DEVELOPING TRANSVERSAL COMPETENCES IN ENGINEERS

Juliana de Melo Bezerra, Cristiane Aparecida Martins, Lara Kühl Teles,
Neusa Maria Franco de Oliveira, Maria Margareth da Silva, Leila Ribeiro dos Santos
and Raquel Caratti Piani
Instituto Tecnológico de Aeronáutica – ITA, São José dos Campos – SP, Brazil

ABSTRACT

The development of transversal competences is essential for the success of engineers, who need to have the ability to adapt to the new and changing demands posed by modern society and scientific advances. It is a challenge for professors to teach and evaluate transversal competences, since such competences are related to attitudes and values. We present a program, held in an Engineering school, with the goal of motivating young people in STEM (Science, Technology, Engineering and Mathematics) areas. Results from the designed initiatives pointed to success in the development of transversal competences, including problem solving, communication, leadership, teamwork, self-management, creativity and innovation.

KEYWORDS

STEM, Education, Non-Cognitive, Competences, Engineering, Student

1. INTRODUCTION

Other than the well-known need for technical knowledge, it has become increasingly important for engineers to improve their social skills and attitudes for professional purposes. This is known as transversal competence. Engineers need to have the ability to adapt to the new and changing demands posed by modern society and scientific advances. Such competences can even improve the chances of employability by influencing the selection of one candidate over another in the labor market. Transversal competences contribute to a more flexible workforce capable of adapting more quickly to the constant changes that occur in an increasingly interconnected world (Rico et al, 2013; Linares et al, 2015).

There are different categories of transversal competences, for instance: cognitive, methodological, linguistic, individual, and interpersonal skills. Cognitive skills rely on the ability to understand and use thoughts and ideas. Methodological skills include time management, learning strategies, decision making, and problem solving. Linguistic skills encompass both oral and written communication. Individual skills are related to the ability to express feelings or perceptions of an issue. Interpersonal skills include the ability to work in a team, and express ethical or social commitments in a socially appropriate way (Rico et al, 2013). Yanaze and Lopes (2014), when studying the job market in the electrical and computer engineering area, identified the need for the following key transversal competences: communication, teamwork, leadership, problem-solving and analysis skills. Prinsley and Baranyai (2015), while investigating the importance of skills in marketplace, highlighted transversal competences such as critical thinking, problem solving, interpersonal skills, and time management.

Universities recognize the importance of the study program design and its relation to the professional profiles and the competences or skills needed, including transversal competences. Transversal competences are not directly related to the theoretical content of the curricula, but to attitudes, values and procedures. It characterizes a challenge for professors to teach and evaluate such competences (Rosa et al, 2013; Linares et al, 2015). In this paper, we focus on the following transversal competences: problem solving, communication, leadership, teamwork, self-management, creativity and innovation. We present a program held in an Engineering institute in partnership with a health-care company. The primary goal of the program was to foster STEM (Science, Technology, Engineering and Mathematics) education for young people as well as incentivizing our engineering students in STEM areas. Initiatives were then designed to maintain the goal of the program, while supporting the development of transversal competences of our students.

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2. A PROGRAM TO SUPPORT TRANSVERSAL COMPETENCES DEVELOPMENT

In this section, we describe the initiatives performed during the program, over a period of 8 months, and the associated results related to the acquisition of transversal competences.

2.1 Program Initiatives and Transversal Competences

The team was composed of six professors, one professional communicator and 34 undergraduate students. Students had to participate in three social initiatives. One social initiative was the promotion of events with the objective of developing transversal skills of the program students. The other two social initiatives, lectures and workshops, aim to spark in children (in middle and high schools) an interest in STEM. Lectures (lasting one hour each) were conducted in schools, while workshops (with duration of three hours) were held in our institute. During 2017, the undergraduate students gave 40 lectures, to a total of 1,586 students aged between 10 and 19 years-old. The workshops were divided into: 'reused workshops' and 'new workshops'. During the first semester, the students selected six workshops already established in 2016 and submitted each one to 120 children. In the second semester, the students defined eight new workshops and applied at least one of them to 240 children. Three events were held just for students on topics such as financial education, professional behavior, and careers in STEM. A specific event regarding leadership, which was open to our community, was also promoted with the presence of speakers discussing the theme in a round table debate.

The way social initiatives were conceived and managed aided students to develop important transversal skills, including problem solving, communication, leadership, teamwork, self-management, creativity and innovation. In our program, students were in charge of all decision making, providing an interesting place to exercise problem solving. Problem solving includes the ability to gather and integrate information, identify alternatives, select the best solution, and evaluate the consequences (Salas et al, 2000). In lectures, students had to prepare or identify materials (presentations or videos), choose the school and schedule the lecture itself, along with evaluating the lecture. In workshops, students needed to develop a hands-on activity clearly stating STEM concepts and desired practices, select the public who would participate, organize the day on which to perform the workshop, and finally to evaluate it. In events, students had to select topics of interest with program participants, to identify and invite people to talk about such topics, to organize the day of the event itself, as well as evaluating it.

During our program, students worked in teams, characterizing the competence of teamwork, but also involving leadership and communication skills. Teamwork can be defined as the set of interrelated behaviors and actions that occur among team members while performing a task. Leadership is the ability to direct and coordinate activities of other team members, assign tasks and motivate team members. Communication considers the process by which information is clearly and accurately exchanged between two or more team members (Salas et al, 2000). Communication was essential for making the program initiatives feasible. Leadership was practiced in two dimensions by students: inside and outside the group. Leadership inside the group was naturally expected. Leadership outside the group includes the interactions needed to performed initiatives, for instance: to be a leader of a group of children during lectures or workshops, and to be the leader of the organization of an event given the interface with lecturers and the public.

Self-management is about knowing what to do at any given moment, including other critical skills such as initiative (being able to work without always being told what to do), organization (plan time and things to do), responsibility and accountability (Bernd, 2008).Since students had to organize themselves in order to provide results for the program by respecting goals and deadlines, and also to conciliate their participation in the program with their academic demands, an improvement in self-management was a likely outcome. We worked based on self-directed work teams and distributed decision making. Creativity is the ability to produce original ideas and items, as well as the combination of existing work and objects in different ways for new purposes. From the viewpoint of engineering education, it is very important to have innovative engineers, since they contribute creatively to design items, processes, and services to meet society demands (Kanematsu and Barry, 2015; Catarino, P. et al, 2016.). In our program, students could train their creativity and innovation, as students needed to be inventive to design lectures, workshops and events to motivate and involve the public.

2.2 Results

We invited students that conducted the program in 2017 to evaluate their participation regarding the developing of transversal competences when participating in the following initiatives: lectures, reused workshops, new workshops, and events. We had 23 respondents to the evaluation questionnaire. Firstly, students evaluated the degree of involvement in the performed activity using a 5-point scale ranging from 1 (poor) to 5 (excellent). The resultant median was 4 for all initiatives, meaning that students had a high degree of involvement in the program. Following that, students used a 6-point Likert scale (with the values: strongly agree, agree, slightly agree, slightly disagree, disagree, and strongly disagree) to assess the sentence "As result of the initiative participation, I developed or enhanced my competence" to each transversal competence: problem solving, communication, leadership, teamwork, self-management, creativity and innovation. Results are shown below. Figure 1a shows the degree of agreement regarding the development of transversal competences when working on the 'lectures' initiative. Figure 1b, Figure 1c and Figure 1d present results respectivelly regarding 'reused workshops', 'new workshops' and 'events'.

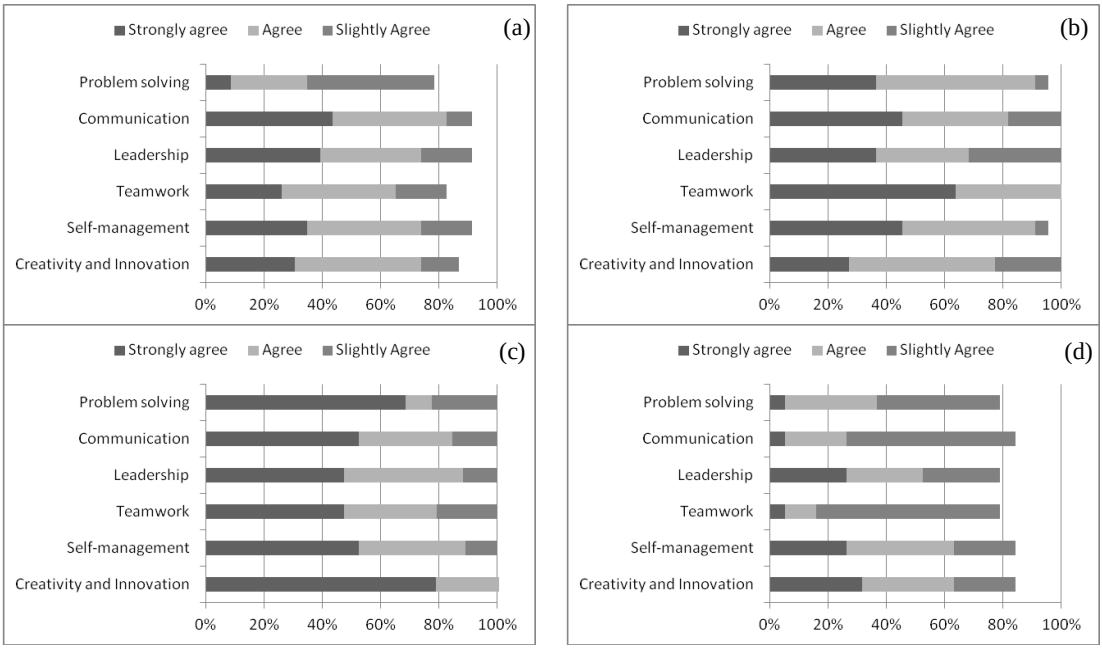

Figure 1. Transversal competences developed in (a) lectures, (b) reused workshop, (c) new workshops, and (d) events

According to the students' feedback, all initiatives contributed substantially to the development of transversal competences. Comparatively, workshops were more effective than lectures, which in turn were more effective than events. The low performance of 'events' was in part expected, since the students that organized this initiative could experience better outcomes, while students that only attended events only acquired knowledge and expertise from speakers. We believe that there is potential here to have other kinds of more formative events and not only informative ones, in order to work with students and advance their competences. 'Lectures' initiative had good results especially regarding communication, leadership, and self-management. With the continuation of the program, if students started to reuse materials, we may experience a reduction in items such as creativity and innovation, so it is important to continuously stimulate students to reinvent the way of giving lectures.

'Workshop' initiatives were the best way to foster transversal competence, as can be seen by the rate of 'strongly agree' answers. An interesting difference in results lies between 'reused workshops' and 'new workshops'. 'New workshops' were more effective to develop problem solving, and creativity and innovation, since students had to create different strategies and define an authentic hands-on activity. In the 'reused workshops', students had to learn about an existent workshop, so they practice competences but not to the same extent. Teamwork competence was well evaluated in 'reused workshops', not only because of the need to interact with other students who had created the workshop, but mainly due to the number of times

they performed the workshop for children. Despite the potential preference of students for 'new workshops', the 'reused workshops' initiative is a strategy to keep promoting workshops for the community while new workshops are being created. In this way, the program can achieve better results in terms of number of children involved. The revision of workshops is also an important activity, in order to improve material related to workshops, aiming to minimize errors and doubts when other people reproduce them. It is also critical to maintain new workshops, due to the diversity that they bring to our portfolio.

3. CONCLUSION

The program presented is an example how to help students apply the technical knowledge and skills while also activating problem solving, communication, leadership, teamwork, self-management, creativity and innovation. We believe that such skills support students to make appropriate and effective choices toward achieving career goals related to STEM during and after university. In the coming versions of the program, we hope to stimulate the reinvention of current initiatives by including other types of activities, such as bringing workshops to public spaces. We also intend to propose new initiatives, such as mentoring programs for children, as well as the formation of a network of practitioners that share the program goal of fostering STEM education. We believe that these challenging actions are likely to support our students in developing their transversal competences. We argue that, based on the program outcomes stated in this paper, it is possible to reflect how engineering schools can stimulate the development of transversal competencies by proposing new programs, not only focusing on research, but also by including an extended mission of schools aligned to the needs and demands of society.

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