

AC 2007-1510: WHAT MOTIVATES ENGINEERING STUDENTS TO WORK IN TEAMS?

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WHAT MOTIVATES ENGINEERING STUDENTS TO WORK IN TEAMS?

Abstract

Generally individuals come together to work in teams to develop a task or achieve a goal. In the higher education environment most of the work done by students takes place in teams and the results of team efforts significantly affects learning outcomes. When working in teams, team members are focused in developing the task. However, they constantly interact with each other in order to achieve this goal. According to McClelland's motivation theory, individuals are motivated by three types of needs: affiliation need (nAff), achievement need (nAch) and power need (nPow). Therefore, if team members are focused on the task and socialize through interaction process while working in teams it is expected that those team members with high achievement need and affiliation need perform better than those with high power need. In teams, where team members with power need prevail over other needs, it is expected that they would try to impose their ideas making the team to perform poorly. A study with 73 engineering student teams formed between 3 and 6 members each was carried out during the spring semester 2006, at the National University of Tachira, Venezuela. The MLP, MPS, and MAFI tests were applied to measure achievement need, power need and affiliation need respectively. The TEE questionnaire was applied to measure team performance. The statistical analysis showed that achievement need prevailed in good performing teams whereas affiliation need prevailed in poor performing teams. Power need showed no statistical significant difference between good performing teams and poor performing teams. These results show that faculty should take into account individual motivation needs when forming teams in the classroom and that they should place more emphasis on forming teams where achievement need prevails rather than affiliation need.

Introduction

Much of the work done by students in higher education takes place in teams and the results of team efforts significantly affects learning outcomes^{1,2,3}. Most students recognize the need of teamwork for improving interpersonal skills, but still they prefer individual work when the goal is to achieve a good performance^{2,4}; however, the team literature indicates that for teams to operate, they should work under two dimensions: accomplishing of task and sustaining team spirit and impetus⁵. This means that teams, additional to help student to improve interpersonal skills also help students to achieve their team goals. Therefore, why students think that they can perform better working individually than in groups? What really move them to work in teams?

Motivation theories state that individual's behaviors are shaped by motives that energize, orient and sustain these behaviors over time⁶. The study of what moves students to work effectively in teams has not received much attention and even less the study of the type of motivation team members should have to work effectively in teams. Among work motivation theories, McClelland's Theory of Needs affirms that at any given time, individuals hold several often competing needs that when activated motivate behaviors. McClelland defines these needs as motives for behaviors as achievement (nAch), affiliation (nAff), and power (nPow)⁶.

According to McClelland (as cited in Steers, Mowday, and Shapiro, 2004)¹, achievement need refers to behaviors directed toward success through competition with a standard of excellence. Also, McClelland, (as cited in Espinoza, 2003)⁷, defines affiliation as the need of being accepted by others and of building interpersonal relationship where friendship, understanding and cooperation predominate and power is defined as a need of having control over one's environment including individuals and resources.

Studies on individual performance have shown that achievement need is a motivational variable having a positive influence on job satisfaction, individual disposition to change, and job performance^{8,9,10}. Individuals with high achievement need show better job satisfaction, better performance and show a better disposition to change.

In the academic environment, Rodriguez (1992) found that high school students with high achievement need obtained better academic performance than those with low achievement need¹¹. In a similar study, Lopez (1992) found that those college students with high achievement need achieved statistically significant higher grades than those with low achievement need¹².

Whit these results in mind, the reasoning for this study was that high achievement need contributes to members' ability to accomplish the task and high affiliation need contributes to members' ability to sustain team spirit and impetus, then, both needs, high achievement and high affiliation need would drive the teams to higher performance. From this, the specific objective of the study was to determine if teams formed with individuals who demonstrate high achievement and affiliation needs perform better than those formed with members not having these motivational needs. Therefore, the hypothesis tested was the following: Teams formed with members that show high achievement need and high affiliation need will perform better than those formed with members not showing high achievement and high affiliation need.

Methodology

From a population of 916 student teams, using proportional stratification sampling, eighty-seven of them were selected to participate in the study. Teams were selected from industrial engineering, electrical engineering, agronomical engineering, animal science engineering, architecture, and mechanical engineering programs at the National University of Tachira, Venezuela as shown in Table 1. Teams were formed of 3, 4 or 5 students. All students were in the last two years of their program.

Table 1
Sample distribution

Program	Proportion	Sample size
Industrial Engineering	54%	47
Animal Science Engineering	2.3%	2
Electrical Engineering	13.8%	12
Architecture	11.5%	10
Agronomical Engineering	9.2%	8
Mechanical Engineering	9.2%	8
Total	100.0%	87

During the spring 2006 semester four instruments were applied to measure achievement need, affiliation need, power need and team effectiveness. Achievement need (nAch) was measured using the Achievement Motivation Inventory (MLP). Affiliation need (nAff) was measured using the Affiliation Motivation Inventory (MAFI). Power need (nPow) was measured using Socialized Power Motivation Inventory (MPS) and Team Effectiveness was measured through the Team Effectiveness Questionnaire (TEE).

The MLP, the MAFI and the MPS are instruments developed by Romero and Salom from the Los Andes University in Venezuela, to measure achievement need and affiliation need respectively. The MLP Inventory presents 24 items related to how individuals set goals, define strategies to achieve goals, engage with the task and with beliefs that support achieving goals. The reliability of this instrument using Cronbach's alpha y Spearman-Brown approach respectively is 0.78 and 0.61.

The MAFI Inventory consists of 16 items measuring individual interest on establishing interpersonal relationships and individuals strategies for gaining acceptance at work. The reliability of this instrument using Cronbach's alpha approach is 0.86.

The MPS Inventory consists of 20 items measuring how individuals use power to influence others¹³. The reliability of this instrument using Cronbach's alpha y Spearman-Brown approach respectively is 0.79 and 0.84. These three instruments use a Likert scale ranging from (1) totally disagrees to (6) totally agrees

The TEE is an adaptation in Spanish of the Team Effectiveness Questionnaire developed by Adams, Simon and Ruiz (2002). The TEE intends to measure the presence in a team of characteristics that determine team effectiveness through individual readiness for working in teams¹⁴. It consists of four sections. The first section assesses individual's previous experience working in teams using 5 multiple choice questions. The second section assesses individual's perceptions on characteristics making a team effective using a 5 points likert scale ranging from completely agree to completely disagree. The third section includes 15 items exploring individual knowledge about team concepts. This variable is measured using a four points likert scale discriminated by "Never heard of it", "Heard of it but do not understand it", "Understand it but not able to using in team situations", and "Understanding and able to using in team situation". The last section identifies demographic characteristics.

Because of the use of four different instruments to measure the variables of the study, it was necessary to identify each of the instruments with a code. The code allowed the identification of the program, course, section, team and team member in each instrument in order to match students' responses during data processing.

Analysis and Results

From the sample of eighty-seven teams selected only seventy-three teams participated in the study counting for 266 students, this due to change in the time and/or place of class meeting making impossible to contact students in some courses.

Fifty-three percent of students were female and the majority of participants (43.6%) were between 22 to 25 years old. Regarding to participants study program, 59.4% of them were majoring in industrial engineering (IE), 12.8% architecture (A), 9.4% electrical engineering (EE), 7.9 % agronomical engineering (AE), 6.8% mechanical engineering (ME) and 3.8% animal science (AS). This proportion was expected because the researchers had more accessibility to IE courses than others.

Regarding academic performance, 39.8% of participants had a GPA between 5 and 6 in a scale from 1 to 9 points. Thirty-eight percent had a GPA between 6 and 6.5 points, 13.9 % had a GPA between 6.5 and 7 points and 4.2% had a GPA greater than 7 points.

Results on team effectiveness and motivation were analyzed at individual and team level. This was due to the nature of the motivation variable. Motivation is an individual process then each of the instruments measures individual motivation. On the contrary, team effectiveness is measured in a team level. Even though in this test data is collected individually, this is processed collectively to obtain a team score, and this is achieved averaging individual team members score.

At the individual level from the TEE, as shown in figure 1, 34.2% of participants were found to be effective team members. Table 2 shows correlation between motivation variables and team effectiveness. Correlation between nAch and team member effectiveness was statistical significant ($r=.283, \alpha=0.007$), whereas correlations between nAff and team member effectiveness as well as nPow and team member effectiveness were not statistical significant ($r = -.180, \alpha=.087; r=.022, \alpha=.834$).

Figure 1. Proportion of effective and non effective team members at the individual level

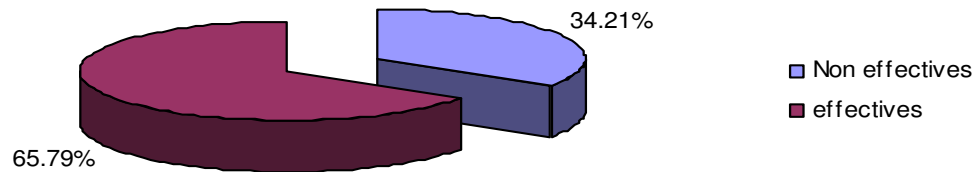


Table. 2
Correlation at individual level

	Effective Team member				Non effective Team member			
	MAFI	MPS	MLP	TEE	MAFI	MPS	MLP	TEE
MAFI	1.000	*0.358	-0.036	-0.180	1.000	*0.256	-0.102	*0.343
MPS	*0.358	1.000	0.052	0.022	*0.256	1.000	0.070	0.087
MLP	-0.036	0.052	1.000	*0.283	-0.102	0.070	1.000	-0.043
TEE	-0.180	0.022	*0.283	1.000	*0.343	0.087	-0.043	1.000

(*) $\alpha = 0.01$ (bilateral)

In order to determine if motivation variables explain variability on team effectiveness, multiple linear regression among variables was used. Tables 3, 4 and 5 show the results. From these tables it is seen that for effective team members, nAch, nAff, and nPow explained 11.5% of the variability on team member effectiveness, with nAch (MLP) coefficient statistically significant ($B = .062$, $\alpha = .009$).

For non effective team members, the multiple linear regression on the variables showed that nAff (MAFI) has influence on team member effectiveness in those individuals with no team orientation ($B = .168$, $\alpha = .000$), accounting for 11.8% of the variability on team member effectiveness.

Table. 3
Model summary

	Model	R	R ²	R ² adjusted	Standard error
Effective team members	1	0.339 ^a	0.115	0.084	3.4011
Non Effective team members	1	0.343 ^a	0.118	0.102	6.0443

(a) Predictors: (Constant), MAFI, MPS, MLP

Table. 4
Coefficients at individual level – Effective team members

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	SE	Beta		
Model 1	Cte.	55.13	3.681		14.979	0.000
	MAFI	-5.70E-2	0.031	-0.199	-1.839	0.069
	MPS	2.02E-2	0.028	0.79	0.732	0.466
	MLP	6.27E-2	0.023	0.272	2.689	0.009
Model 2	Cte.	55.96	3.497		16.000	0.000
	MAFI	-4.89E-2	0.029	-0.170	-1.693	0.094
	MLP	6.39E-2	0.023	0.277	2.754	0.007

Dependent variable: TEE

Table. 5
Coefficients at individual level – Non Effective team members

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	SE	Beta		
Model 1	Cte.	35.441	5.094		6.957	0.000
	MAFI	0.168	0.037	0.342	4.574	0.000
	MPS	1.74E-6	0.037	0.000	0.000	1.000
	MLP	-3.86E-3	0.034	-0.008	-0.114	0.909
Model 2	Cte	35.441	4.751		7.460	0.000
	MAFI	0.168	0.035	0.342	4.757	0.000
	MLP	-3.86E-3	0.034	-0.008	-0.115	0.909
Model 3	Cte.	34.974	2.462		14.208	0.000
	MAFI	0.168	0.035	.0343	4.808	0.000

Dependent variable: TEE

At the team level, results from the TEE showed that 22% of the participant teams were effective and within them 34.2% team members were effective team members, as shown in figure 2. Tables 6, 7 and 8 show results from correlation and regression analysis on the variables. In effective teams correlation analysis on nAch, nAff, nPow and team effectiveness found no statistical significant correlation between them. Moreover, using linear regression on variables showed that none variable had influence on team effectiveness.

Figure 2. Proportion of effective and non effective team members at the team level

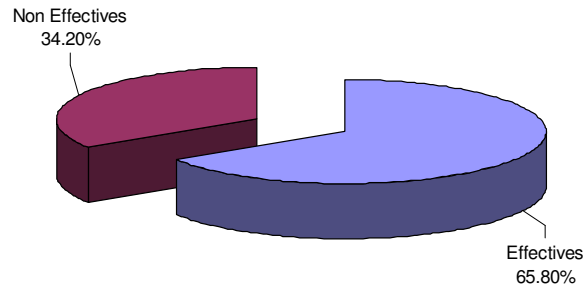


Table. 6
Correlation at team level

	Effective				Non effective			
	MAFI	MPS	MLP	TEE	MAFI	MPS	MLP	TEE
MAFI	1.000	*0.438	0.095	-0.107	1.000	*0.234	-0.117	*0.331
MPS	*0.438	1.000	0.241	-0.175	*0.234	1.000	0.007	0.057
MLP	0.095	0.241	1.000	0.068	-0.117	0.007	1.000	0.041
TEE	-0.107	-0.175	0.068	1.000	*0.001	0.057	0.041	1.000

(*) $\alpha = 0.01$ (bilateral)

Table 7
Coefficients at team level – Effective teams

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	ET	Beta		
Model 1	Cte.	59.524	5.966		9.977	0.000
	MAFI	-1.38E-2	0.056	-0.035	-0.245	0.808
	MPS	-6.32E-2	0.050	-0.188	-1.272	0.209
	MLP	3.81E-2	0.043	0.177	0.877	0.384
Model 2	Cte.	58.893	5.336		11.038	0.000
	MPS	-6.84E-2	0.044	-0.203	-1.538	0.130
	MLP	3.82E-2	0.043	0.117	0.887	0.379
Model 3	Cte.	62.496	3.454		18.093	0.000
	MPS	-5.89E-2	0.043	-0.175	-1.367	0.177
Model 4	Cte.	57.844	0.597		96.811	0.000

Dependent variable: TEE

Table 8
Coefficients at team level - Non effective teams

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	ET	Beta		
Model 1	Cte.	30.162	5.965		5.056	0.000
	MAFI	0.212	0.042	0.347	5.044	0.000
	MPS	4.60E-2	0.038	0.081	1.217	0.225
	MLP	-1.55E-2	0.042	-0.025	-0.0366	0.715
Model 2	Cte	29.280	5.445		5.378	0.000
	MAFI	0.208	0.041	0.341	5.114	0.000
	MLP	4.55E-2	0.038	0.080	1.207	0.229
Model 3	Cte.	34.858	2.883		12.092	0.000
	MAFI	0.202	0.040	0.331	5.001	0.000

Dependent variable: TEE

For non effective teams the correlation between nAff (MAFI) and team effectiveness (TEE) was statistical significant ($r=.331$, $\alpha=.000$). On the contrary, results showed no statistical significance in the correlation between nAch (MLP) and team effectiveness (TEE) ($r=.041$, $\alpha=.564$) as well as with nPow (MPS) and team effectiveness (TEE) ($r=.057$, $\alpha=.419$). Regression on the variables confirmed that nAff (MAFI) had influence on team effectiveness (TEE) ($B=.212$, $\alpha=.000$), differently from nAch (MLP) and nPow (MPS). It seems that these two variables have not impact on team effectiveness for non effective teams.

A comparative analysis on the variables at the team and individual level was also carried out to look for differences on motivational variables between effective and non effective teams and

effective and non effective team members. At individual and team level, the t-test showed statistical significant difference on the affiliation need variable between effective and non effective teams ($\alpha = .000$ at individual level; $\alpha = .015$ at team level) as shown in tables 9 and 10.

Table 9
Independent samples t test at individual level

		Levene's test for equality of variances		T test for equality of means							
		F	Sig.	t	df	Sig.	M D	SED	95% CID		
										Lower	Upper
MAFI	$\sigma^2 = \sigma^2$	0.051	0.821	3.779	264.0	0.000	6.233	1.649	2.986	9.481	
	$\sigma^2 \neq \sigma^2$			3.846	191.4	0.000	6.233	1.621	3.036	9.430	
MLP	$\sigma^2 = \sigma^2$	1.523	0.218	1.571	264.0	0.117	2.891	1.840	-0.732	6.516	
	$\sigma^2 \neq \sigma^2$			1.513	164.6	0.132	2.892	1.910	-0.881	6.664	
MPS	$\sigma^2 = \sigma^2$	2.067	0.152	-0.016	264.0	0.987	-2.8E-2	1.714	-3.403	3.347	
	$\sigma^2 \neq \sigma^2$			-0.016	170.2	0.987	-2.8E-2	1.757	-3.498	3.442	

MD: Mean Difference, SED: Standard Error Difference, CID: Confidence Interval of the Difference

Table 10
Independent samples t test at team level

		Levene's test		T test for equality of means							
		F	Sig.	t	df	Sig.	Mean Differen ce	Std. error differen ce	95% Confidence interval of the difference		
										Lower	Upper
MAFI	$\sigma^2 = \sigma^2$	1.184	0.277	2.455	264.0	0.015	4.639	1.889	0.918	8.359	
	$\sigma^2 \neq \sigma^2$			2.626	109.8	0.010	4.639	1.766	1.138	8.140	
MLP	$\sigma^2 = \sigma^2$	0.000	0.997	0.798	264.0	0.426	1.662	2.084	-2.441	5.766	
	$\sigma^2 \neq \sigma^2$			0.801	99.1	0.425	1.662	2.075	-2.454	5.779	
MPS	$\sigma^2 = \sigma^2$	0.503	0.479	1.240	264.0	0.216	2.390	1.928	-1.407	6.188	
	$\sigma^2 \neq \sigma^2$			1.212	95.2	0.229	2.390	1.972	-1.525	6.307	

MD: Mean Difference, SED: Standard Error Difference, CID: Confidence Interval of the Difference

Conclusions

This study proposed to analyze the motivational needs that move individuals to work in teams effectively. It was hypothesized that team effectiveness was influenced by motivational needs of achievement and affiliation in more proportion than power need.

From the results it seems that the nAch variable has a direct effect on team effectiveness. This means that team members having high achievement need will be more effective working in teams to carry out the task and accomplishing the team goals. On the other hand, from the regression analysis it was observed a negative relation between the nAff variable and team

effectiveness on effective team members and a positive relation on non effective team members. Thus, team members with high affiliation need could make the team less effective or unsuccessful. This seems to imply that affiliation is the inflection point in determine team effectiveness. Regarding power motivation, it seems that this variable has no impact on team effectiveness.

Therefore, the hypothesis of team members being motivated by needs of achievement and affiliation to become effective was not supported completely. Even though, it is important that team members are oriented toward achievement for teams to be effective, it seems that the relevant variable is affiliation. In order for a team become effective it is important that team members show low motivational need of affiliation and high on achievement.

Finally, as recommendation, faculty using the team approach in the classroom should develop strategies to help student to become effective team members by making emphasis on achieving the task rather than interpersonal relationships.

Bibliography

1. Bobbitt, L. Michelle, Scott A. Inks, Katie J. Kemp and Donna T Mayo (2000). Integrating Marketing Courses to Enhance Team-Based Experiential Learning. *Journal of Marketing Education*. 22 (1). 15-24.
2. Buckenmyer, James A. (2000), Using Teams for Class Activities: Making Course/ Classroom Teams Work. *Journal of Education for Business* 76 (2). 98-107.
3. Deeter-Schmelz, Dawn R., Karen N. Kennedy, and Rosemary P. Ramsey (2002). Enriching our Understanding of Student Team Effectiveness. *Journal of Marketing Education*. 24 (2). 114-124.
4. Anderton-Lewis, L., and King, T. (1995). An assessment of global communication awareness achieved through teamwork. *Delta Pi Epsilon Journal*, 39(1). 12-23.
5. Rees, F. (1998). *Equipos de trabajo*, México: Prentice Hall.
6. Steers, D., Mowday, R., and Shapiro, R. (2004). The Future of Work Motivation Theories. *Academy of Management Review*. 29 (3). 379-387.
7. Espinoza, R. (2003). Perfil Motivacional del Personal Directivo y Empleado en Organizaciones de Santa Bárbara del Zulia. *Visión Gerencial*. 1 (2). 14-23.
8. Crespo, A. and Díaz, G. (1992). Necesidad de Logro, Autoestima y Satisfacción Laboral. Memorias EVEMO 4. Mérida. Psychological Research Center. (4). 102-105.
9. Salom, C., and Pérez, E. (1992). Las Motivaciones Sociales y la Satisfacción Laboral. Memorias EVEMO 4. Mérida. Psychological Research Center. (4). 94-101.
10. Koch, D., and Ramos, C. (1992). Motivaciones Sociales y Rendimiento Laboral. Memorias EVEMO 4 . Mérida. Psychological Research Center. (4). 120-125.
11. Rodríguez, M. (1992). Necesidad de logro, Autoestima Académica y Rendimiento académico. Memorias EVEMO 4. Mérida. Psychological Research Center. (4). 312-314.
12. López, M. (1992). Necesidad de Logro y Rendimiento Académico. Memorias EVEMO 4. Mérida. Psychological Research Center. (4).332-334.
13. Romero, O. (1999). *Crecimiento Psicológico y Motivaciones Sociales*. Mérida: Ediciones ROGYA.
14. Adams, S., Simon, L., and Ruiz, B. (2002). A Pilot Study of the performance of student teams in engineering education. *Proceedings of the 2002 American Society for Engineering Education Annual Conference*. Montreal, Canada.