Creativity and job tension in experiential learning

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***Abstract*— This work-in-progress research paper presents a study on employability skills. Employability or soft skills refer to personality traits, attitudes and behavior that are complementary to professional knowledge. These skills are part of a series of competencies that are intertwined with the engineer's technical work** [1]**. A high percentage of job success depends on employability skills** [2]**. A gap exists between the attributes of engineering graduates and company requirements** [3]**. Experiential learning can develop a myriad of skills required by the workplace. Universidad EAFIT, located in Medellin (Colombia), has developed an experiential learning program called KRATOS. KRATOS was sent an invitation to participate in an international competition that implied designing and building a solar/electric powered vehicle. Think creatively is a competency that is important for engineering practice across areas, disciplines and countries** [1]**. Although student competitions that include design activities may enhance a passion for engineering, they can also have negative emotional consequences** [4] **(i.e. job tension). Using the structural equation modeling technique, the authors of this study analyzed the responses of 334 undergraduate students. The results of the study indicate that job tension significantly decreased over time, whereas no significant change was detected in terms of creativity.**

Keywords: Experiential learning, creativity, job tension, soft skills, engineering education

I. INTRODUCTION

The technical knowledge imparted by the universities nowadays is insufficient, in and of itself, to account for the success of graduates in the job market. Soft skills are becoming increasingly more important for employability in today's companies. Soft skills are usually referred as employability skills, and are related to an individual's perceptions about present and the future conditions and how they expect to deal with those positive or negative circumstances [5].

The Conference Board of Canada defines these as the skills a person needs to possess to enter, keep or progress in the working world [6]. The basic soft skills according to Gainer, and cited in the Educational Resources Information Center, are: individual competencies (communication skills, comprehension, computation and culture), personal reliability skills (personal management, ethics), economic adaptability skills (problem solving, learning, career development) and group and organizational effectiveness skills (interpersonal skills, organizational skills, negotiation, creativity and leadership) [7].

Companies have stated that a gap exists between the attributes of engineering graduates and company requirements [3]. There is a clear need to improve these soft skills in university contexts and some of the techniques used to do this include case studies, role playing, business games, corporate analysis and group discussions, among others[2]. EAFIT University has developed an experiential learning program called KRATOS. KRATOS facilitates the enrollment of students in international competitions in order to foster their potential.

Based in extant literature on experiential learning, the authors of this work-in-progress research paper posit that competitions are a good scenario to develop the students' soft skills such as creativity and job tension management. Specifically, previous research has shown that experiential learning and student competitions that require design activities may enhance creativity [8] and passion for engineering but can also have negative emotional consequences [4]. In this study, creativity and job tension were measured at two time points in students that participated in an international challenge aiming at designing and building a solar /electric vehicle.

A. Experiential learning

Engineering education is framed by a dynamic effort in which learning pedagogies continuously evolve with the goal of improving the educational experience [9]. This perspective has created a fertile environment for the appearance and application of new approaches, including experiential learning [10]. This theoretical and conceptual proposal maintains that knowledge is created through a transformation of experience, resulting from a combination of acquired experience and its evolution, emphasizing the potential for discovery individual learning [11]. This implies the existence of learning situations characterized by a high degree of active and immersive participation [12].

Developed based on the contributions of psychologists such as Piaget and Dewey, experiential learning theory contemplates a holistic model of the learning process [13]. It proposes a four stage ongoing cycle involving concrete experience, reflexive observation, abstract conceptualization and active experimentation [14]. Thus, the experience/activity becomes the starting point for the creation of knowledge, which requires previous reflection and understanding of general underlying principles to materialize the conceptualization and validation of the theory, model or hypothesis analyzed [15].

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The literature acknowledges the contribution of experiential learning in terms of people's commitment, reflection and active participation [16], [17]. It also refers to long term knowledge appropriation and learning in students [18], [19]. On the other hand, it highlights its effects on developing multiple skills that are inherent to the workplace. [20], [21].

B. Soft skills

The dynamics of the environment have derived in new employment trends and expectations in the job market [22]. This has made necessary the promotion and adoption of a set of previously unexplored skills within the spectrum of engineering education [23]. Employability or soft skills refer to personality traits, attitudes and behaviors that are complementary to professional knowledge [2]. These skills are part of a series of competencies that are intertwined with an engineer's technical work [1].

A high percentage of job success depends on employability skills [2]. Employers do not simply identify talent with technical competencies: they also evaluate skills such as communication, leadership, teamwork, problem-solving and decision-making [24]. Personal attributes (individual personality traits, motivation, emotional intelligence and self-efficiency) are another critical factor during talent selection processes [25].

The literature refers to the existence of a gap between the attributes of engineering graduates and company requirements, pointing out a lack of alignment between the skills developed during their university studies and the skills required in the workplace. [3]. This situation answers to a difference of priorities and perceptions. While employers emphasize the importance of skills like creativity, personal communication, decision-making and problem-solving during candidate selection, engineering students tend to focus on the acquisition of the knowledge and technical skills inherent to their discipline [26]. In light of the relevance of the use of teaching strategies that will foster the acquisition of multiple soft skills, the following is a definition of the concepts of creative thought and job-related stress, the specific objects of analysis of this research:

C. Creativity

Creativity, in an organizational context, refers to the generation of novel and potentially useful ideas [27]. This is a process through which ideas are conceived: a process of reinvention and redefinition the underlying purpose of which is to find original solutions [28]. Creativity plays a fundamental role in overcoming obstacles and occurs in situations that require novel solutions [29], [30]. Creativity has been incorporated into the specific field of engineering education, highlighting its importance for problem solving. [31]. In this regard, the literature alludes to the efforts made for developing approaches that will systematically improve student creativity. These approaches include innovative teaching techniques [32], [33], creative design heuristics [34], and workspaces for fostering new ideas [35].

D. Job-related stress

Job-related stress arises from an interruption of an individual's cognitive-emotional system and/or natural balance by external demands within the working environment [36]. Over time, this stress can have negative effects on people's mental and physical health [37]. Additionally, job-related stress influences people's results and levels of satisfaction, as a result of the exhaustion of their mental and physical resources [38], [39]. The literature has discussed the stress experienced by different types of work-related tasks [40]. The evidence indicates that a relationship exists between physical health, psychological wellbeing and work satisfaction [41]. It also alludes to excessive workloads, ambiguous roles, unpaid overtime, changing technology, financial pressures and customer demands as some of the most frequent and significant causes of stress [42].

II. METHOD

A. Sample and Procedure

The researchers measured creativity and job-related stress at the beginning (t0) and halfway through (t1) the experiential learning project (4-month gap). Data provided by 334 undergraduate students who voluntarily responded to an online survey were analyzed. Personality traits or academic requirements were not considered requirements for participation in the competition. Participants mean age was 20.5 years (SD = 3.07). 51.6% of respondents were women.

B. Measurements

The original versions of the measures were developed in English. To ensure the adaptability of the scales, all measurements were back translated using the procedure suggested by Schaffer and Riordan [43], and adapted to the educational context. The measures were selected having into account their reliability.

Creativity (CREA) was evaluated using 6 items of Zhou and George's scale [44]. The measure demonstrated excellent reliability ($\alpha > .96$). Participants entered their responses using a five-point Likert scale. Sample items were: "Suggest new ways to increase quality"; "Come up with new and practical ideas to improve performance". Perceptions of job tension (PJT) were assessed using 6 items of House and Rizzo's [45] measure. In a recent three-study research [39], the scaled showed excellent reliability ($\alpha > .84$). Participants manifested their level of agreement with the statements using a five-point Likert scale. Sample items are: "I study under a great deal of tensions", and "Problems associated with my assignments have kept me awake at night".

C. Analysis

Mplus v.8 [46] statistical package was used to analyze the data. The structural equation modeling technique was adopted to test measurement invariance for the scales while simultaneously evaluating latent differences and correlations between scores. The researchers selected the Exploratory

Structural Equation Modeling (ESEM) approach to test time invariance and compare latent means. ESEM was used since the model included non-observed variables (i.e. CREA and PJT) that to date had not been used in the context under study. Specifically, they tested an ESEM model at two-time points with factor loadings set to equality and correlated item residuals over time. The latter to account for the model's longitudinal character.

The study's hypotheses were the following:

H1: Participation in the solar/electric powered vehicle reduces student PJT

H2: Participation in the solar/electric powered vehicle increases student CREA

Since the authors could not identify a variable related to the missing data, they were was managed using the Missing Completely at Random (MCAR) approach. The Maximum Likelihood Estimator (MLE) and CF-Varimax (orthogonal) rotation were employed. The MLE was selected given that the data complied with the assumption of normality (i.e. skewness and kurtosis of all the observed variables were between -2 and 2 [47]). Since no relationship was hypothesized between CREA and PJT, the researchers selected an orthogonal rotated solution. The following coefficients were used to assess overall model fit: Chi square test of model fit/Degrees of freedom ratio ($\chi 2/df$) and given the high number of parameters the Root Mean Square Error of Approximation (RMSEA), instead of the Comparative Fit Index (CFI). The researchers adopted the rule of thumb for RMSEA suggested by Hu & Bentler (RMSEA < .06) [48]. The critical value of < .40 for factor loadings was taken from Hair, Black, Babin, & Anderson [49].

III. RESULTS

The results show time metric invariance for both measures. The model (see Figure 1) obtained acceptable goodness of fit coefficients ($\chi 2/df < 2$; RMSEA = .05).

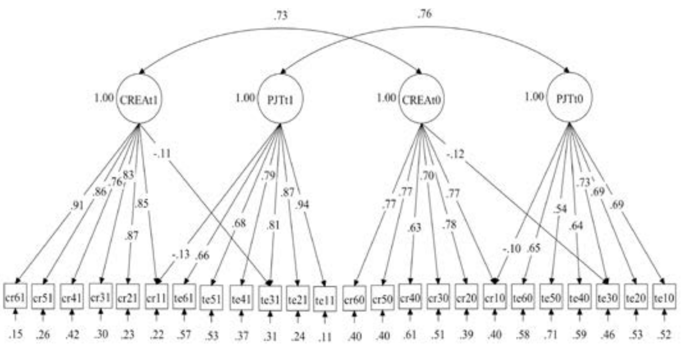

Figure 1 ESEM model at two time points

As shown in Figure 1, CREA at time 1 was positively correlated with CREA as measured at time 2. PJT at t1 and t2 were also positively correlated. Summarizing, both scales are useful to assess creativity and perceived job tension in the context of experiential learning implying design activities. The researchers also found full support for H1; PJT decreased when latent mean scores at t0 and t1 were compared (Mt1 = -.37, $p < .05$). Although positive, the latent mean difference in creativity was non-significant (M =.16, $p > .05$). Therefore, H2 was rejected.

IV. DISCUSSION AND CONCLUSIONS

Non-technical skills cannot be taught in isolation from the technical context in which they will be used, and engineering education needs a greater connection with practice from the initial stages of the curricula [1]. Additionally, companies now demand more of professionals: not just the knowledge shared within the classroom and the technical skills to perform the job, but also the necessary soft skills that will increase the probabilities of success in the workplace. Unfortunately these skills are not developed in the classroom when using traditional educational practices. Hence, the learning process needs to be revitalized through the incorporation of new strategies. These include projects that will make students face real challenges, learn by doing, and acquire self-knowledge. Also, students would develop soft skills for dealing with difficult situations and working with others, while being pressured by deadlines, imminent loss of resources, and competing in contests, among others [32], [33], [34], [35].

In this study, the authors inquired if and to what extent employability skills such as creativity and job stress management changed over time in students participating in a competition. The students are part of KRATOS, a program conceived to facilitate the enrolment in experiential learning activities with the aim of enhancing the development of employability skills. It is directed to all students of Universidad EAFIT disregarding their studies.

The results of this study suggest that student job-related stress is reduced when participating in experiential learning projects. This could be attributed to the fact that students are more familiar with the tasks and performed roles at time 2 than at time 1. It is important to point out that the project still has several months to go before conclusion, so further measurements may not reveal a reduction in job-related stress and stress levels may therefore increase during later stages of the project [36].

At the beginning of the project, roles, functions, resources and schedules were established, and engineering students were in the initial phases when deadlines seem far away and big budget has been assigned to the project. Perhaps, as time and resources start to run out and deadlines approach, job-related stress could increase, simultaneously affecting team work, resilience, emotional intelligence, creativity, and other soft skills being measured during the project.

As for creativity, the hypothesis of enhancing this soft skill was rejected. This could be explained by the fact that during early project stages there are no complex problems to solve [29], [30]. Resourcefulness is not yet needed when all resources are still available at the start of the project. Idea generation [27] takes place during all stages, but it is most needed when crucial design functions begin to appear.The measurement of other soft skills could provide a better analytical framework for drawing conclusions about the success of this experiential learning project in engineering students. Both creativity and job-related stress, can be brought together and compared to emotional intelligence, team work, communication skills, leadership, resilience, or other soft skills. This would enrich the study by delivering more complete and complex information from which to extract cause-effect relationships or correlations that can lead to implementing actions for improving the pedagogical strategy.

These kinds of experiential learning scenarios doubtless offer many benefits to engineering students, but the university is also being forced to rethink and reflect on its teaching practices, its curricular design, and its pedagogical tools so as to offer experiences that will develop the type of skills companies are requiring in addition to the technical knowledge imparted in the classroom.

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