IMPLEMENTING *"STUDENT LEARNING TEAMS"* IN ENGINEERING ECONOMICS

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ABSTRACT

Universities constantly strive to provide students with a solid education in their discipline. The real challenge in obtaining this goal is the creation of an educational environment that stimulates and encourages student learning. The key to establishing this dynamic learning environment involves engendering in students a deep personal sense of ***ownership*** *of their education. When students accept the personal responsibility for learning they automatically assume a more proactive role in the educational process.*

Using ***"Student Learning Teams"*** *is one way of fostering the student's sense of ownership. Learning becomes both a personal and group responsibility with individual team members holding each other accountable for the course material. Team sessions or meetings become mini-classroom experiences with every member functioning in a variety of important roles inherent in any team. Also, developing teams following engineering models used in industry provides the "organizational" foundation, authenticity and realism necessary for a meaningful and worthwhile student learning experience.*

Research on group development in industry indicates a team's effectiveness is a function of five areas encompassing the performance domain. These areas include ***mission, roles, operating processes, interpersonal relationships, and inter-team relations****.*[1] *When using* ***"Student Learning Teams"*** *in an academic setting each of these areas must be thoroughly understood and adequately addressed by the faculty member and student team member. Knowledge of these areas significantly increases the team's level of performance. This understanding permits teams to achieve a synergistic relationship that greatly enhances the likelihood that the team's goals will be accomplished.*

While this paper discusses incorporating ***"Student Learning Teams"*** *in Engineering Economics classes the concept is equally applicable and has been successfully implemented in both Engineering Statics and Dynamics classes. The paper provides explanations and examples on how to incorporate each of the five functional areas into* ***"Student Learning Teams".*** *Guidelines and suggestions based on "lessons learned" from "coaching" the* ***"Student Learning Teams"*** *are presented to assist those interested in further exploring this method of teaching.*

INTRODUCTION:

Cooperative learning at the college level has been lauded as one of the most effective means to enhance student learning. This was pointed out explicitly in the following reference.

> "The best answer to the question, "What is the most effective method of teaching?" is that it depends on the goal, the student, the content, and the teacher. But the next best answer is, 'Students teaching other students.' There is a wealth of evidence that peer teaching is extremely effective for a wide range of goals, content, and students of different levels and personalities."[2]

The cooperative learning experience usually manifests itself in the form of ***informal*** groups, ***formal*** groups, and ***base*** groups. The longest lasting of these groups, the **"base"** group, is usually constituted for the duration of the academic term. Base groups are long term cooperative learning groups with stable membership whose primary responsibility is to provide support, encouragement and assistance in completing assignments.[3] ***"Student Learning Teams",*** hereafter referred to as **"SLT",** use the base group cooperative learning model as an integral part of its conceptual foundation and, of equal importance, it relies heavily on another significant major element to help students achieve maximum learning. This additional major component of the foundation draws upon the research in the areas of group dynamics and organization development.

Linking an academic cooperative learning model with an industrial based group dynamics and organizational development model extracts the best of both to the full advantage of the student learner. Additionally, since "teams" are widely used in the engineering profession, the "SLT" concept takes on added significance when implemented in technical classes. As a consequence of the integration of these two models, "SLT" fosters collective ownership, group responsibility, individual accountability, positive interdependence interpersonal skills, and group processing. It addresses these from a team's effectiveness perspective and uses group dynamics and organizational development nomenclature to identify each of the five areas of performance.

CONCEPT DEVELOPMENT:

Transforming a "group" of randomly selected volunteer students into a "SLT" involves a deliberate process culminating in the synergistic performance of the team. In the academic environment, it entails exposing students to the essentials of what is involved in team building. When SLTs are formed at the beginning of the semester, they are told about the five functional areas of performance they must monitor throughout the term. Continuous discussion occurs on each of these functional areas and especially when "teachable moments" present themselves throughout the semester. Initially, the SLTs are deeply immersed in a dialogue on the first ***three*** functional areas; namely, ***mission, roles*** and ***operating processes.*** This discussion is absolutely essential to begin the transformation from student groups into SLTs.

SLTs are also acquainted with the interpersonal and inter-team dimensions that constitute the fourth and fifth functional areas of the industrial model. However, these can only be intelligently discussed after team members have had the opportunity to interact with each other for some period of time, usually three weeks after the term begins.

Each of the functional areas will now be discussed in detail, thus providing an understanding of the framework and foundation necessary for implementing SLTs.

(1) MISSION

Background:

Effective teams have a compelling vision of their future articulated in the form of clearly defined and well-communicated statement of purpose or "mission". From the mission flows specific goals designed to accomplish that mission. These are formulated and agreed upon by the team members. Extensive interviews with industrial teams noted that in every case, without exception, when an effectively functioning team was identified, it was described by its members as having a clear understanding of its mission and objectives.[4] Numerous other sources confirm this conclusion. One can quickly surmise the importance of a mission and subordinate goals as "critical activities" for effective teams.

Guidelines and Suggestions for Implementation:

SLTs must be taught how to develop a mission statement and supporting goals. This occurs

during the first class period or two before students are assigned to a SLT. They are told the mission statement must ***not*** include any direct reference to a course grade. Rather, the mission statement must focus on what they expect to learn and achieve as a result of being on a SLT learning Engineering Economics.

After constituting the SLTs, each team must produce a *written mission statement* within one week. This statement is reviewed and critiqued by the instructor with the team editing their original statement as necessary. Simultaneously, a *litany of goals* are produced. The reason for this commitment to written goals is to capture the students initial zeal, idealism, and high expectations prior to them encountering the "nitty-gritty" of the day-to-day trials and tribulations of being on a team.

SLTs reflect on their mission statement and goals throughout the semester. This helps them rekindle the "fire" of their collective commitment to becoming a team. The instructor must also *challenge, exhort and reprove* the teams, especially during the first month of the term. This "coaching" serves to intensify the seriousness of the commitment the students made while providing them with the finer points on how to succeed at this team experience.

Coaching the SLTs on setting necessary and realistic goals assists the team in establishing their organizational "marching orders" for the semester. Included in the goals are selecting specific times to meet during the week and on weekends for the purpose of doing homework and other assignments, monitoring individual contributions and efforts, deciding when and how to prepare, review and study for major examinations, ensuring individual learning of the material, etc. Goal setting becomes opened ended, offering students an opportunity to adjust as necessary throughout the term. On the other hand, the team's well-conceived and articulated mission statement remains in tact for the entire semester. It serves as a "beacon" reminding them what they are all about and what they are attempting to learn and achieve as a SLT.

(2) ROLES

Background:
In highly effective teams, "work" is organized to support individual and team performance. Individual roles, responsibilities and accountability are clear to everyone. While the team's structure refers to the organization they develop to accomplish their mission, *"roles"* refers more to the behavior expected of individual team members in filling the different positions within the structure. Clearly defining the roles and accountability of team members is one of the most important features in building a team[4]. Also, role clarification needs to occur when a new team is formed, when tasks are assigned, or when there are changes in responsibilities within the team[5].

Guidelines and Suggestions for Implementation:
Role clarification within teams occurs more as a process than an initial assignment. Strengths and weaknesses, along with personal interest, are considered for the various tasks required of teams. The team deliberately discerns which member(s) possess certain abilities necessary for an engineering analysis and they draw upon them when the team engages in problem solving.

Specifically, some students comprehend reading and understanding a problem statement better than others. Some students articulate and guide the ensuring discussion as a correct "free body" or "cash flow" diagram evolves. Still others have the ability to produce a neat, legible and meaningful diagram. While students pay particular attention to the analyzing of the diagram, others have the "calculator" ability to use this tool effectively to obtain the numbers necessary for the analysis. Together, these abilities serve to produce a "solution " of much higher quality with errors than possible, had each student worked the problem individually. This solution, based on the synergistic effect associated with the team, serves to demonstrate in a very tangible form, the

very essence of synergy which can only be learned through actual experience.

(3) OPERATING PROCESSES

Background:

SLTs develop "guidelines" (policies and procedures in industry) to manage their work. These guidelines support both ***"task"*** and ***"relationship"*** needs. The ***"task"*** needs are those activities required for the team to accomplish its various assignments. On the other hand, ***"relationship"*** needs refer to the human needs for recognition, participation, appreciation, and the general quality of ***"life on the team".*** Specifically, operating processes are manifested in the form of problem solving, decision-making, conflict management, and the quality of the team's meetings where a variety of learning occurs in a non-threatening environment.

Also central to the effectiveness and efficiency of the team's operating processes, lies both ***"participation"*** and ***"collaboration".*** While a fine line delineates these two distinct terms, an inseparable connection exists between the two words. Students must thoroughly understand this relationship and how each term applies to the other. One could easily argue that collaboration is not possible without participation and that participation leads to collaboration. In short, summarizing the connection between the two terms, every individual has to be a proactive member of the team ***exercising initiative*** and ***accepting responsibility*** for their individual contributions to the success of the SLT.

Participation or the willing and deliberate engagement in the SLT's "work" is essential to take full advantage of the resources of the SLT. Without it the potential of emergent solutions to problems, be they task or relationship in nature, is severely limited. On the other hand, collaboration has been defined as "a process in which those parties with a stake in the problem actively seek a mutually determined solution. They join forces, pool information, knock heads, construct alternative solutions and forge an agreement. When collaboration exists, team members who see different aspects of a problem can constructively explore their differences and the reasons for these differences."[6] Understanding this, they can begin the search for solutions that go beyond their own limited vision of what is possible.

Guidelines and Suggestions for Implementation:

The primary "operating process", which receives the most direct and obvious attention by a SLT, is "problem solving" since it is so germane to the SLT's "work". It focuses on the SLT, developing a specific problem solving methodology that they will utilize throughout the term. Each SLT creates its own unique way to solve problems and the method is perfected as the SLT does the assigned homework.

Informal evaluations of the SLT's operating process indicate the most effective methodologies encompass a three-phase analysis. The first phase observes the SLT members working collaboratively to ensure they (1) understand the problem statement, (2) agree upon the proper free body (cash flow) diagram and (3) mutually support the conceptual solution to the problem. The first phase represents the most critical one since the vast majority of problem solving errors occurs in this area.[7]

The second phase involves SLT members individually working out the subsequent details, usually the number crunching, associated with arriving at the solution. The third phase sees the students again discussing, critiquing and providing feedback to each member on their conceptually understanding of the problem and the individual work they each just performed.

The primary motivation for the SLT to develop an effective and efficient problem solving methodology lies in the fact SLTs take the major examinations together as a team. Having a proven problem solving "operating process" developed on homework problems is critical for the

success of the SLT when they take these major examinations. Team members understand the necessity to establish and perfect a problem solving method developed in the non-threatening homework environment.

Other areas under "operating processes" include the actual conduct of SLT meetings, decision making, conflict resolution, team standards and norms, rewards, and monitoring and evaluating team performance. A detailed discussion of each of these aspects of operating processes lies beyond the scope of this paper. Collectively, they are a topic for future development and discussion.

(4) INTERPERSONAL RELATIONSHIPS

Background:

Basically, the higher the quality of the interpersonal relationship the more effective the team will be at accomplishing its mission and achieving its goals. Each team member needs to be fully interactive with every other team member. Also, a high level of trust must exist if the problems encountered are to be solved in an equitable manner. In turn, a positive trust experience lends itself to the team's work being productive, satisfying, and personally rewarding to its members. Trust is the key ingredient at the heart of good team communications.

While the subject of team communications is extremely broad, it must provide for clear and candid exchange of information within the team. An essential part of communication lies in communicating the high expectations for performance team members must have for each other. When expectations are clear, concise and articulated explicitly, it sets the "tone" and standards for performance, participation and collaboration required of each team members.

In general, the literature on team development prescribes open communications that is assertive and task focused as well as creating opportunities for giving and receiving feedback aimed at the development of a high trust climate.[8]

Guidelines and Suggestions for Implementation:

From an interpersonal relationship perspective, *two* areas need immediate attention. First, students must have time to get to know each other; and, secondly, the team must ensure each team member will be available throughout the semester to do the SLT's "work".

Regarding the first point, the vast majority of students do not really know each other even though they may have been in several classes together. Being assigned to a SLT is a new and somewhat frightening experience for them. Initial exercises aimed at helping them overcome their anxiety and learn more about each other are imperative for the first week of class. This significantly minimizes the time group members need to become "comfortable" and somewhat "accepting" of each other before they begin functioning as a team. Numerous techniques for accomplishing this are available through a wide variety of training firms.

The second issue above requires some guidelines be agreed upon and adopted by the teams to ensure an "equity of effort and availability standard" applicable to any individual choosing to be on a SLT. This permits fairness to other team members and attempts to prevent any serious confrontation over certain team members not being available when the SLT meets to accomplish assigned projects, homework, studying for exams and any other requirements levied upon the team.

Several conditions can naturally exist which limit and preclude the trust relationships essential for the SLT's success. These include, but are not limited to, students with outside commitments such as part time/full time jobs, living off campus, commuting excessive distances, military training, family responsibilities, a "loner" attitude, introverted personality, etc. While not

intentional on the part of the student(s) they breed suspicion about some student's willingness to bear their part of the responsibility required of the SLT members. Having the guidelines in place at the beginning of the term helps minimize the potentially negative impact of the above.

Constant monitoring of the SLT is also recommended to ensure the teams are developing as required. Students are encouraged to immediately visit with the instructor and discuss any problems, particularly interpersonal relationship problems, which develop in the SLT. When "trust" has been compromised, usually in the form of a team member not living up to an agreed upon expectation, the "coach" must intervene immediately to prevent the self-destruction of the SLT. Depending on the severity of the trust infraction, the "coach" may choose to remove the team member in question from the SLT. If this is necessary, the extricated individual continues taking the course but does so by themselves and without the imposition of any penalty.

(5) INTER-TEAM RELATIONS

Background:

One of the most serious drains on organizational energy results when departments or divisions of the same organization compete inappropriately with each other. If "win-lose" situations exist they need to be changed to "win-win". "Win-win" foster cooperation rather than competition within an organization. While competition has its place, namely when dealing with external competitors, it is completely dysfunctional internal to a firm.

Paul Lawrence and Jay Lorsch, researchers at the Harvard Business School, have suggested that four variables are the root of cooperation between groups. These include ***time orientation*** (depending on the nature of the work, groups operate with different time frames); ***goal orientation*** (different groups have different goals); ***interpersonal orientation*** (some groups emphasize task-oriented style while others have a relationship-oriented style); and ***internal formal structure*** (some groups have more written policies, systems, and controls for performing their work).[1]

Guideline and Suggestions for Implementation:

Traditional classroom learning environments usually imply competitiveness among students. While appropriate in certain academic circumstances, this type of learning atmosphere is not conducive or supportive of SLTs. Each class must view itself as a collection of teams working within and for the same corporate entity. This scenario sets the stage for "cooperation" rather than "competition" among the SLTs. Explaining and modeling the necessity for cooperation among the teams is another requirement of the "coach" or instructor.

One of the primary reasons competition exists in a classroom, focuses on the "grade" each student ultimately receives for the course. While essential that grades be given, the competitive implications of attaining it can be minimized.

After numerous years of teaching a subject, instructors should possess a fairly clear idea of what final score is necessary for students to receive the various grades possible for the course. With this knowledge, publishing this information the first day of class sets the external academic standard of performance for the students. All students, whether they choose to be on a SLT or not, are told explicitly they are ***not*** competing against each other but rather against the written performance scale just published.

To further emphasize this point, all students are told that, "Yes, everyone in the class could theoretically receive an "A" or an "F" depending on their performance for the course". Although this is very unlikely, it demonstrates the reality of "non-competition" between students and SLTs in the course. Students desiring a certain grade can only obtain it by achieving a final score in

the range specified for that grade. Performance rather than competition with other students or SLTs are the only criteria to achieve their desired grade.

Along that same line, another important consideration involves "how" the SLTs are to be tested. One of the major challenges of using SLTs focuses on providing the team with some definite "reward" for their collective performance while ensuring the integrity of individual learning. Without a grading component serving as a team "reward", little incentive exists for students to participate fully and learn the underlying concepts, skills, and synergistic potential associated with being a member of a high performance team.[9] Consequently, a team grading method needs to be developed to support the basic premise of being on a SLT.

The second major element that contributes immensely to "cooperation" rather than "competitiveness" among SLTs focuses on developing a healthy *interdependence* between them. This can be accomplished when two SLTs become "partners" for a short time during the semester. The teams become functionally interdependent when they learn new course material and are required to teach that material to their "partner" team.

The responsibility and accountability of each SLT for both learning and teaching culminates when testing occurs on the new course material. "Partner" teams are tested on what was taught to them by their other "partner" team and ***not*** on what they learned firsthand from the course instructor. Both "partner" teams receive the identical test score earned by each "partner" from their portion of the examination.[10] Details of this innovative cross-teaching concept are found in the reference.

CONCLUSIONS:

"***Student Learning Teams"*** offer a viable complement to the traditional classroom model. The unrealized by-product of employing SLTs is the development of organizational and communications skills which are not available in the usual learning environment.[11] While conveying the required course content, the SLT model offers the added advantage of an experiential component of learning which cannot be obtained any other way.

Intrinsically connecting the academic collaborative learning models with the organizational development and group dynamics research in industry, yields an educational concept readily accepted by students. This observation is based upon several years of positive student evaluations and feedback very supportive of the team building experience gained while functioning as a member of a SLT.

Team based production models are rapidly gaining popularity in the corporate world and are the key to improving performance in all kinds of organizations.[12] The synergistic results associated with functioning as an empowered team to produce a quality product are abundantly available from numerous sources. Educating students to this reality needs to be done concurrently while they are acquiring university level "knowledge" to become responsible, mature and competent members of their profession and society.

The "Guidelines and Suggestions for Implementation" in this paper are derivatives of the "lessons learned" from several years of using SLTs in academia and from consulting engineering management experience. The latter involves assisting firms in transitioning from a department to team based production environment.

Finally, utilizing ***"Student Learning Teams"*** is more of a *process* than an end product. Implementing the concept, learning from the experience as it is being lived, experimenting with one's own ideas to enhance effectiveness, and seeking feedback from the students, will build the confidence necessary for the instructor to become "comfortable" and "knowledgeable" with it.

The end result for the students will be a new type of learning environment conducive to taking more ownership, exercising more initiative and overall being more responsible for their education.

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