films and videos, group activities, observation and description of their own behavior and of their colleagues, performance feedbacks, and others. Some studies are also concerned with how to teach social skills, trying to extrapolate the traditional teaching model [6, 26].

The PRODIP reported in this paper was part of the Internship Program (PROLIDER). Therefore it was designed for the last undergraduate year of the Engineering course. Thus, in the future the impact of a program such as PRODIP could be investigated for students in the middle of the Engineering course and determine its effect on student performance in subsequent academic disciplines, on group work and internships. For this, studies with experimental control could be designed (control group and placebo, for example).

A proposal to be tested is joining the academic discipline of social skills with PRODIP. Initially, an academic discipline of social skills could be provided to new students and then, at the end of the engineering course, offer PRODIP. Thus, this could ensure all students receive interpersonal relationship skills, and those who want and/or need this would have the opportunity to improve their own social skills.

Currently, the importance of incorporating interpersonal skills into undergraduate courses seems to be increasingly evident, mainly in engineering courses, as demonstrated by several researchers [3, 4, 6–8, 14, 23, 24, 32]. However, there is also a question about how the university could implement such content to the curriculum [3] given the research strategies that enable the inclusion of this theme.

The partnership between the Production Engineering Department at EESC-USP and the Research Group on Interpersonal Relationship and Social Skills (RIHS) at the Psychology Department of The Federal University of Sao Carlos (UFSCar) has been perceived as a key-factor to enable implementing social skills in engineering students. This partnership has been tested for ten years, with last year students (internship), however in the last two years this initiative spilled over into the industrial engineering course at EESC. As shown by the results of this paper, the students have accepted and positively evaluated a social supplement in the course curriculum. The current overall situation of Sao Carlos School of Engineering is very promising because several discussions have emerged about changing the curricula.

Currently the Sao Carlos School of Engineering (EESC) has ten engineering courses and receives about 500 new students every year. The EESC belongs to the University of Sao Paulo, the best

university of Latin America according to Webometrics Ranking of World Universities, CSIC, 2011 [33]. Consequently, the engineering courses at USP are expected to provide high-level engineers for Brazilian and foreign companies and other organizations. Many of these students will be hired for managerial or leadership positions in the short to medium term. Hence, we believe that newcomer engineers from USP have to perform successfully in their job positions, in other words with technical expertise added to managerial and leadership competences. The Interpersonal Professional Development Program has demonstrated its ability to develop such skills in the EESC engineering students.

Finally, the integration of psychology and engineering offers the research groups in both areas (namely the Research Group on Interpersonal Relationship and Social Skills at UFSCar and the Research Group on Quality and Change Management at EESC-USP) opportunities to develop further research in themes such as: leadership in engineering, social skills for engineering, engineering education, and so on. This paper is a productive result of such interdisciplinary partnership.

5. Conclusions

In the case of PRODIP, the training was effective to improve and maintain the students' social skills, as well as to better qualify them for the job market. The academic discipline opened the possibility to discuss the importance of developing interpersonal skills and also to teach some alternatives to adequate professional performance. It should be noted that in both situations the engineering students positively evaluated the strategies adopted by the university.

Lastly, the experiences reported on teaching social skills to engineering undergraduate students, both in the PRODIP training format or as an academic discipline, can be configured as successful strategies to enhance the university student's interpersonal development. This development will surely improve their working skills as well as contribute to their psychological health and to the organizational environment.

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