Active Learning: A Range of Options Intended for Engineering Faculty in the Arab Gulf States

Waddah Akili

Professor of Civil Engineering (Retired)
Principal, Geotechnical Engineering
Ames, Iowa, 50014, USA

Abstract:

This paper reviews the literature in search of common forms and strategies of *active learning,* engineering faculty in the Arab Gulf States (the Region) could add to their repertoire as viable alternatives to traditional teaching. The article is a follow up to previous work, by the author, on viable strategies to improve the classroom environment of engineering colleges in general, and those of the Region, in particular. To start, the paper provides an overview of relevant benchmarks of engineering education in the Region. Then, defines common terms in relation to: *learning stages* and *learning styles*; and focuses, in detail, on meanings and forms of *active learning* believed to be effective and implementable in the Region**.** Next, it examines potential barriers against *reformation*, in general, and the use of *active learning* strategies in particular; and finally, points out how obstacles against barriers could be overcome. To conclude, there is a broad and solid support for reformation of engineering colleges in the Region! The outcome of a recent survey attests to the overwhelming desire of Region's engineering graduates toward a shift in the direction of *active learning*, and favoring, specifically, methods that promote students' engagement.

Introduction:

Active learning is generally defined as a wide range of instructional methods that engage students in the learning process. It has recently attracted strong advocates among faculty members in the Arab Gulf Region(Saudi Arabia, Bahrain, Kuwait, United Arab Emirates, Qatar, and Sultanate of Oman) looking for alternatives to traditional teaching methods that have persisted for decades, and have adversely affected outcome. Some have suggested that many of the deficiencies of engineering graduates in the Arab Gulf Region, are largely attributable to the rigidity of the curricula and the passive approach to teaching, practiced on a wide scale.[1-5]

Fortunately, more and more engineering educators are becoming aware of the need to reform the current education systems in the Region, and assert that *active-engagement* methods are the right choice. For many faculty there remain questions about what *active learning* is, and how it differs from traditional engineering education; since students are presumed to be actively involved while

listening to formal presentations in the classroom.[6] Analysis of the research literature,[6,7,8] however, suggests that students must do more than just listen: They must read, write, discuss, or be engaged in solving problems. Most important, to be actively involved, students must engage in higher-order thinking tasks, such as: analysis, synthesis, and evaluation. Further, cognitive research has shown that a significant number of individuals have learning styles best served by pedagogical techniques other than *straight-forward* lecturing.[6]

A scholarly approach to meaningful teaching requires that faculty become knowledgeable about *active learning* in general, and the ways strategies promoting *active learning* have been successfully used across the disciplines. Additionally, each faculty member should engage in self-reflection, exploring his/her personal willingness to experiment with alternative approaches to the common practice of traditional lecturing.[6] Within this context, and from author's perspective, the paper sheds light on the common forms of *active learning* most relevant for engineering faculty in the Arab Gulf Region. Further, it examines the core elements for each method, looks at the pros and cons, and underscores those specifics that are believed to be implementable in the Region. In short, careful selection from published literature on alternatives to traditional classroom presentations provides a rich menu of different approaches, faculty in the Region could readily add to their repertoire of instructional methods.

This paper is a follow up to a previous one, by the author, on viable strategies to improve the classroom environment of engineering colleges in general, and those of the Region in particular.[4] It compliments the previous paper by focusing on common forms of active learning believed to be effective and, with proper planning, could be implemented in the Region**.** Reforming engineering education presents a formidable challenge to the various "stakeholders"(administrators, faculty members, students, graduates, industry, and government leaders) in the future of engineering education. Despite conflicting views and interests of stakeholders, plus academe's bias toward preservation of the status quo; the author believes that debating the issues and allowing differing views to surface would help to lay the foundation for future reform initiatives. Therefore, the objectives here are two fold: to amplify the need for reformation of the educational systems, and to motivate young educators of the Region to consider using *active learning* as an alternative to other forms of learning.

In this article, the author draws on: his long-term experience as an academician; his direct involvement and familiarity (as a parent) with the education systems of the Region, where his five children progressed through the systems of the Region, i.e., from kindergarten all the way through college; along with views of: colleagues, ex-students, alumni and others in the same arena. The author is strongly committed to the Region, and has been an advocate of reformation of its current education systems at all levels! It should be pointed out here, that the *need for reformation* is by no means author's views alone, but rather the consensus of opinions of Region's engineering graduates, arrived at through a properly conducted survey[5] back in 2000. Pertinent details concerning the survey are provided below.

The article addresses several interrelated spheres of information. First, it provides an overview of the education systems of the Region, citing relevant specifics. Second, it defines the term *learning* and highlights some concepts and views on *learning styles*. Third, it examines the

literature, in some detail, on meanings and substance of *active learning*; how to proceed with *active learning,* and focuses on *strategies and methods* deemed appropriate for the Region. Finally, it considers all the potential barriers against *reformation* in general and *active learning* in particular; and points out how obstacles may be overcome?

As previously noted, although the paper is primarily intended for novice engineering faculty of the Region; the information provided here may well be of utility elsewhere!

Relevant Bench Marks of Engineering Education in the Arab Gulf States:

Engineering education in the Arab Middle East is relatively new, as organized educational endeavors go. It had its early start shortly after World War I. Colleges of engineering (or schools of engineering as they were labeled) were founded then, in Cairo and Alexandria, Egypt, and also in Beirut, Lebanon. By the end of World War II, colleges of engineering sprung out in Iraq and Syria. And two decades later, Jordan had its first college of engineering in its capital, Amman. The colleges in Lebanon and Syria paralleled, by and large, the French schools of engineering; except for the American University of Beirut (AUB), typically a North American school, looked after by a consortium representing colleges on the East Coast of the USA. Colleges in Egypt and Iraq were influenced, at the time of their establishment, by the British system of education.[1,2,3]

Engineering education in the Arab Gulf States (the Region) started, in earnest, during the early to mid sixties. Initially, colleges of engineering were founded in Riyadh, Jeddah, and later, in Dhahran, Saudi Arabia. In the other smaller states of the Region, engineering colleges were founded soon after these states have gained their independence.[1,2,3]

The strong political and economic ties between the States of the Region and western countries- the USA in particular- has helped enormously in setting up, manning, and providing needed guidance to these fledgling institutions during their early years. The dramatic increase in oil revenues during the 70s, and 80s, coupled with lack of skilled professionals in areas deemed necessary for growth and development of oil-related industries of the Region, has been pivotal in the start-up of higher education in general and engineering in particular. There are today eight public colleges of engineering in the Region (Table 1) in addition to several, recently established, private and semi private colleges and/or universities that offer engineering degrees.

These eight public colleges have, since their inception, been guided by advisory boards made up largely from faculty members and administrators drawn from US colleges. Previously, the Grinters Report[9] and the Goals Report[10] have been used to guide the educational process. Recently, ABET Engineering Criteria 2000[11] has been the subject of seminars and workshops, intended to shed light and assist engineering colleges in the Region in making use of the EC2000 whenever possible. Indeed, the EC2000 has generated a lot of interest and challenges in the Region. Whether or not it will be fully implemented, would depend on: institutional vision, available resources, students' preparedness, and prevailing traditions and norms.

Country	*College of Engineering*	*Year Established*
Saudi Arabia	King Saud University – Riyadh	Early sixties
Saudi Arabia	King Abdul-Aziz University - Jeddah	Early sixties
Saudi Arabia	King Fahd University of Petroleum and Minerals (KFUPM) – Dhahran	Late sixties
Bahrain	University of Bahrain – Manama	Mid seventies
Kuwait	College of Engineering and Petroleum at Kuwait University - Kuwait City	Mid seventies
Qatar	University of Qatar – Doha	Early eighties
United Arab Emirates	UAE University - Al-Ain	Early eighties
Oman	Sultan Qaboos University – Muscat	Mid eighties

Table 1. The Eight Engineering Colleges of the Arab Gulf Region

The public colleges of engineering -eight in all- are part of the public university systems of the Region, and thus are government run and almost totally government financed. The organizational structure is nearly the same in all. Students are mostly nationals of their respective countries and graduates of similar public education systems. Admission policies, for all eight colleges, are based on grades obtained in an official examination sanctioned by the Ministry of Education, upon completion of the 12th grade. Additionally, an entrance exam and evidence of proficiency in English, a requirement imposed by many of these colleges, may exempt the applicant from a pre-engineering "prep year" administered as a separate unit from the college. Statistics have shown that over 80% of first year engineering students do attend the "prep year," during which students embark primarily on improving their English skills. The author has proposed to reform the "prep year" by making it two years, and widening the scope of the subject matter to include (in addition to building up English language skills to a pre-set level), the following tasks:(i) math and science courses, in preparation for engineering "gateway" courses;(ii) a practical hands-on "pre-college" training period; and,(iii) fostering a "proper learning environment", to help students acquire desirable attributes such as: analytical skills, curiosity and desire to learn, creative thinking, and the importance of team work [2, 3]

Thousands of native Arabs (citizens of the Arab Gulf States) have completed their engineering education at one of the eight public colleges (Table 1) of the Region, and have occupied government positions or joined the private sector, side by side with expatriates. Some have established their own business, and many have moved up the ladder into responsible managerial positions. *In a recent **survey** directed at graduates of engineering colleges of the Region on: the pros and cons of the engineering education they have received, and any advice they may be willing to offer? **Fifty seven** out of a total of **sixty five** respondents were critical of the*

classroom environment and teaching styles practiced during their college years. By and large, majority of the respondents, were between 25 to 30 years of age, citizens of the Gulf States, and either employed or practicing engineering in the Region.

The ***Survey***, conducted in 2000, aimed at getting first hand information from graduates on a number of topics, including :(i) curricula, classroom environment, and *teaching–learning issues*; (ii) alumni- college relations; and, (iii) industry–academe relationships, as perceived by the graduates. Of particular interest here are the remarks made and arguments presented by the respondents, on the need to replace *traditional teaching* that has persisted, with better more effective methods of course delivery.[5]Therefore, the impetus behind this paper has been, the remarks made and suggestions offered by these graduates, who have experienced some negative aspects of a "classroom setting", as students of science and/or engineering in the Gulf Region. Majority of respondents have come to the realization, after having finished college, that learning is not an automatic consequence of pouring information into a student's head. The process should have an enduring value beyond the classroom. It was also a call for faculty to explicitly consider how students engage in their college experience, in both formal and informal ways. In moving forward, we seem to have many tools available, including: select strategies that promote *active learning*.

Learning Stages and Learning Styles:

It is appropriate at the outset to examine the term *"learning"* in general, and to highlight some relevant concepts and views that researchers have put across.[12] *Learning*, as defined today, is more than the acquisition of knowledge. Bloom[13] has defined six increasing levels of learning and/or comprehension, beginning with *fact-based knowledge*, and followed by: *comprehension* (using factual information and explaining facts), *application* (applying facts to solve problems, analyzing concept structures), *synthesis* (creating something new using different components), and *evaluation* (exercising judgments and comparing new facts with existing knowledge). It is said that traditional teaching engages only the first level of learning, as students download information from a lecture and upload it back on an examination and/or a report. Not only does traditional teaching fail to take students through all six levels of learning, it also fails to engage all kinds of students. Kolb[14] describes four stages of learning and four *learning styles* based on the ways people receive and process information. Kolb contrasted receiving information through *concrete experience* (when reading and doing homework) with receiving through *abstract conceptualization* (when thinking about concepts and models). For processing information, once it is received, Kolb contrasted *reflective observation* (when listening to lectures) with *active experimentation* (when involved in active exercises and/or in laboratory settings).[14,15] Learning is enhanced as more of the *learning styles* are engaged. It is believed that about 20 percent of the information presented is retained if *abstract conceptualization* is used alone. Whereas retention could reach 90 percent if all four stages are employed.[14, 15]

Different preferred *learning styles* are a fertile area to search through when non-traditional "effective" teaching (and learning) is being considered. Teaching is "effective" when it recognizes students' various *learning styles*, and deploys teaching (and learning) methods to stimulate students and engage them in the learning process. The term "learning style" may be

described as: "biologically and developmentally imposed set of personal characteristics that make some teaching (and learning) methods effective for certain people but ineffective for others."[16] Other models of *learning style* preferences have been described. The most prominent ones are: the Myers-Briggs Type Indicator (MBTI),[17] the Felder-Silverman Learning Style Model,[18] and the Dun and Dun Learning Style Model.[19]

The MBTI, based on Jung's theory, has been popular in explaining differences in learning for normal people. The dimension of most interest for learning is *sensing*(S) versus *intuitive* (N) type.[20] The *sensing* person prefers a straightforward, logical, step-by-step approach to learning. The *sensing* person often learns by solving problems, and tends to find theory difficult. The *intuitive* individual, on the other hand, will skip steps and follow hunches. He/she learns from theory and tends to do a minimal number of problems because they think they understand without having to solve problems.[21]

Perry's Model of College Student Development[22] can also be used to monitor student learning. According to this model, which consists of nine positions (i.e., stages) occupying four general outlooks, people progress from positions 1 and 2, (dualistic), *right versus wrong* orientations to multiplicity (positions 3 and 4) where *multiple answers* are possible. Positions 5 and 6 are assigned to *relativism* where the person realizes that the world is *relative* with right versus wrong being a special case. Finally, people may reach stages 7, 8, and 9 - these three stages represent *commitment to value within relativism*. Generally, students move up the scale (i.e., from 2 or 3 to 4 and 5) with gaining knowledge, maturity and experience.

Another useful way of considering student learning is to look at *deep* versus *shallow* approaches to learning.[23, 24] These two terms that describe learning, stem from a research in Sweden.[20] Also, *deep* approach to learning has been connected to chemical changes in the brain which may result in lasting changes in cognition, attitude and character structure.[25] In the *shallow* approach, students focus on learning isolated tasks often through memorization. The student's goal is to be able to reproduce information; and does not focus on understanding but rather on superficial form. In the *deep* approach to learning, students focus on determining the meaning of what they are learning and learning how to connect information, which makes the learning *holistic*. Students who are intrinsically motivated prefer a *deep* approach, while extrinsically motivated students prefer a *shallow* approach. Almost every one is capable of using either *deep* or *shallow* approach to learning; however, people do have preferences. Those who prefer a *shallow* approach may find *deep* approach difficult. And those who are forced to use a *shallow* approach to learning would be annoyed and dissatisfied.[20]

Some engineering educators argue in favor of adopting a learning style approach within a variety of teaching strategies[26] while others have preferred to look at the psychological implications of learning styles in specific educational domains.[27] The author is of the opinion that engineering educators, today, should not overlook the extensive research that exists on *learning styles*. Educators should try to keep up with research development in the arena of learning/teaching styles, and attempt to use it whenever possible. To start, an instructor who is interested in developing his/her classroom skills should begin by discovering his/her own learning style. An interesting question is: *How does the way you learn influence the way you teach?* It is equally

important to contemplate different approaches to accommodate different learners, particularly after having learned about one's own learning style. An instructor with some understanding of differences in students' learning styles is well on his/her way in making his/her teaching more effective.[28]

A viable *learning style* model must be grounded in research, periodically evaluated, and adapted to reflect the developing knowledge base.[19] Implementation of *learning style* practices must conform to accepted standards of ethics, and be carried out by competent instructors, who can provide suitable activities that appeal to each learning style. To promote effective learning, within the context of varied learning styles, it is important to form groups within the class. How do you form effective groups? How do you make groups work? What do groups do? The answers to these questions will differ from one course to another depending on: course type, course content, course level, prevailing culture, available resources, and applicable guidelines.

Research has shown that some learners have to express themselves openly in the class, and do desire personal interaction with the instructor and their fellow students. This type can forge ties easily with others, and sees his/her work and the outcome through the "group". They are excellent participants and extremely successful in "teamwork". On the other hand, there are those that seem to prefer learning on their own. They usually obtain information through abstract *conceptualization*. These individuals are self-motivated, curious, like to test information, resort to trial and error in learning, and can learn by doing. If motivated, the latter individuals can also be active participants and often visualize themselves as group leaders.[28,29] The task of forming groups in his/her course lies on the shoulder of the instructor who has to make sure that the formed group is: homogeneous, compatible, and that each and every group member has the opportunity to learn. The following statements, based on the work of Rita Dunn,[19] and recast by Finelli,et al,[28] provide explanations and add meanings to the concept of *learning style* from different perspectives.

- Each student is unique, able to learn, and has an individual *learning style*.
- Individual *learning styles* should be acknowledged and respected.
- *Learning style* is a function of heredity and experience, and develops individually over one's life span.
- *Learning style* is a combination of affective, cognitive, environmental, developmental, and physiological responses that characterizes how a person learns.
- Individual information processing, fundamental to *learning style*, could be improved over time with practice.
- *Learning style* is a complex construct for which comprehensive understanding evolves.
- Learners are empowered by knowledge of their own and others' learning styles.
- Effective teaching implies continuous monitoring to ensure compatibility of instruction with each individual's *learning style*.
- Teaching individuals through their *learning style* strengths, improves their achievement, self-esteem, and attitude toward learning.
- Every person is entitled to counseling and instruction that is compatible with his/her style of learning.

- Applicable curriculum and teaching methods should ultimately become learning-style based and personalized to address and respect diversity.

The practice of incorporating some or all of the elements listed above in an "engineering" course in which one is already faced with the problem of too much material in too short a time is daunting. But the challenge is exciting to any instructor who wishes to "humanize" the teaching (and learning) process, and reconcile within himself/herself that: he/she is teaching students rather than "unloading" teaching material in accordance with a time schedule.

Examining the Literature on Meanings and Substance of Active Learning:

It is difficult to come to grip with all the cited definitions and meanings, and interpretations of the term *"active learning,"* since different contributors in the field have interpreted some terms differently. However, by gleaming at the literature, it is possible to arrive at general consensus of what appears to be widely accepted definitions, and to shed light on how common terms are used today.

Active Learning is generally defined as any instructional method that engages students in the learning process. It is widely accepted that *active learning* requires students to take part in "pre-planned" learning-related activities, believed to spark and stimulate their learning, while in the classroom.[6] These activities would include: reading, writing, solving problems, answering questions, participating in a discussion, etc.; and most important, students must be engaged in thinking tasks while actively involved. It is generally understood that during *active learning*, less emphasis is placed on transmission of information and more on developing students' skills. Additionally, during an active learning cycle, emphasis is placed on students' exploration of their own abilities, including: their thinking process, their value system, their intellect, and their courage to express themselves orally and in writing. *Active learning* is often contrasted to the traditional lecture where students passively receive information from the instructor.[6,7,8]

Collaborative Learning refers to any and all of the instructional methods where students work together in small groups towards a common goal.[30] It can be viewed as encompassing all group-based instructional methods, including cooperative learning.[8,31,32] However, some researchers view collaborative and cooperative learning as having two distinct historical developments and differing philosophical roots.[33]Despite differences and similarity of the two approaches (collaborative vs. cooperative), the fact remains that the core element of both, is the emphasis on student interactions, as the primary source of learning, rather than learning as individuals.

Cooperative Learning is a formalized active learning structure where students work together in small groups to accomplish shared learning goals and to maximize their own and each others learning. The most common model of cooperative learning in engineering is that of Johnson, Johnson and Smith.[34,35] This model has five specific elements: mutual *interdependence*, individual *accountability*, face to face *interaction*, *interpersonal* and small group *skills*, and individual *assessment* of group *functioning*.[34] Although different cooperative models exist,[36]

the core element in all of these models is the emphasis on cooperative incentives rather than competition in the promotion of learning.

Problem-based learning (PBL) is an instructional method where relevant problems are introduced during the course to provide the context and motivation for the learning that follows.[37] PBL, by and large, is self-directed learning, that helps develop positive student attitudes, foster a deeper approach to learning, and helps students retain knowledge longer than traditional instruction. It is appropriate here to mention that several approaches go under the name of *Problem-Based-Learning*. These known approaches to PBL have as many differences as they have elements in common, making interpretation of outcome rather difficult.[38]

Before adopting a specific method of *active learning*, faculty members need to become familiar with the literature and, in particular, the various strategies that promote *active learning* in the classroom. Despite familiarity with the literature, ambiguity and confusion may result, at times, from reading the literature; particularly when the effectiveness of any instructional method is examined and/or compared with another method. Assessing "what works" requires looking at a broad range of learning outcomes, interpreting results carefully, and quantifying the magnitude of any reported improvement. To assess critically "what works" for a given set of conditions, the reader has to attain sufficient knowledge and familiarity with the subject matter.

Reported studies, by and large, tell us about success stories and seldom reveal what has not worked! Irrespective of how data, results, and interpretations are presented in the literature, faculty adopting a specific method with the expectations of experiencing similar results to those in the literature, should be aware of the limitations of any reported piece of research, i.e., such reports may not reveal all factors and details; and therefore, extrapolating without a thorough investigation would be misleading. This should not, by any means, discourage faculty from moving towards *active learning*; but rather intended as a "precautionary" observation, to new instructors: Not "to make too much" out of what they have read unless it is credible, thorough, and substantiated with facts and figures. Despite some pitfalls, engineering faculty should be strongly encouraged to study the literature on *active learning*, including: the empirical research on its use, and the common obstacles and barriers that may arise as a consequence of its application.

.

How to Proceed with Active Learning?

This study categorizes *active learning* under two headings: A) introducing selected activities into the traditional lecture, and B)Using a formalized active learning structure such as: *Collaborative Learning, Cooperative Learning, and Problem-Based Learning.* Both categories are presented, with the primary intention of being of use to engineering faculty in the Arab Gulf States.

A) Introducing selected activities into the traditional lecture: The modification of traditional lectures is one way to incorporate active learning in the classroom. Research has shown that a number of identifiable attributes must be implemented to make "a run of the mill" lecture more effective. The following attributes and consequences are worth mentioning:

- Students remember material presented at the beginning of the lecture better than information presented at the middle or at the end.
- The effectiveness of the lecture varies inversely with the difficulty of the material presented.
- Listeners, by and large, retain factual material better when sentences are short and concise rather than long sentences.
- Speaking extemporaneously is more effective than reading from lecture notes.
- Changing the pitch, intensity, and timber of one's voice during the lecture is positive and helps to draw the attention of listeners.
- Lengthy lectures are not conducive to efficient learning.

A related line of research has demonstrated, that if students are given the opportunity to clarify their notes by *pausing* two to three times in an hour-long lecture, they would learn more as a result of the pause procedure.[39] Two other simple yet effective ways to involve students during a lecture are: to insert *brief demonstrations* that can be used to stimulate students' curiosity and to improve their understanding of conceptual material and processes; or short *in-class exercises*(not to be graded) followed by a class *discussion*. Other alternatives to the lecture format to further increase students' engagement: i) the *feedback* lecture, which consists of two *mini-lectures* separated by a small group study session built around a study guide, and ii) the *guided* lecture, in which students listen to a 20 to 30 minute presentation without taking notes, followed by writing what they remember and spending the remainder of the class period in pre-arranged small groups clarifying, elaborating the material, and correcting and adjusting their notes.[40]

The modification of traditional lectures give rise to a common question: "Is the large class a special case?" Although a shared perception among many faculty members is that large classes preclude significant participation by students, the literature suggests otherwise.[41] For example, a faculty member in a class of any reasonable size can instruct students to write a brief response to a question, to pair with another student seated on the left or the right, and to compare and contrast both responses. Simply stated, activities could be tailor-made to take into consideration the class-size, if need be. Also, it should consider differences in levels, nature of the material being taught, and the maturity of the recipients.

In-class discussion is considered by most as a very effective strategy in promoting active learning. If the objectives of a course are: to promote long-term retention of information, to motivate students toward further learning, to allow students to apply information in a new setting, or to develop students' thinking skills, then discussion is preferable to lecture.[42] Research has pointed out that to achieve the goals noted above, faculty must be knowledgeable of alternative techniques and strategies for questioning and discussion and must, also, create a supportive intellectual and emotional environment that encourages students to take reasonable risks.[43]

Additional strategies promoting *active learning*, within the context of modification to traditional lecture, have been similarly shown to influence favorably students' attitudes and achievement. *Visual-based* instruction, for example, can provide a helpful focal point for other interactive

techniques. Two other popular instructional strategies based on problem–solving models include the *case study method* and *Guided* Design.[6, 44] The latter, is based on a modified decision-making model that explores solutions to open-ended problems.[44]Guided Design has numerous advocates and has been implemented in many undergraduate disciplines.

Lecturing is invariably the dominant form of teaching and will remain so for along time to come! However, despite known constraints and limitations of lecturing and classroom setting, there are those characteristics that could make "lecturing" per say a more desirable approach in the classroom. The instructor is undoubtedly the major player, the proponent, the decision maker, and the one who selects appropriate methods of delivery compatible with: course objectives, the complexity of the subject matter, the physical setting of the classroom, and the capabilities of the learners. Lectures have a number of characteristics that can make them a desirable approach in the classroom. An enthusiastic instructor could:

i) Communicate the intrinsic interest of the subject matter differently from any other form of communication or media;
ii) Provide students with a thoughtful, scholarly role model to emulate;
iii) Describe, relate, and comment on subject matter revealing different views, including: recent research, new developments, personal experiences, and material not yet documented in textbooks;
iv) Organize material in ways to meet the particular needs of a given audience; and
v) Deliver efficiently large amounts of information if certain conditions are met.[45]

The above noted characteristics presume that the lecturer is an enthusiastic, caring, and knowledgeable scholar. We all recognize that most campuses have few gifted and dedicated practitioners, who routinely achieve these ideals; but majority are not! Even if it is assumed that most lecturers possess these desired characteristics, research suggests that *the exclusive use of straight- forward lecture in the classroom constrains students' learning.* Even with bright, competent students listening to an interesting lecture presented by a knowledgeable speaker, several serious problems would arise; including: i) *inattention* within 15 to 20 minutes; ii) *boredom*; and, iii) *inability to recall*, with clarity, major points and/or significant details. The evidence suggests that if an instructor's goals are not only to "unload" information but also to develop *cognitive skills* and to change *attitudes*, the *alternative teaching strategies* should be interwoven with *straight lecturing* during classroom presentations

It is therefore necessary that faculty of the Region realize the negative aspects that *straight lecturing* has on learning in general; and be willing to "leap forward" with *alternative teaching strategies*. To begin with, introducing *appropriate modifications* to traditional lectures-as pointed out earlier- would be a step in the right direction.

B) Using a Formalized Active Learning Structure: There are those well established learning protocols, defined earlier, namely: Collaborative, Cooperative, and Problem-Based-Learning. These methods have been extensively tried out over the last two decades and the evidence for their effectiveness is very compelling. Despite major differences amongst the three separate approaches, they do have a common denominator: *The instructional practices-in the three methods- engage students in the learning process*. In general, introducing activities into the

classroom is both, positive and necessary for active learning; but not sufficient! It is pivotal that activities be designed around important learning outcomes, and at the same time, promote thoughtful engagement on the part of the students. Adopting instructional practices that engage students in the learning process is the defining feature of the three methods.

***1) Collaborative Learning*:** The main element of *collaborative learning* is collaboration (team-based learning) vs. individualistic learning. Often, the analysis focuses on how collaboration impacts learning outcomes. Numerous studies have shown that cooperation ,within a group, improves learning outcomes when compared to individual effort across the board.[34] Included here are improvements in: academic achievements, self-esteem, quality of interpersonal interactions, and perceptions of greater social support.[34,35] *Collaborative learning* not only does a better job of engaging all learning styles, but also does a better job of preparing students for the real world where teams are the norms of modern organizations.[46] Furthermore, some studies have suggested that collaboration reduces attrition in technical programs. A relevant point of interest is the duration of the "group work" Should collaboration be for a long time, or for relatively short periods? Springer et al. investigated the effect of incorporating small ,medium and large amounts of "group work" on achievement and concluded that the highest benefits was with medium time in groups.[47] In contrast, more time spent in groups produce the highest effect on promoting students' attitudes.

Silberman[7] has proposed certain strategies designed to maximize the benefits of *collaborative learning* and to minimize the pitfalls. As an example, one of Silberman's strategies is to give students, a short, well-formatted instructional handout; a brief; or a relevant chart or diagram. ***Ask*** them to read it silently. ***Form groups*** (or subgroups) and allow them to conduct their study session at their own pace. ***Provide clear instructions*** that guide students to study and explicate the material carefully. ***Include directions*** such as:i) ***Clarify*** the contents; ii) ***Create*** examples, illustrations, or potential applications based on the information provided in the material, iii)***Identify*** points that are confusing or with which you tend to disagree; iv) ***Argue*** with the text and develop opposing views; and v) ***Assess*** how well you understand the material. The strategies that could be incorporated in a *collaborative learning* environment are numerous. Instructors have to either design their own or select from a broad range of documented strategies, commensurate with the complexity of the subject matter, the physical setting of the classroom, and the capabilities of the learners. It has been noted that *collaborative learning* is not always effective. There may be unequal participation, poor communication, and confusion instead of real learning.[7] Also, there is the danger of students loafing. Some individuals tend not to work as hard in groups; if every one is responsible, no one is responsible.[12]

To summarize, most of the documented literature is supportive and argues in favor of utilizing *collaborative learning* for promoting a wide range of learning outcomes. In addition, *collaborative learning* enhances interpersonal skills, builds up self-esteem, and makes students better team players.

2) Cooperative learning: *Cooperative learning* is "a formalized active learning structure which entails students working together in small groups to accomplish shared learning goals and maximize their own and each other's learning."[28] Indicators have shown also that an active

learning environment (including *cooperative learning*) impacts student's personality very positively. It tends to boast self-confidence, improves communication skills, and makes the person a better team member. Cooperation will not be induced simply because students are physically near each other. It is actually a state of mind. A willingness to open up to others; exchange information and views with others, and accept the fact that working together is more beneficial to all involved in the exercise. For a cooperative learning experience to be successful, it is imperative that the following be integrated into the exercise and/or the class activity.[28, 34]

- *Interdependence*- Students should perceive that they need each other to complete the planned activity.
- *Interaction*- Students should work together in planning, executing, and arriving at conclusions. They should share the work load, and share the credit.
- *Accountability*- Each student's role and performance is to be assessed, and the results are those of the group (and for the group). Keeping track of the contribution and knowledge gained by each member could be monitored by either testing each and every student in the group, or by randomly selecting a group member (or members) to be tested and thus proxy for the group.
- *Sharing known skills*- Students who possess certain knowledge or skills (examples: computer skills, laboratory skills, data reduction skills, presentation skills) should be willing to pass it on, and/or share it with their group members.
- *Collaborative Skills*- Groups cannot function effectively if members do not have (be willing to learn) or use some needed social skills. These skills include leadership, decision making, trust building, and conflict management.
- *Monitoring Progress*- Groups need to discuss amongst themselves whether they are achieving their set goals; they also need to prioritize the scheduled activities, introduce changes if need be, solicit advice and assistance with the consent of the instructor, and maintain effective working relationships among the members. Instructors also monitor group progress, give feedback on how well each group is doing, report each group's progress to the class as a whole, and insure adherence to accepted standards of: ethics, social responsibility, and safety.

For *cooperative learning* to work effectively during a lecture, the students have to come to class prepared.[48] As a standard practice, students are expected to prepare ahead of lecture time. They are expected to read, attempt to solve problems, and discuss assigned material prior to the start of the lecture. To avoid the negative effects of competition among groups and to foster a spirit of cooperation among all the students in the class, teams are sometimes asked to bail each other out.[48] For example, when a group has achieved what is expected in the allotted time, the group members may be asked to help other groups until every one in the class is comfortable with the particular problem.

Success in implementing *cooperative learning* is attributable, in large measure, to: proper planning, efforts, dedication, and foresight of the instructor. Experience definitely is a major factor. A proper start for instructors wanting to try *cooperative learning* for the first time is to step into it gradually, and to seek continuous feedback as to how the course is going and how the students feel about it. In addition, he/she can tap into available documented sources, attend

seminars/workshops on the subject matter, and discuss planned activities for his/her course with experienced colleagues who can offer constructive comments and advise.

***3) Problem-Based Learning (PBL)*:** *Problem-based learning* is a pedagogical strategy for posing significant, contextualized, real world situations, and providing resources, guidance, and instruction to learners as they develop content knowledge and problem-solving skills.[49] In *problem-based learning*, students collaborate to study the issues of a problem as they strive to create viable solutions. Unlike traditional instruction, which is often conducted in lecture format, teaching in *problem-based learning* occurs within small discussion groups of students facilitated by a faculty tutor.[50, 51].Because the amount of direct instruction is reduced in *problem-based learning*, students assume greater responsibility for their own learning.[51] The instructor's role becomes one of subject matter expert, resource guide, and task group consultant. This arrangement promotes group processing of information rather than an imparting of information by faculty.[52] The instructor's main role is to guide and encourage student participation, provide appropriate information to keep students on track, avoid negative feedback, and assume the role of a fellow learner.[50]

Proponents of PBL argue that real-life problems seldom parallel well-structured, classroom-based problems; hence, the ability to solve traditional classroom-based problems does little to increase relevant, critical thinking skills students need to interact with life beyond classroom walls. Unfortunately, students skilled in solving classroom problems are not prepared when they encounter problems in which they need to transfer their learning to new domains, a skill required to function effectively in society.[53]A properly deployed PBL equips participants with the tools necessary to tackle real-life problems that present an ever changing variety of goals, contexts, obstacles, and unknowns which influence how each problem should be approached. PBL has been used extensively in medical schools, and to a lesser degree in engineering programs. In fact, over 80% of medical schools use the *problem-based learning* methodology to teach students about clinical cases, either real or hypothetical.[54]

The large variation in PBL practices makes the analysis of its effectiveness rather complex. There are different methods and/or practices that fall under the umbrella of PBL, and readers should not be surprised if no consistent results emerge from meta-studies that tend to group together different PBL practices.[8] Despite this, there is a general consensus that emerges as one reviews the literature, which is that PBL produces positive student attitudes.[37, 54] There is also evidence that PBL promotes better study habits among students.[8] PBL has been frequently shown to increase library use, reading in general, class attendance, and studying for the purpose of understanding rather than simple recall.[8, 37, 38, 54]

For PBL to work, students, tutors, and faculty have to have the proper prerequisites: the drive, the curiosity, and the willingness to stay the course despite some pitfalls. Research comparing experts to novices in a given field has demonstrated that becoming an expert is just not a matter of "good thinking," but rather the depth and breadth of factual knowledge that an expert needs to possess in his/her field. The same appears to be true for tutors in PBL.[8] Pointing at what seems to work, there are significant positive effect sizes associated with placing students in small groups and using *cooperative learning* structures. Although PBL and *cooperative learning* are

two distinct approaches, there is a natural synergy that instructors should try to exploit whenever possible. This is to say that the "real problems" used in PBL require "teams" of *cooperative learning* to solve effectively. At the same time, the challenge of "real problems" in PBL could enrich the "mutual interdependence", a major element in *cooperative learning*.[8]

Based on the review presented by Prince,[8] there is no evidence that PBL enhances academic achievement as measured by exams. To the contrary, Albanese and Mitchell[37] report that students in PBL programs scored lower than students in traditional programs on tests of basic science. However, there is evidence that PBL "works" in achieving other important learning outcomes. PBL helps develop more positive student attitudes, fosters a deeper approach to learning, and helps students retain knowledge longer than traditional instruction. Further, since PBL equips learners with problem solving and life-long learning skills; then, an argument could be made that a connection exists between PBL and ABET engineering outcome of life-long learning, since "self-directed learning" and "meta-cognition" are common to both.

How do the particulars of this discussion apply to teaching/learning protocols within the Arab Gulf Region? How ready are the institutions in the Region to switch over from a "traditional" classroom setting to *active learning*? How should these institutions get started? And what prerequisites need to be in-place to bring about the needed "change"? We will address some of these questions in the section to follow.

The Barriers against Reform in General, and Active Learning in Particular:

The present state of engineering education in the Region suffers from: the persistence of "traditional" methods of teaching, inability of decision makers to accept and support reformation, future uncertainties and fear of failure, and "deficient" public school systems that have failed in: a) equipping the graduates with the needed skills, b) imparting the required knowledge, and c) developing the personal traits deemed necessary in transitioning from public schools into engineering education. To address adequately why engineering institutions of the Region have not embraced educational reform-including the incorporation of *active learning* in the classroom, it is necessary to identify and understand common barriers to any instructional change, including:

- The powerful influence of educational tradition;
- The discomforts, anxieties, and uncertainties that a "change" would create;
- Faculty self-perceptions and self-definition of roles;
- Lack of incentives for faculty to change.

Certain obstacles are associated with the deployment of *active learning*:

- The problems that may arise from not covering the assigned course content in the limited class time available;
- A possible increase in the effort spent and in the amount of preparation time;
- The difficulty of using *active learning* in large classes;
- A lack of required resources (materials, equipment, support services, etc.)

Perhaps the greatest barrier of all, however, is the fact that faculty members' efforts to use *active learning* involves risk taking: The risks that students would not participate, use higher-order

thinking, and not learn enough as a result of using *active learning* protocols. Also, risks that may result from faculty members feeling loss of control, lack necessary skills to embark on the process, or be criticized for teaching in "unorthodox" ways. Table 2 shows contrasting characteristics associated with low-and high-risk strategies when using *active learning*.[6] Further, instructional activities may be categorized in terms of the level of risk they entail, as shown in Table 3.

The Role of the Faculty and the Risk Involved: The reform must begin with faculty members' efforts. A plausible start may take place when an individual faculty or a small group of instructors adopt the view of themselves as reformers within their immediate sphere of influence; the classes they teach daily. An excellent first step is to select strategies promoting *active learning* that one can feel comfortable with. Such low risk strategies are typically of short duration, structured and planned, focused on subject matter that neither too abstract nor too controversial, and familiar to the faculty member and the students. In terms of ***class time***, for example, when students meet to discuss an issue or to solve a problem for 10 to 15 minutes, less risk is involved and the bulk of the class time is saved for lecturing and/or pre-planned instruction. Therefore, faculty wishing to incorporate a low risk strategy might consider dividing the class time into segments with mini-lectures followed by short exercises involving *active learning*. Also risk is minimized when ***highly structured strategies*** such as: case studies, feedback lectures, or exercises in Guided Design are incorporated. Conversely, responsive lectures, and discussion groups typically involve less structure. The degree of structure imposed depends on: the nature of the course, faculty member's preference, and students' abilities and background.

Dimension	*Low Risk Strategies*	*High Risk Strategies*
Class Time Needed	Relatively Short	Relatively Long
Degree of Structure	More Structured	Less Structured
Degree of Planning	Meticulously Planned	Spontaneous
Subject Matter	Relatively Concrete	Relatively Abstract
Students' Prior Knowledge of the Subject Matter	Reasonably Informed	Less Informed
Students' Familiarity with The Teaching Technique	Familiar	Unfamiliar
Instructor' Prior Experience with the Teaching Technique	Extensive	Limited
Pattern of Interaction	Between Faculty and Students	Among Students Only

Table 2. A Comparison of Low-and High - Risk Active Learning Strategies.

Lower Level Risk	*Higher Level Risk*
• Structured small group discussion • Class and/or lab demonstration • In-class problem solving • Field trips • Lecture with discussion • Feedback lecture • Brainstorming activities • Quizzes or examinations • Surveys or questionnaires	• Unstructured small group discussion • Individual students' presentations • Uncontrolled students' review session • Invited guest lecturer of unknown qualifications

Table 3. A Classification of Selected Instructional Strategies According to Level of Risk Involved.

In the same vein, faculty can vary in the ***degree of spontaneity*** in the class room. Some routinely write meticulously detailed lecture notes complete with formal definitions, illustrative examples, and pre-set text, views, and conclusions. While others prefer to rely upon skeletal notes, a repertoire of possible examples, and the mood of the moment to: conduct the class, relate their views, and bring the lecture to a conclusion. Another dimension that could influence the risk level associated with a particular strategy is the ***subject matter***. Certain subjects are more difficult to handle in an *active learning* mode, particularly subjects that strongly depend on prerequisites. ***Students' knowledge*** of the subject will also influence the risk involved in an activity; the better informed the students, the lower the risk of instructor's disappointment. ***Prior exposure*** to any given teaching strategy would invariably influence the risk level for both students and instructors; the less experience students or instructors have, the greater the risk. This observation suggests that strategies promoting *active learning* attempted early on in the semester, when students are unfamiliar with a faculty member particular style of teaching, will involve greater levels of risk than the same activities attempted later in the semester.

Faculty members could successfully overcome most of the major barriers to the use of *active learning* and reduce the possibility of failure by gradually incorporating those strategies that involve more activity from students, and therefore greater risks, into their regular teaching style. Before this process can take place, faculty should identify those strategies that they are using and appear to be comfortable with. Then, based on their knowledge and familiarity with other potential strategies, they could determine what they could add to their repertoire of new techniques for potential implementation, on a trial basis during the following semester.[(6)] Until an instructor becomes comfortable with his/her students and reaches a reasonable level of competency in utilizing the selected strategies, he or she are likely to face high-risk situation.

The Role of University Administration: One arena in which college/university administration could help set the stage for wider use of *active learning* is through the recognition and reward of excellent teaching in general and the deployment of *active learning* strategies in particular. Unfortunately, these goals are not sufficiently emphasized by the Administration. While paying lip service to "teaching excellence," most institutions of the Region do not provide clear and

visible support and/or rewards for innovative teaching. Therefore, institutions have implicitly endorsed the status quo of "traditional" classroom instruction.

Faculty members see few incentives to change for several common reasons. ***First***, is the pervasive belief that "we are all reasonably good teachers". ***Second***, there is a very limited financial incentive, if any, to devote the time and effort acquiring alternatives to traditional approaches of classroom teaching. ***Third***, the perception shared by most faculty that time and effort spent pursuing research and research money, is more rewarding, from an institution point of view, than time spent improving one's teaching skills. Thus, although many faculty members, Region-wide, are strongly committed to effective teaching, the system does little to reward or nurture that interest.

In what ways might administrators address this disparity? The author believes that an effort should be made to create a climate for improvement in classroom instruction by changing the social and cultural norms that have prevailed for decades. Such an effort should permeate throughout the academic arena, re-defining the role of teaching, to be championed by the academics throughout the Region. The specifics of such an effort ought to include the following:

- *Rid classroom teaching environment from prevailing passive approaches to learning and plant the seeds for active learning protocols throughout the public education system*. Student-teacher interactions stimulate learning for all parties at all levels.
- *Establish education units and/or centers that define, promote, and encourage the art of appropriate teaching, including active learning protocols*. Scholarly research about teaching, in general, should be encouraged, valued, and discussed.
- *Provide instructors with clear and consistent communications about expectations regarding teaching*. Faculty become frustrated and confused when told that teaching plays a vital institutional role, but to find out that rewards are for research.
- *Encourage alternative instructional strategies to meet the specific needs of students' different learning styles*. Students are inherently different, and so are their learning styles.
- *Target new instructors, in particular, and help them to make the transition from traditional to active learning methodologies.* Young faculty must feel that it is all right to try a new strategy, even if the first trial is less than satisfactory.

Some institutions have attempted to meet these objectives by relying exclusively on teaching awards. This modest approach has not worked! Broader, more effective initiatives appear to be needed to infuse a commitment to proper teaching and *active learning* throughout the Region. The real key to establishing and nurturing a supportive environment for innovative teaching, is to create an administrative structure that takes it upon itself to promote, reward, and publicize excellence in the classroom.

Summary and Concluding Remarks:

To keep pace with fast changing global marketplace, engineering education in the Arab Gulf States (Saudi Arabia, Kuwait, Bahrain, Qatar, The United Arab Emirates, and Oman) has to undergo major "reformation" including revitalization of the classroom environment. There is considerable concern among students, faculty, and graduates of the Region's institutions, as

expressed through a recent survey targeting new engineering graduates of the Region; that current teaching practices (traditional teaching) appear to have adversely affected outcome, and there is an urgent need to adopt new and innovative approaches in teaching. *Active learning* has lately attracted advocates among engineering faculty in the Arab Gulf Region searching for alternatives to traditional methods.

The paper reviews the literature on *active learning*, defines the common forms of active learning most relevant for engineering faculty in the Region, and examines the core elements of each form. The paper argues that the introduction of *modifications* to traditional lectures, such as: *pausing* periodically during lecture time, insertion of brief *demonstrations*, or short exercises followed by class *discussion*, increase students' level of engagement, allow students to apply information in new settings, and help develop students' thinking skills. Also, the three known forms of "structured" instructional methods: *collaborative, cooperative, and problem-based learning* are highlighted and analyzed visa vie their suitability as alternatives to traditional instructional methods. The evidence is overwhelming that these three pedagogies can be extremely effective in terms of their favorable influence on students' attitudes and achievement. When *collaborative* and *cooperative* forms of learning are selected, the entire course need not be team-based, nor must individual responsibility be absent as seen by the emphasis on individual accountability in *cooperative learning*. The evidence supporting *problem-based learning* is primarily seen as achieving longer-term outcomes. While no evidence proves that *problem-based learning* enhances academic achievement by exams, studies have shown: that it has positive impact on students' attitude, fosters deeper approach to learning, and helps students retain knowledge longer than traditional instruction.

Educators must realize that learners come in different *learning styles*. Learning style is a function of heredity and experience. It develops individually over one's life span. It is a complex construct that characterizes how a person learns. Various models of learning style preferences have been described in the literature. It is argued that teaching is more effective when it recognizes students' varied learning styles and deploys instructional methods that are compatible with the majority of the learning styles in the classroom. Otherwise, the selected teaching strategies may turn out to be effective for certain learners but ineffective for others.

The reform of instructional practice has to begin with faculty members' efforts. A wise first step is to select strategies, known to promote *active learning* that one is comfortable with. Such low risk strategies are typically of short duration, structured and planned, focused on subject matter that is neither too abstract nor too controversial, and familiar to both the faculty member and students. Conversely, greater levels of risk occur when one or more of these dimensions are altered. Faculty may overcome the major obstacles or barriers to the use of *active learning* by getting into it gradually, starting with strategies that require less activity from students, and thus lowering the risk of failure and/or disappointment. The degree to which the faculty member controls the dimensions of time, material, and structure, as well as the technique chosen, tends to limit the level and type of risk involved.

Academic administrators, program planners, and decision makers can help stimulate and support faculty members' efforts to change by: emphasizing the instructional significance of *active*

learning, sponsoring seminars and workshops on the subject, providing the logistical support for the transformation from traditional to *active learning* mode, and by recognizing and rewarding excellent teaching in general and the adoption of instructional innovations in particular. Comprehensive programs to carry out this type of administrative commitments should address:

- Institutional employment policies and practices;
- Allocation of adequate resources for instructional development;
- Establishing a research unit to guide future practices in the classroom; and
- The establishment of strategic administrative action plans to move the process forward.

Equally important is the need for more cooperation among the institutions of the Region in sharing: experiences, initiatives, plans, and relevant data and case studies. In retrospect, it is highly recommended that credible information on teaching/learning issues be disseminated in journals. There may well be a need for a new regional journal that specializes in teaching innovations, including *active learning* issues, for the benefit of the faculty in the Region.

References:

1. Akili, W., "Engineering Education in the Arab Gulf States: Stagnation versus Change," *Proc. The 2002 ACEE Annual Conf.*, (Session 3160), Montreal, Canada, June, 2002.
2. Akili, W., "On Reform of Engineering Education in the Arab Gulf States: A Focus on Pre- Engineering 'Prep-Program," *Proc. The 2003 ACEE Annual Conf.,* (Session 2160), Nashville, Tennessee, June, 2003.
3. Akili, W., "Restructuring Pre-Engineering "Prep-Program" to Bridge the Gap: A Proposal for the Arab Gulf States," *Proc. ASEE North Midwest Regional Conf.,* Ames, Iowa, October, 2003.
4. Akili, W., "Improving the Classroom Environment: With a Focus on the Arab Gulf States," *2004 ACEE Annual Conf., (*Session 3560), Salt Lake City, Utah, June, 2004.
5. Akili, W.," Students' Desires, Trends, and Misconceptions: Underlying Causes of Students' Attrition in Engineering," *in-house document, University of Qatar*, Doha, Qatar. 2000.
6. Bonwell, C.C., and J.A. Eison, "Active Learning: Creating Excitement in the Classroom," *ASHE-ERIC Higher Education Report No.1*, George Washington University, Washington, DC 1991.
7. Silberman, M., "Active Learning: 101 Strategies to Teach Any Subject," *Temple University,* Allyn and Bacon, Needahm Heights, Massachusetts, 1996.
8. Prince, M., "Does Active Learning Work? A Review of the Research," *ASEE Journal of Engineering Education,* vol. 93, no.3, pp.223-231, 2004.
9. Grinter, L.E., "Report on the Evaluation of Engineering Education (1952-1955)," *Journal of* Engineering *Education,* vol.46, 1955.pp.25-63.
10. Walker, E.A, J.M.Petit, and G.A. Hawkins, "Goals of Engineering Education," *American Society for Engineering Education,* Washington, 1968
11. < *http://www.abet.org*>, Accessed December 20, 2003.
12. Randolph, G.B., "Collaborative Learning in the Classroom: Writing Across the Curriculum Approach."*Journal of Engineering Education, vol.89, no.2*, April 2000, pp.119-122.
13. Bloom, B.S., *Taxonomy of Educational Objectives: The Classification of Educational Goals by a Committee of College and University Examiners*, McKay Co., Inc., New York, NY, 1956, pp.189-193.
14. Kolb, D.A., "Experiential Learning: Experience as the Source of Learning and Development," *Prentice Hall,* Englewood Cliffs, CA, 1984
15. Stice, J.E., "Using Kolb's Learning Cycle to Improve Student Learning," *Engineering Education*, vol.77, Feb.1987, p.292.
16. Klinger, A., C.J.Finelli, and D.D. Budny, "Improving the Classroom Environment,"*30th Annual IEEE/ASEE Frontiers in Education Conf.,* Kansas City, MO, Oct.18-20, 2000.

17. Myers, I.B.andM.H. McCaulley, "Manual: A guide to the Development and Use of the Myers-Briggs Indicator," *Consulting Psychologists Press, Inc*. Palo Alto, CA, 1985
18. Felder, R.M., "Reaching the Second Tier: Learning and Teaching Styles in College Science Education," *Journal of College Science Teaching,* vol.23, no.5, 1993, pp.286-290
19. Dunn, R., "Understanding the Dunn and Dunn Learning Styles Model and the Need for Individual Diagnosis and Prescription," *Reading, Writing and Learning Disabilities,* vol.6, 1990, pp.223-247.
20. Wankat, P.H., "Reflective Analysis of Student Learning in a Sophomore Engineering Course," *Journal of Engineering Education,* vol.88, no.2, April, 1999, pp.195-203
21. Fairhurst, A.M., and L.L. Fairhurst, "Effective Teaching, Effective Learning," *Davies-black Publishing,* Palo Alto, CA, 1995
22. Culver, R.S., and J.T. Hackos, "Perry's Model of Intellectual Development," *Journal of Engineering Education,* vol.73, 1982, pp.221-226
23. Ramsden, P., "Learning to Teach in Higher Education," *Routledge*, London, 1992.
24. Marton, F.and R. Saljo, "Approaches to Learning," in: Marton, F. et al (ed.), *"The Experience of Learning," Scottish Academic Press*, Edinburgh, Scotland, 1984
25. McLeod, A., "Discovery and Facilitating Deep Learning States," *National Teaching and Learning Forum,* Vol.5, no.6, 1996, pp.1-7
26. Tendy, S.M., and W. F. Geiser, "The Search for Style: It All Depends on Where You Look," *National FORUM of Teacher Education Journal,* vol.9, no.1, 1998, pp.3-15.
27. McCully, M.,et al., "Application of Psychological Type in Engineering Education," *Journal of Engineering Education,* vol.73, no.5, 1995, pp.394-400.
28. Finelli, C., A.Klinger, and D.D. Budny, "Strategies for Improving the Classroom Environment," *Journal of Engineering Education,* vol.90, no.4, Oct. 2001, pp.491-497.
29. Tobias, S., "They Are Not Dumb, They're Different: Stalking the Second Tier," *Science News Books,* Long Branch, NJ, 1994.
30. Online Collaborative Learning in Higher Education,<http://clp.cqu.edu.au/glossary.htm>, accessed 11/15/ 2004.
31. Millis, B. and P. Cotell, Jr., "Cooperative Learning for Higher Education Faculty," American Council on Education, ORYX Press, 1998.
32. Felder, R., Brent, R., and Stice, J., "National Effective Teaching Institute: Workshop Materials," 2002 American Society for Engineering Education Annual Conference, Montreal, Quebec, Canada, 2002.
33. Bruffee, K., "Sharing our Toys: Cooperative Learning Versus Collaborative Learning," *Change,* January/February,1995.p.12.
34. Johnson, D., R., Johnson, and K. Smith, *Active Learning: Cooperation in the College* Classroom, 2nd ed., Int. Book Co., Edina, MN, 1998.
35. Johnson, D., R., Johnson, and K. Smith, "Cooperative Learning Returns to College: What Evidence is There That it Works?," *Change*, vol.30, no.4 July/Aug., 1998, p.26-35.
36. Stahl, R., "The Essential Elements of Cooperative Learning in the Classroom," ERIC Digest ED 370881, 1994.
37. Albanese, M. and S. Mitchell, "Problem-Based Learning: A Review of Literature on its Outcomes and Implementation Issues," *Academic Medicine*, vol. 68, no.1, January 1993.
38. Gallagher, S., "Problem-Based Learning: Where Did it Come From, What Does it Do and Where is it Going?," *Journal for Education of the Gifted*, vol.20, no.4, Summer 1997, pp.332-362.
39. Di Vesta, F., and D. Smith, "The Pausing Principle: Increasing the Efficiency of Memory for Ongoing Events," Contemporary Educational Psychology, vol.4, 1979.
40. Penner, Jon, G., *Why Many College Teachers Cannot Lecture.* Charles C. Thomas, Springfield, Ill., 1984.
41. Frederick, Peter J., "Student Involvement: Active Learning in Large Classes," *In Teaching Large Classes Well*, edited by M.G.Weimer. New Directions for Teaching and Learning no.32, Jossey-Bass, San Francisco, Ca, 1987.
42. Mckeachie, W. J., P.R. Pintrich, Y.G. Lin, and David A.F. Smith, "Teaching and Learning in the College Classroom: A Review of the Research Literature. Ann Arbor: Regents of the University of Michigan, ED 314999,124 pp, MF-01; PC-05, 1986.
43. Lowman, Joseph, *Mastering the Technique of Teaching*, Jossey- Bass, San Francisco, Ca. 1984.
44. Wales, Charles E., and Robert A. Stager, *The Guided Design Approach*. Educational Technology Publications, Englewood Cliffs, N.J., 1978.
45. Chism, N., C., Jones, B. Macce, and R. Mountford., *Teaching at the Ohio State University: A Handbook*, Center for Testing Teaching Excellence, Ohio State Univ., Columbus, OH, 1989.

46. Kolar, R.L., and D.A. Sabatini, "Changing from a Lecture–Based Format to a Team Learning/Project Driven Format: Lessons Learned," Proc. ASEE Annual Conf., 1997, pp.1-15.
47. Springer, L., M. Stanne, and S. Donavan, "Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta-Analysis," *Review of Educational Research*, vol.69, no.1, 1999, pp.21-52.
48. Mourtos, N.J., "The Nuts and Bolts of Cooperative learning in Engineering" *Journal of Engineering Education*, vol. 86, no.1, 1997, pp.35-37.
49. Mayo, P., M.B.Donnelly, P.P.Nash, & Schwartz, R. W., "Student Perceptions of Tutor Effectiveness in Problem Based Surgery Clerkship," *Teaching and Learning in Medicine* Vol.5, no.4, 1993, pp. 227-233.
50. Aspy, D.N., C. B.Aspy, and Quimby, P.M. (1993). "What Doctors Can Teach Teachers about Problem-Based Learning," *Educational Leadership*, vol.50, no.7, 1993, pp. 22-24.
51. Bridges, E. M., & Hallinger, P. (1991, September). "Problem-Based Learning in Medical and Managerial Education," Paper presented for *the Cognition and School Leadership Conference of the National Center for Educational Leadership and the Ontario Institute for Studies in Education*, Nashville, TN.,Sept.1991.
52. Vernon, D. T., and R.L. Blake, R. L. (1993). "*Does Problem-Based Learning Work?" A meta-Analysis of Evaluative Research*. Academic Medicine*,* vol.68, no.7, 1993, pp. 550-563.
53. Reich, R., "Redefining Good Education: Preparing Students for Tomorrow," In S. B. Bacharach (Ed.) *Education Reform: Making Sense of it All.* Boston: Allyn and Bacon, 1990.
54. Venon, D. and R.Blake, "Does Problem-Based Learning Work? A Meta-Analysis of Evaluation Research," Academic Medicine, vol.68, no.7, July 1993

Biography:

WADDAH AKILI

Waddah Akili has been in the academic arena for over 35 years. He has held academic positions at Drexel University, Philadelphia, Penna (66-69), at King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia (69-87), and at The University of Qatar, Doha, Qatar (87-00). Professor Akili's major field is geotechnical engineering and materials. His research work & experience include: characterization of arid and semi arid soils, piled foundation, pavement design & materials, and concrete durability. His interests also include: contemporary issues of engineering education in general, and those of the Middle East and the Arab Gulf States, in particular.