STUDENTS' STRESS AND SATISFACTION IN CDIO EXPERIENCES: FINDING THE BALANCE

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ABSTRACT

The Conceive-Design-Implement-Operate (CDIO) educational framework has been revolutionizing the world of engineering education since its inception at the beginning of this century. Its approach to business reality, encouraging comprehensive and contextualized project-based learning, has been the subject of numerous praises in recent years. However, working within CDIO initiatives requires maturity on the part of the students, who go from working individually to being part of a team, with the management of conflicts that this transition entails. This new way of working, together with the imposition of delivery dates and the fact of facing new design challenges, which students tend to approach in too many cases through a trial and error strategy, can lead to a higher workload and relevant doses of stress. This workload stress needs to be compensated by the levels of students' satisfaction, especially as regards their understanding of the learning process and gained outcomes so that the experience can be considered successful in terms of its positive impact on students. This study seeks to assess students' satisfaction and their relationship with the workload they face. The assessment is done in a set of interwoven courses (Bioengineering Design and MedTech) related to the development and delivery of technological solutions for health challenges. These courses are respectively included in the Master's Degree in Industrial Engineering and the Master's Degree in Engineering Management at the ETSI Industriales from the Universidad Politécnica de Madrid. The results show that if students feel supported by the group of professors participating in the subjects, their level of satisfaction is very high, regardless of the workload stress, which is not perceived so high. The CDIO methodology is thus reinforced, establishing itself as a set of practices that bring the future engineers closer to their next steps in professional life through a satisfactory process.

KEYWORDS

CDIO as Context, workload stress, students' satisfaction, Project Based Learning, Biomedical Engineering, Standards 7, 8, 11, 12

INTRODUCTION

The Conceive-Design-Implement-Operate (CDIO) educational framework is an international initiative in revolutionizing and reforming the previous world of engineering education. This framework, based on Project-Based Learning (PBL), is aligned to the current business reality. Nevertheless, the business world is a riddle of difficulties, and to work with engineering projects requires coping with stress, as previous studies have shown (Anantatmula, 2015; Ballesteros et al., 2019). Are the engineering students prepared to deal with these stressful and, sometimes, overloading the role of pretending to be professionals? And, most important, do they value the role-play experience as satisfactory?

This research aims to discover the self-perception of the work overload and satisfaction by asking the students of the "Bioengineering Design" and "Medtech" courses. These courses are part of the *Industriales Ingenia*, a compulsory course for master's students that born as part of the CDIO initiatives, and they are included in the first year of the Master's Degree in Industrial Engineering, and the Master's Degree in Engineering Management, respectively. The students from both courses work together during the whole year in seven teams under the CDIO framework and with the PBL methodology. This particularity of mixing students from different Masters is something unique in the ETSI Industriales from the Universidad Politécnica de Madrid, and it is interesting to discover if it causes more stress or satisfaction in the students.

LITERATURE REVIEW

Work-life balance

The idea of work-life balance emerged at the 1970s coinciding with the incorporation of the women into paid employment (Dizaho et al., 2017) but has gone beyond women in the last decades, and it has been particularly noticeable in recent generations as millennials, the great advocates of working to live and not living to work.

Although the definition of work-life balance is still not clear in the literature due to some authors link this concept to the care of dependent relatives while others open it to enjoy the free time (Gregory et al., 2013), it can be understood as the compromise between work and non-work activities. There are numerous studies that show that when there are mismatches in that balance, symptoms such as lower levels of job satisfaction and work performance, absenteeism, stress increase, and burnout, begin to appear (Beauregard & Henry, 2009; Chatrakul Na Ayudhya et al., 2017). These symptoms have been studied in detail in professional environments, especially in the healthcare area in the recent years (Holland et al., 2019; Yehya et al., 2020), probably because previous research pointed to healthcare workers as more stressed than people in other professions (Theorell et al., 1990).

Nevertheless, work-life balance has been scarcely studied in the higher education environment, with some exceptions focused on academic staff (Catano et al., 2019; Fontinha et al., 2019) where the high levels of stress have gone increasing over the last years, turning a motivational work by a demanding combination of excel at teaching as well as research.

Stress and satisfaction at the university

The effects of stress suffered by professors in some way are also transmitted to the students, who face the increasingly demanding educational systems from an awkward position since they are not used to cope with stressful situations (Amirkhan et al., 2019).

The tendency to bridge the educational methodologies with the professional reality requires maturity and coping by the students, defining coping as the cognitive and behavioral efforts to deal with stressful situations (Folkman & Lazarus, 1985). Some of these situations are the overload of credits in the semester, the number of tasks to develop in different teams, and conflict management in the working groups. Despite these situations, there are also a few studies about how stress influences the students (Karakas, 2015; Weidner et al., 1996).

Something similar happens around the satisfaction levels at university; there is little published about how students and professors are having their expectations fulfilled. Concerning professors, the study of Fontinha et al. (2019), reveals that although academic life provides flexibility, the higher number of extra hours causes dissatisfaction in the academic community. Regarding the students, despite the stress of facing new challenges, some students show dissatisfaction related to a large number of educational activities and the scarce linkage between the conceptual issue - taught at university - and the experiential learning - demanding by the labor market - (Cavallone et al., 2020). Moreover, work in teams uses to be appreciated by students, but the research of Backlund & Garvare (2019) shown they feel more comfortable with an individual assessment within the group.

METHODOLOGY

To contribute to the scarce literature on stress and satisfaction in students, this research aims to assess both levels in a course conceived under the CDIO standards.

The method consisted of the design and distribution of a questionnaire to discover the opinion of the master's students attending to the Bioengineering Design and MedTech course, developed entirely under the CDIO practices.

The questionnaire had two sections. The first section collected information about the gender, country, the program they are coursing, and their previous formation. The second section had two different parts based on the level of agreement of the students about the causes of the stress level (first part) and the reasons for the satisfaction level (second part). The level of agreement was measured by a 1-7 Likert-scale (fully agree to fully disagree).

The section dedicated to the stress levels has partially followed the items designed by Spielberg (1994) in his *Job Stress Survey* (JSS) (Spielberger & Reheiser, 1994), adapting the stressors to the academic context. The JSS assesses the levels of stress measuring the severity and frequency of each of the 30 stress items.

The session devoted to the satisfaction levels includes items that have also been adapted from the study about job satisfaction of nurses, designed by Kekana et al. (2007).

The total number of students attending the course is 44 (31 from Bioengineering Design and 13 from MedTech), and the number of responses is 14 (10 from Bioengineering Design and 4 from MedTech). It is a reduced number, but it has the responses of two persons from every

team, to homogenize the levels of stress and satisfaction of all the teams. These two persons act as representatives of their teams. Table 1 shows the main characteristics of the sample.

The analysis of the responses from the questionnaire has been made with the assistance of IBM SPSS software. Stress and satisfaction levels were analyzed by means of a descriptive statistic. The descriptive statistic was completed with the correlation matrix. To keep the simplicity of the descriptive analysis, the most usual Pearson's coefficient was used. Correlation coefficients were obtained in three stages: firstly, the correlation matrix for the stress variables, secondly, the correlations between the satisfaction variables, and finally, the cross-correlations between the stress and satisfaction variables. Although the number of observations is very small (14), many significant coefficients have been obtained. These are indicated in the corresponding tables with a double asterisk.

Table 1. Profile of the respondents

Gender		Master		Country of previous studies		
Male	Female	Industrial Engineering.	Engineering Management	Spain	France	Perú
11	3	10	4	12	1	1

Table 2. Descriptive of the Stress level

		Mean	S. D.	Median
SS1	Team members not doing their job	1,642	,744	1,5
SS2	Inadequate support by professors	1,785	,699	2
SS3	Insufficient team members to handle assignment	1,571	,513	2
SS4	Lack of recognition for good work	1,571	,937	1
SS5	Frequent Interruptions in the course development	2,500	1,160	2
SS6	Dealing with crisis situations within the team	1,785	,801	2
SS7	Inappropriate behavior by my team colleagues	1,142	,534	1
SS8	Inappropriate behavior by professors	1,428	,937	1
SS9	Poorly motivated other teams in the course	2,214	1,050	2
SS10	Poorly motivated team colleagues	2,714	1,138	2
SS11	Lack participation in the course decisions	2,642	1,499	2
SS12	Difficulty getting along with professors	1,642	,928	1
SS13	Assignment of disagreeable duties	1,928	1,328	2
SS14	Inadequate quality equipment for doing the duties	2,357	1,392	2
SS15	Excessive paperwork of the assignments	2,642	1,549	2
SS16	Very tight delivery times	2,642	1,691	2
SS17	Assignment of increased responsability	2,571	1,504	2
SS18	Assignment of new or unfamiliar duties	3,785	2,006	4
SS19	Frequent changes in the assignments	2,928	1,859	2
SS20	Periods of inactivity	3,071	1,899	2,5
SS21	Working overtime	2,642	1,336	3
	TOTAL STRESS LEVEL	2,247		

RESULTS

Table 2 and Table 3 show the self-perception of the students about the stress and satisfaction level, respectively).

Regarding the stress analysis (Table 2), a low-stress level is appreciated (mean of 2,247 over 7), highlighting as the more stressful the *assignment of new or unfamiliar duties* (3,785), the *periods of inactivity* during the course due to breaks for exams or holidays (3,071), and the *frequent changes in the* assignments (2,928). On the other hand, the *inappropriate behaviors of their team colleagues* (1,142)*, or professors* (1,428), and the *lack of recognition for good work* (1,571), are hardly perceived as stress variables.

Table 3. Descriptive of the Satisfaction level

		Mean	S. D.	Median
ST1	Previous university studies	5,071	1,141	5
ST2	University contributing to my life	4,785	1,050	5
ST3	Mission and vision of this university	4,357	,841	4
ST4	The opportunity to have a variety in this course	5,142	1,657	5
ST5	The workload of this master's first year	4,285	1,637	4
ST6	The workload of this course	4,000	1,467	4
ST7	The help of the professors	5,642	1,598	6
ST8	The help of the team colleagues	6,071	,730	6
ST9	The sense of belonging to a team	5,357	1,215	6
ST10	The materials/equipment available in the course	3,928	1,730	4
ST11	The option of doing my favorite tasks in the team	5,428	,851	6
ST12	The cooperation within the team	5,571	,937	6
ST13	The professional ethics perceived in the course	5,500	,940	5,5
ST14	The interest in the projects developed	4,928	1,639	5
ST15	The ability to improve the methods used	5,285	,825	5
ST16	The possibility to discuss about the assignments	5,642	,633	6
ST17	My opinion is considered	5,928	,828	6
ST18	The attitudes of my team colleagues	5,714	1,204	6
ST19	The interaction with healthcare professionals	5,571	1,157	6
ST20	The commitment to the quality in the course	5,285	,825	5,5
ST21	Self- motivation for the good work	5,571	,851	6
ST22	The support of the professors	5,928	,997	6
ST23	The possibility of helping other colleagues	5,285	1,138	5,5
	TOTAL SATISFACTION LEVEL	5,229		

Analyzing the data of satisfaction (Table 3), it is possible to appreciate a high satisfaction level according to the values obtained (mean of 5,229 over 7). Between all these values, stand out

as causes of more satisfaction with the *help of the team colleagues* (6,071), the feeling of *personal opinion is considered* (5,928), and the *support of the professors* (5,928). By contrast, the *materials/equipment* available for the course (3,928), the *workload of the course* (4,000), or *the workload of the whole master* (4,285) were chosen as the causes of major dissatisfaction.

Table 4 and Table 5 show the correlation matrix between the stress variables and the satisfaction variables, respectively. Both matrixes have been simplified, showing the rows or columns exclusively where appeared a high statistically significant level.

Table 4. Correlations between the Stress variables

	SS4	SS5	SS6	SS10	SS11	SS12	SS13	SS14	SS17	SS19	SS20	SS21
SS1	0,315	0,489	,764**	,596*	0,359	0,469	0,205	0,132	0,059	0,091	0,019	0,017
SS2	,670**	,616*	0,323	,690**	,802**	,702**	,562*	,717**	0,272	0,461	0,186	0,323
SS4	1	,707**	0,073	,669**	,649*	,782**	,653*	,774**	0,241	0,467	0,148	0,114
SS5	,707**	1	0,455	0,466	,730**	,750**	0,374	,785**	0,485	,624*	0,506	,620*
SS8	-0,12	0,495	,643*	-0,16	0,336	0,366	0,026	0,227	0,358	0,24	0,413	,684**
SS11	,649*	,730**	0,251	,566*	1	,785**	,566*	,692**	0,234	0,377	0,172	0,507
SS12	,782**	,750**	0,406	0,478	,785**	1	,726**	,641*	0,322	0,43	0,103	0,261
SS16	0,526	0,411	-0,06	0,143	0,158	0,5	0,501	0,385	,751**	,676**	0,511	0,075
SS17	0,241	0,485	0,046	0,148	0,234	0,322	0,099	0,336	1	,868**	,819**	0,454
SS18	,561*	0,512	-0,17	0,409	,637*	0,492	0,34	,607*	,655*	,779**	0,489	0,457
SS19	0,467	,624*	0,144	0,353	0,377	0,43	0,06	,575*	,868**	1	,698**	0,484
SS20	0,148	0,506	0,112	0,117	0,172	0,103	0,063	0,484	,819**	,698**	1	,677**
SS21	0,114	,620*	0,282	0,079	0,507	0,261	0,028	,611*	0,454	0,484	,677**	1

** Statistically significant at the 0,01 (bilateral) level. * Statistically significant at the 0,05 (bilateral) level.

Table 5. Correlations between the Satisfaction variables

	ST4	ST12	ST14	ST15	ST16	ST17	ST18	ST19	ST20	ST21	ST22
ST2	,681**	,056	,839**	,076	,338	,069	-,052	,614*	,342	-,196	,058
ST4	1	,141	,684**	,418	,712**	,400	,138	,756**	,699**	,210	,193
ST7	,166	-,213	,019	,258	,320	,676**	,063	,119	,258	,105	,369
ST9	,240	,752**	,477	,274	,078	,256	,863**	,281	,350	,308	,530
ST10	,433	,217	,595*	,069	,326	-,004	,100	,751**	,339	-,179	-,092
ST12	,141	1	,479	,071	-,019	-,240	,837**	,314	,170	,041	,129
ST13	,345	,349	,324	,694**	,323	,345	,340	,565*	,793**	,672**	,779**
ST19	,756**	,314	,712**	,299	,614*	,286	,126	1	,782**	,267	,305
ST20	,699**	,170	,414	,548*	,652*	,482	,166	,782**	1	,735**	,681**
ST21	,210	,041	-,189	,516	,407	,498	,171	,267	,735**	1	,776**

** Statistically significant at the 0,01 (bilateral) level. * Statistically significant at the 0,05 (bilateral) level.

Between the correlations of both, the Stress variables (Table 4) and the Satisfaction variables (Table 5), it is possible to appreciate the great number of positive and highly significative correlations.

Attending to the results achieved in Table 4, some interesting relations can be highlighted, as the link between *the support of the professors* (SS2) and the *participation of the students in the course decision* (SS11), or how the *assumptions of responsibilities* by the students (SS17) make them see with critical eyes the *periods of inactivity* (S20) or the *frequent changes in the assignments* (S19).

Attending to the results achieved in Table 5 and with the focus on the highest correlations, it is possible to appreciate how students feel satisfaction when *university contributes to their lives* (ST2) in the sense of being able to *develop projects of interest* (ST14). Also, they feel satisfied with working in a team, when the *attitudes of the team members* are positive (ST18), as they strengthen the *sense of team membership* (ST9) and the *cooperation* principles (ST12).

Finally, this research has checked the correlations between stress and satisfaction levels (Table 6). This analysis has allowed identifying which variables can balance the relationship between stress and satisfaction. On this occasion, and as expected, most of the correlations are negative.

Table 6. Correlations between the stress and the Satisfaction variables

	ST2	ST12	ST13	ST14	ST19	ST20	ST21	ST22	ST23
SS1	-,204	-,677**	-,384	-,463	-,459	-,197	-,017	-,244	-,324
SS2	-,591*	-,151	-,526	-,618*	-,692**	-,685**	-,295	-,575*	-,593*
SS5	-,410	-,141	-,529	-,425	-,515	-,562*	-,467	-,698**	-,466
SS7	-,215	-,789**	,153	-,514	-,142	,249	,483	,309	-,072
SS8	,100	-,300	-,523	,021	-,455	-,568*	-,716**	-,458	-,124
SS9	,254	,022	-,428	,278	,018	-,342	-,663**	-,718**	-,055
SS10	-,505	-,412	-,503	-,754**	-,508	-,398	,102	-,358	-,703**
SS11	-,296	-,227	-,791**	-,387	-,538*	-,782**	-,671**	-,842**	-,657*
SS12	-,084	-,101	-,572*	-,170	-,296	-,559*	-,597*	-,860**	-,260
SS13	,098	-,088	-,400	-,073	-,071	-,261	-,301	-,701**	,015
SS18	-,498	,152	-,550*	-,403	-,340	-,657*	-,463	-,700**	-,510
SS19	-,678**	,158	-,330	-,481	-,444	-,537*	-,264	-,459	-,389
SS21	-,223	-,009	-,581*	-,188	-,604*	-,737**	-,618*	-,482	-,484

** Statistically significant at the 0,01 (bilateral) level. * Statistically significant at the 0,05 (bilateral) level.

Table 6 shows the reduced correlation matrix where it is possible to highlight the important role of the *support of the professors* (ST22) to counter the effects of the stress in the students, *encouraging their incorporation into decision-making* about the course (SS11), and *facilitating interaction with them* (SS12).

DISCUSSION

Despite the low-stress level perceived by the students, variables linked to ambiguity or uncertainty (*assignment of unfamiliar duties* or *changes in assignments*) are appreciated as stressors. This result match with previous studies where ambiguity had an important role in stress and dissatisfaction levels (Yehya et al., 2020). To minimize the stress levels, this study reveals that the *appropriate behavior of the team and professors*, and the *recognition for good work* are good allies.

The satisfaction analysis proves that the students need to feel valued and cared for by the ecosystem integrated by supervisors and colleagues to reach their satisfaction, and how if it happens, other aspects as the scarcity of *materials/equipment* or the *workload* become relegated to the second place.

The correlations between the stress variables demonstrate that when students feel confidents and supported by professors, they assume responsibilities and demand more commitment from everyone, even themselves, taking ownership of their projects.

In the same line, the correlations between the satisfaction variables show that students are pleased with Higher Education Institutions when they learn by doing exciting projects, and the teamwork is made in a cooperative environment. These results confirm the idea of designing collaborative spaces for millennials established by Karakas et al. (2015).

Finally, as the cross-correlations between stress and satisfaction variables demonstrate, the support of the professors takes an active role in balancing these variables. Professors are called to help to design an atmosphere of trust during the course where students can interact and participate in the decision process.

CONCLUSIONS

It has been shown that a low level of stress and a high level of satisfaction is perceived by the students in this course developed under the CDIO methodologies. These results encourage further work under CDIO practices, supporting teamwork and the students' participation in making decisions about their assigned projects. The analysis also demonstrates the need for more significant commitment from professors, whose support for the teams has been shown to be essential to balance the stress and satisfaction levels.

Despite these favorable results for the CDIO practices, it is necessary to mention that this study has been made in the middle of the semester, and the designs of the products were in an early phase. An increment of the stress level is foreseen during the last days of the course when the students must present their final prototypes.

Likewise, to be able to generalize the conclusions drawn, it would be necessary to carry out this research with a larger sample and incorporating students from other courses under the CDIO methodologies to complement the study contrasting through an analysis of variance.

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