A conceptual framework for designing team training in engineering classrooms

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Changes in customers' perceptions about service and products and technological advances have compelled companies to change the way they do business. The use of teams in organizations has become an effective way for organizations to satisfy new customers' needs. Research has shown that teams promote creativity and enhance performance in the form of speedy processes and quality products and services. However, the team approach is not successful in every situation. Organizations recognize that new employees need to bring team work skills to the workplace. Although employers may be willing to provide on the job training, they expect that their new employees, at least, possess the understanding of why this skill is important in the organization[1].

As result, the corporate environment has created pressure on institutions of higher education to prepare students to be effective team players [1,2,3]. For this reason accreditation boards at the collegiate level such as the Accreditation Board for Engineering and Technology (ABET), the Accounting Education Change Commission (AECC), and the Joint Commission for Accreditation of Health Care Organizations (JCAHO), among others, are requiring higher education institutions to introduce teamwork activities into their curriculums [4,5,6].

In response, institutions of higher education are developing a variety of methodologies for introducing teamwork in their classrooms. Collaborative learning, cooperative learning and other forms of active learning are being used in classrooms as ways to promote teamwork among students and enhance their learning [7,8].

Studies on cooperative and collaborative learning, as well as on the use of groups in classroom prove that trying to incorporate teams into the classroom is a highly complex task [9]. Difficulties with implementing teams have led researchers and practitioners to look for characteristics that make the difference between an effective and an ineffective team. Team performance and teaming process have been the focus of research within industry as well as in the educational field. It has been found that multiple variables related to individual differences, team task structure, context or environment and group characteristics have an effect on the teaming process and team performance.

From these results, group dynamics techniques, guidelines, and checklists have been developed as supporting tools for helping teams to become more effective. Nevertheless, it seems that more is required to achieve that goal. Today, the focus has turned to better structured team training programs addressing required individual and team competencies. They have to be designed under instructional strategies allowing individuals the opportunity of experiencing real team situations and have time for reflecting on their learning process.

Studies on team training have been focused on internal team process and while few have made reference to the importance of team members consciously understanding what a real team means, and how team members can manage the process of teaming. This author believes that when team members consciously understand the real meaning of being a team player and how to manage the many variables present during the process of teaming, they will be able to succeed in any team situation. In order to achieve this understanding, a training program oriented to this goal could make the difference in helping students to become real team players in the classroom and in the corporate world.

Therefore, the purpose of this paper is to present a *conceptual framework* that shows the elements to consider when designing *team training programs* to help students to become effective team players. First definitions on teams and team effectiveness are presented, followed by an overview of the need of team training. Then, a summary of the team training literature is shown and finally the Effective Team Player (ETP) - Team Training Framework is explained.

Team Definition

In order to understand the need for team training, it is necessary to review the literature on teams. First, it is necessary to define what team means and how this differs from groups. The word "team" has been loosely used that any group of people getting together to do a task is called a team. According to Forsyth (1999), teams have the basic elements of all groups [10]. They have interaction, structure, cohesiveness, social identity and goals, but the character and dimension of their group dynamics is different from other types of groups. Interactions within teams are cooperative and coordinated. Unlike groups, team structure is based on norms, role specification and communication patterns that are explicitly stated. Furthermore, a main characteristic of teams that is not present in other types of groups, is that team members recognize their membership in the team and feel that the team is greater that the sum of their individual members [10].

Katzenbach and Smith (1999) also make a clear distinction between teams and work groups [11]. For them, work groups do not have the need for significant improvement on performance. Work group members interact only to help each other to perform within his or her area of responsibility. They do not look for overall results but individual results. On the other hand, teams look for a significant impact on performance based on their members' interaction. They take advantage of their complementary skills in order to achieve their common goal. Team members are focused on improving performance for achieving outstanding results.

Several definitions of teams are available in the literature. Among them, Katzenbach and Smith's and Cohen and Bailey's are the most cited. For Katzenbach and Smith (1993), "a team is a small number of people with complementary skills who are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable."[12]. Cohen and Bailey (1997) define team as "a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more larger systems (for example, business unit or the corporation), and who manage their relationships across organizational boundaries."[13].

For the purpose of this paper, team is defined based on Katzenbach and Smith's and Cohen and Bailey's definition of teams. *A team is as a collection of individuals, generally small groups, who are interdependent in their tasks because of their complementary skills. They are committed to a common purpose, set of performance goals, and approach for which they hold themselves mutually accountable and share responsibility for outcomes. They see themselves, and are seen by others, as a social entity embedded in one or more larger systems and perform tasks that affect others.*

Studies have demonstrated that teamwork is an effective approach to achieving good individual and organization performance [12,13,14,15,16,17,18]. However, all teams do not perform successfully. Avolio (1999) and Katzenbach and Smith (1993), agree in that the most relevant difference is in how companies treat the *team concept* [12,19]. Managers think that a team is a group of people getting together to do a task. According to the team definition, a team is more than that. Successful teams recognize this difference. They have a clear understanding of what being a team and a team player means.

Team Effectiveness

Similarly to the team definition, there is not agreement between authors on the definition of team effectiveness. In general, team effectiveness is defined as a function of performance, attitudes, and behaviors. More explicitly, according to Hackman (1990), team effectiveness is the degree to which a group's output meets requirements in terms of quantity, quality, and timeliness (performance). The group experience improves members' ability to work as a group in the future (behavior), and the group experience contributes to individual and team satisfaction (attitude) [20].

Studies indicate that there are some factors that influence team effectiveness. Factors such as the type of task [9], internal and external team processes, and motivation factors including values, beliefs, and reward and performance assessment systems are cited as the most relevant to consider when looking for team effectiveness [13,14,17].

Recently, task characteristics and internal team processes have been the focus of research. As Cohen (1994), Salas and Cannon-Bowers (1997) and Forsyth (1999) mention, the type of task assigned to the team is what defines how the team organizes to accomplish it [9,10,21]. The team task has to be one that requires resources such as information, knowledge, heuristic problem-solving strategies, materials and skills that no single individual possesses, so that no single individual is likely to accomplish the task objectives without the input and participation from others. For a task to fit to the team structure, it requires that each team member exchange resources with others before the task can be completed [9].

With regards to internal team processes (effective teaming), there are different models available in the literature showing specific characteristics that are necessary for teams to become effective [13,22,23,24,25,26,27]. Trying to identify the most relevant and common characteristics among these models, Adams, Ruiz and Simon (2002) developed a framework to assist in the facilitation and measurement of effective teamwork [28]. In this model, seven constructs are identified as the main characteristics that need to be present in teams in order for their internal processes become

effective. The seven characteristics are: 1) common purpose, 2) clearly defined goals, 3) psychological safety, 4) role clarity, 5) mature communication, 6) productive conflict resolution, and 7) accountable interdependence.

Common purpose is defined as the main objective of the team, which should be understood and shared by all team members. This element should lead to the development of the team's goals.

Clearly defined goals refer to quantifiable and commonly agreed upon statements that define the actions to be taken by the team. Clear and common goals help team members maintain their focus.

Psychological safety is the shared belief that the team is safe for interpersonal risk taking [29]. The team climate is characterized by interpersonal trust and mutual respect in which people are comfortable being themselves. Team members are confident that the team will not embarrass, reject or punish someone for speaking up.

Role clarity is the team member's common understanding of each individual's expected role that helps to minimize misunderstandings regarding task assignments and avoid role ambiguity.

Mature communication refers to team members' ability to articulate ideas clearly and concisely, give compelling reasons for their ideas, listen without interrupting, clarify what others have said and provide constructive feedback.

Productive conflict resolution refers to the procedures and actions taken when a conflict occurs that lead to results such as facilitating the solution of the problem, increasing the cohesiveness among team members, exploring alternatives position, increasing the involvement of everyone affected by the conflict, and enhancing the decision-making process [30].

Finally, *accountable interdependence* refers to the mutual dependence that all team members have regarding the quality and quantity of each individual's work within the team.

Attitudes Toward Team Work

Results from studies about the use of teamwork activities in classrooms mention that these activities help students to see the benefits of working in team [3,7,8]. However, negative team experiences undermine students' attitude toward teamwork. Most students recognize that teamwork in the classroom helps them to improve their interpersonal skills, but still prefer individual work to teamwork in order for individual effort to be recognized [31,32,33,34].

The most significant aspect affecting students' attitude toward teamwork is freeloading or social loafing [33,34]. Social loafing refers to the reduction of individual effort exerted when people work in groups when compared with when they work alone [10]. Social loafing makes individuals reduce their own efforts in an attempt to establish equity in effort for achieving the task. Results show that social loafing is not only a prevalent collective action problem but is also expected to

happen and even tolerated by some members [33]. Social loafing happen when there is not information concerning to group member's intended level of effort in conditions in which individual output is not identifiable [35].

Social loafing effect can be eliminated when individual efforts or contributions are identifiable in the outcome and processes [36]. High personal involvement, task complexity, accountability for the group product, clarity of the group goals, collective efficacy, cohesiveness of the collectivity and potential for evaluation are other variables that have been shown to mitigate social loafing effects [10,36]. It is important to note the similarity between the variables to mitigate social loafing effects with those identified as the main characteristics of team effectiveness. It is safe to assume that it is possible that social loafing will not be present in effective teams.

Need for Team Training

Team members need to apply certain knowledge and skills, and develop a positive attitude within the team to warrant an effective team performance [24,34,37,38] and this can be achieved through team training.

Studies of unsuccessful teams and negative team experiences have emphasized the need for team training. For instance, reviewing the conditions under which the use of small groups in classrooms can be productive, Cohen (1994) found that using cooperative learning applications, groups have quite frequently failed to show collaborative or cooperative behaviors [9]. Developers of cooperative learning strongly recommend team-building or skill-building activities prior to cooperative learning.

Snee, Kelleher, Myers and Reynard (1998) evaluated team effectiveness on three organizational case studies using self-evaluation by team members, regular assessment by key managers, and evaluations by managers and team leaders. They found that one of the most common barriers to team success was that the teams were not trained [39]. In the same line, investigation on the effects of cooperative learning strategies on group effectiveness using engineering employees found that training groups on cooperative learning performed better than those who did not receive training [40].

Studies on using teams in the classrooms showing student preference for individual work rather than teamwork were designed assigning students to work in teams with little or no previous training on teamwork [3,7,8]. Therefore, it is possible that learning to use tools for becoming an effective team player could make a difference in making teams in classrooms successful.

Team Training

According to Salas and Cannon-Bowers (1997), team training is defined as an instructional process supported by tools, methods and content that combine to form particular strategies that create a context in which team skills can be practiced, assessed and learned [21]. However, studies show that in the process of training in addition to instructional methods,

elements such as the background and characteristics of the students, during training condition and organizational support, have impact on training outcomes [41,42,43]. Taking this into account, training should be seen as a system rather than a process. Team training could be defined as an instructional system in which individuals enhance knowledge, skills, and attitudes that applied in a team context result in improved team effectiveness.

There is evidence in the literature that team training works [42]. Research on this area, however, has been focused on team training in military settings with specific characteristics such as hostile, dangerous and stressful environments, in which members are required to make complex decisions under severe time pressure [21]. No work is reported in industrial or higher education settings.

Team Training Models

Models, based on research in the military field, have been developed to design team training focused on knowledge and skills competencies related to the task and the team development process [21,44]. Others are focused only on the team building process [45]. In the classroom environment Buckenmyer (2000) developed a faculty and student guide for making classroom teams work [34]. The guide is focused on the elements that faculty and students need to take into account when using teams in the classroom. Turk, McFadden, Stoss and Dreiling (2001) also developed a manual of team building activities useful in educational settings. The manual is focused on the development of team building skills in four specifics areas; foundational teaming skills, communication, relationships and leadership, and collaboration [46].

According to the literature on training, there are five main phases to consider when designing a training program: needs assessment or analysis, design, development, implementation and evaluation [43,47,48]. Most of the team training models in the literature have been focused on the design and development phases. Activities as instructional tools to use when delivering training have been the main objective of these models with the exception of Salas and Cannon-Bowers' model (1997). In this model they mention that the design for team training must take into account the student, the learning environment and the task or context. Tools for diagnosing, assessing, and remediation of team performance are required in order to generate strategies that combine instructional tools, methods and content to create the opportunity for learning [21].

All the aforementioned models have enhancing team performance as training objective. None address team effectiveness in terms of performance, behaviors and attitudes. Armstrong and Reigeluth (1991) and Bohlander and McCarthy's models (1996) are focused on the team development process while Salas and Cannon-Bowers (1997) are focused on the task [21,44,45]. For the former, the content and activities used during training have to be related to the team development stage that the team is at. For the latter, instructional tools, methods and content used in the training will depend on the task. All models assume that team members know what a real team means. None include the assessment of individual knowledge on teams or include content on learning on what a real team is.

The Effective Team Player (ETP) - Team Training Framework

Most of the models and approaches on team building proposed in the literature emphasize the use of group dynamic activities for attempting to explain and teach individuals how to work in teams. As main objective, these activities are focused on clarifying team members' roles and responsibilities [49]. Activities not related to real team environments are used in team building approaches to make teams more effective. All models assume that group members know what it means to be a team member and what it means to perform as a team.

New models need to be focused on factors affecting team performance and effectiveness than on the team building process. There are many factors influencing team performance and effectiveness. Factors related to the individual, context or environment, task and group characteristics have been identified as main elements affecting team outcomes. Factors related to the individual are background, gender, previous experiences with teams and personality. Context or environment related factors are reward systems, supervisory support, organizational culture, organizational communication systems, work place design and team design [13,21,23,27,50,51,52].

Task design, another factor affecting team performance and effectiveness, refers to the characteristics of the task such as task variety, identity, significance, complexity, interdependence, and autonomy. Finally, group characteristics such as expertise, size, stability of membership, norms, potency, cohesiveness, and shared mental models have also been identified as having an impact on team performance.

In the higher education environment the literature shows that learning styles, context, task, individual differences, team longevity, student preference for teaching methods, attitude toward teamwork and misunderstanding of the meaning of teams are the main factors having an impact on team effectiveness. Each of these elements can be identified with one of the main factors aforementioned. In other words any element related to context, task, individual and group characteristics would affect the outcomes of team performance.

Authors of these models propose that factors influencing team performance need to be controlled in order to make the team successful. Commonly, team leaders, managers, coordinators or the person on charge of the team project is who is expected to control all these variables. Some of them share this responsibility with team members. However, if the majority of the variables (context, task, individuals and group characteristics) are not under their control, how can team members or people in charge of teams control all these variables?

Since controlling the variables affecting team effectiveness is a difficult task for those willing to follow the team work approach, researchers have explained that teams need training in order to remedy deficiencies related to some of the variables affecting team performance, especially those related to group characteristics and task [21,42]. Guidelines and checklists have been designed to help deal with these variables [34,53], but variables such as individual differences and context are still unexamined in the literature.

The Effective Team Player (ETP) – team training framework presented in this paper (Figure 1) intends to include all the factors affecting team effectiveness. It is understood that

team members will not be able to control all variables, for instance those related to context or individual differences; but it is possible for team members to develop strategies to make the best use of the skills they possess to make the team successful. Therefore the foundation of the ETP-team training framework is preparing team members to consciously understand the meaning of teams. They will be trained on understanding the difference between teams and groups, barriers and characteristics of the teaming process and factors that make and affect team effectiveness. Under the proposed framework even though, team members still cannot control all variables, they will be able to use the knowledge and skills that they have learned from the training program to choose the best strategy to make the team successful.

The framework assumption is that team members need to know, understand and be able to address the causes of team failure through understanding and learning about the factors that will be present during their team process and how these factors can affect their effectiveness. The framework proposes that team members understanding in advance about the causes of possible barriers that they will face in their teaming process, will give them the advantage of being able to develop strategies in order to overcome barriers based on their skills and capabilities. Strategies that will conduce the team to success.
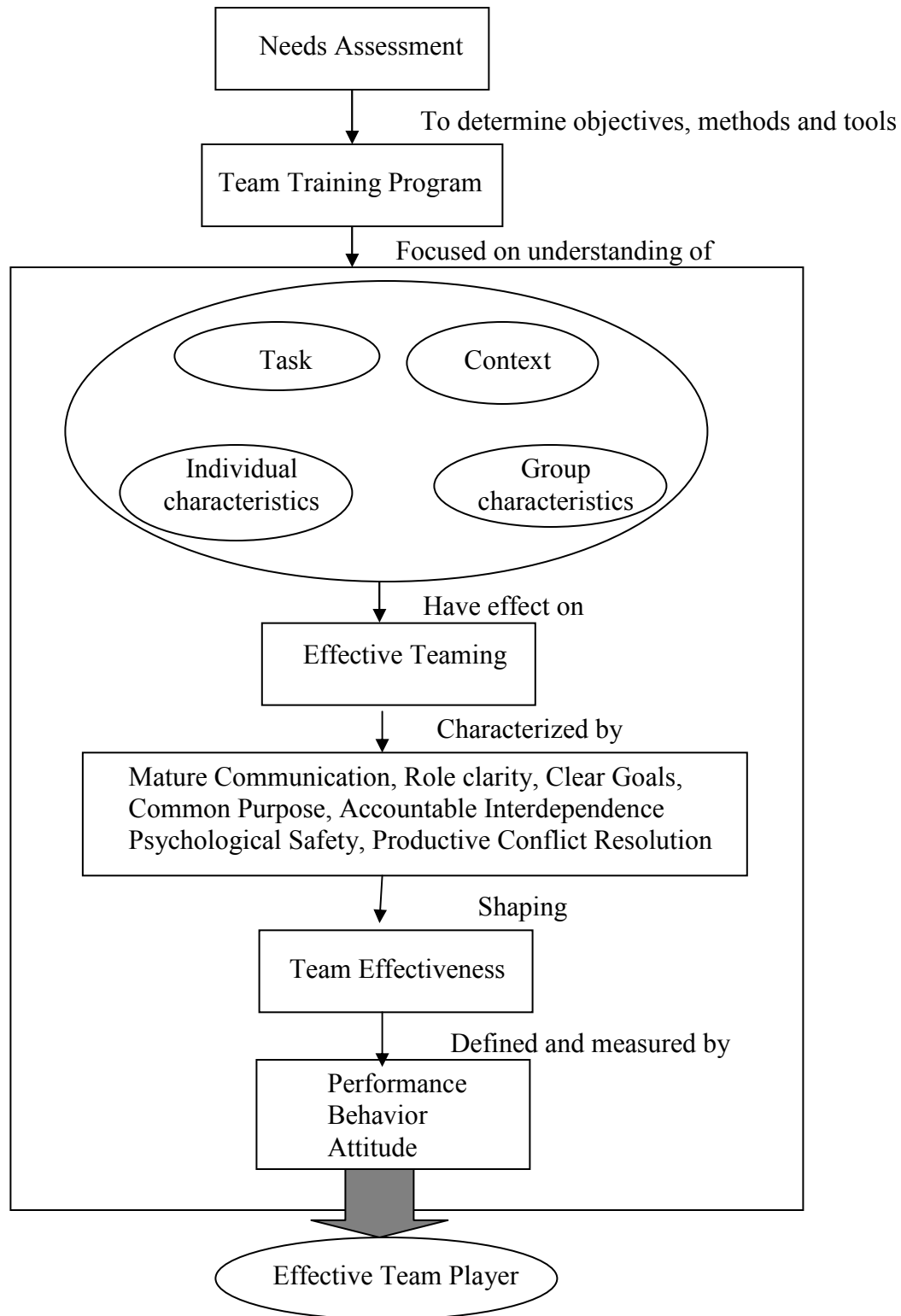
The ETP - team training framework begins with a *need assessment* phase in which individual and team deficiencies are detected in order to determine objectives, methods and tools of training. Even though all topics on team process and team effectiveness will be covered in the training; objectives, methods and tools will make emphasis on addressing weaknesses in knowledge, skills, behaviors and attitudes identified in the need assessment phase.

After the assessment, the team training program should be designed. Based on the outcomes from the need assessment, the team training program is designed with instructional strategies focused on team members' understanding and learning of factors affecting *effective teaming* and *team effectiveness*.

As shown in the framework, the training program should be focused in make team members understand that context, individual, task and group characteristics affect effective teaming as supported by the literature. Effective teaming is defined as the process which teams go through displaying specific characteristics that make the team effective. These characteristics are mature communication, role clarity, clear goals, common purpose, accountable interdependence, psychological safety and productive conflict resolution. The presence of these characteristics during the team process is the key for the team achieving success. The degree in which these characteristics are present in the team process will shape team effectiveness in terms of performance, team behavior and individual attitude toward teamwork.

In summary, the framework implies that any team training program should be designed to prepare team members for managing their own team process and be able to define and apply strategies that allow them to deal with those factors affecting team effectiveness. Program content, activities, and resources should be targeted to students achieving a conscious understanding of the process of teaming and team effectiveness as the key for preparing them to become effective team players.

Figure 1. The ETP-Team Training Framework

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