

On Reform of Engineering Education in the Arab Gulf States: A Focus on Pre-Engineering “Prep-Program”

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Introduction:

Engineering education in the Arab Gulf States (Saudi Arabia, Bahrain, Kuwait, United Arab Emirates, Qatar, and Sultanate of Oman) faces many challenges today. Changes in the external environment (e.g. reduced funding, increased costs, demands by industry for well-seasoned graduates, and rapid advances in technology) coupled with the quest for educational relevance in undergraduate engineering, are forcing colleges of engineering in the Region (*the Arab Gulf States*) to “rethink” engineering education and to undertake constructive steps towards reforming the current system.

The higher education arena interacts in a complex way with a variety of external partners whose role, participation, and expertise must be harnessed to overcome the challenges ahead. The most prominent partner of all is the pre-college community (elementary, intermediate, and primary schools). Graduates of primary schools in the Region are the main pool for undergraduate student body. Concerned individuals - both administrators and faculty- recognize the need for some sort of a working relationship between the college of engineering and the K-12 community, to help insure a smooth transfer of primary school graduates into engineering.

The current state of pre-college education in the Region- and in public schools in particular- is in dire need of reform. It suffers from obsolescence, rigidity, and a passive approach to the transmission of knowledge. It is also burdened with inflexible and creativity-suppressing examination procedures that have adversely affected the quality of education at large. These systems have produced weaknesses in primary school graduates over decades. Unfortunately, decision makers have been reluctant and slow to respond. Unless rectified, deficiencies in pre-college education (K-12) will continue to have negative effects on engineering students’ abilities to grasp, retain and assimilate new knowledge.

The paper sheds light on the multi-faceted and complex issues of pre- college education in the Arab Gulf States, and argues for urgently needed reform of the public school systems in the Region. For the present, and until existing K-12 systems are reformed, a well-structured, two-year pre-engineering “prep- program”, intended to rectify the pre-college education, for those that elect to get into engineering, is the plausible alternative.

From the author's perspective, the "prep- program" would have a mission statement (goals) and strategic plans to help accomplish the following: (i) rekindle the tacit knowledge acquired by students during the pre-college years (K-12); (ii) improve their English skills to a desired level; (iii) help develop a proper learning environment and foster creative thinking; (iv) provide, in cooperation with industry, a short-duration "practical/hands-on" training period, to help create an appreciation for the role of the engineer in the work place; and (v) re-visit high school math and science through innovative pedagogical approaches in an attempt to fill gaps and develop a firm foundation for future math/science courses in the engineering program. It is believed that a well-conceived properly run pre-engineering "prep- program" would provide an excellent venue for rejuvenation and preparation of students entering engineering in the Arab Gulf States.

In this endeavor, the author draws on his own observations as a faculty member in the Region (recently in Qatar and earlier in Saudi Arabia) along with views expressed by colleagues, ex-students, alumni and others in the same arena.

Background:

Engineering education in the Arab Middle East had its early start shortly after World War One. Colleges of engineering- or Schools of Engineering as they were referred to- were founded in Cairo and Alexandria, Egypt and in Beirut, Lebanon. By the end of World War Two, colleges of engineering sprung out in Iraq and Syria, and later on, in Amman, Jordan. The colleges in Lebanon and Syria paralleled, by and large, the French views on engineering education. The exception was the set up at the American University of Beirut (AUB), looked after by a consortium comprised of 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)

Engineering education in the Arab Gulf States began in earnest during the early to mid sixties, when colleges were founded in Riyadh, Jeddah, and later, in Dhahran, Saudi Arabia. Other states in the Region followed suit after gaining their formal independence.⁽²⁾

The dramatic increase in oil revenues during the 60s, 70s and 80s in all the sates of the Region, coupled with lack of indigenious skilled professionals, encouraged the rapid development in higher education including engineering. There are today eight public colleges of engineering in the Region (Table 1) plus a number of recently founded private colleges with engineering programs.

The eight public colleges of engineering of the Region have operated with curricula, standards, and procedures drawn, at their time of establishment, by advisory boards made up of faculty members from U.S. colleges. The Grinters Report⁽³⁾ and the Goals Report⁽⁴⁾ were the two bench marks used to guide the educational process. All eight engineering colleges are within public universities. They 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 primarily on grades obtained in an official examination administered by the Ministry of Education after completion of the 12th grade. The results of a non-standard entrance exam and evidence of proficiency in English 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 students attend “prep year”. The effectiveness of present pre-engineering “prep year” is under scrutiny, and the consensus is that radical changes are required including: relevant curriculum, more appropriate teaching methods, and meaningful assessment schemes.

Over the years, thousands have completed their engineering education at one of the eight colleges of the Region (Table 1) and have either filled government positions or joined the private sector, side by side with expatriates. Some have established their own business or moved up the ladder into responsible managerial positions. Today, engineering colleges of the Region are well on their way towards seeking accreditation by recognized accreditation boards. Some have already been subjected to several program accreditation reviews under ABET Engineering Criteria 2000 for a variety of programs.^(5,6) Although outcome indicators have varied over a wide range, the willingness to undergo a program evaluation review is a positive sign in itself and a step in the right direction.

<i>Country</i>	<i>College of Engineering</i>	<i>Year Established</i>
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

Schools of the Region:

Pre-college education in the Arab Gulf States (public schools in particular) has undergone a major change over the last three decades. Number of students in elementary schools has more than doubled over the last decade, and number of students in all schools (K-12) has quadrupled since mid 60s. Education has become compulsory till the age fifteen, and programs to wipe out illiteracy have been set up in urban and rural areas as well.

Triggered by recent wealth derived from oil revenues, public schools have made tangible progress on many fronts. In broad terms, measurable improvements have been realized in the following domains: (1) provision of well-equipped modern school buildings; (2) substantial modifications to

curricula and academic programs in conformity with standards and guidelines of neighboring Arab countries; (3) availability of better qualified teachers, drawn principally from neighboring countries; (4) provision of special education for physically and/or mentally challenged students; and, (5) the emergence of a more concerned general public with education.

Public schools, by and large, are under the auspices of the Ministry of Education who is solely responsible for planning, operations and budget. Little, if any, real difference exists among schools of the same category in any of the states of the Region. Admission policies, teaching materials, subjects covered, teaching methods, and examinations' standards are almost identical in all schools. Schools at all levels are tuition-free for nationals and expatriates alike. Textbooks are also given free of charge. In addition, a stipend, equivalent to \$200 per month, is provided to those students that are in need.

Teaching Learning Issues: Despite progress made and positive changes introduced to many facets of the K-12 educational arena, over the last three decades; there remains more difficult, harder to overcome, intrinsic traits that have persisted over the years. In other words, it is the *traditional* approach to teaching, practiced on a large scale- where students are bombarded with information and little, if any, attention is given to proper learning. The view shared by many is that: teachers in the Region are primarily dispensers of information in a rigid setting that would not allow for dissention or discourse. As a result, emphasis on *rote memorization* over cognitive learning takes precedence.

The pressure experienced by most students is: how to memorize vast amounts of “testable” information so they can do well on the exam. The process is such that students of public schools in the Region seem to be much less concerned about knowledge, per say, and much more concerned about making the grade. Some educators have argued that today’s students are thoroughly deficient when it comes to *critical thinking* about topics and problems other than those they have been tutored to respond to for passing examinations.

Owing to preconceived *archaic* notions, education is generally “one way”. Teachers lecture and students listen without questions or open discussion. This has resulted in minimum interaction between students and teachers. Generally, in western schools, student-teacher interactions are encouraged and expected. Enlightened educators today have come to realize that it is important not only to ask questions, but to learn how to ask the right questions. “Two-way” interaction between teachers and students stimulates learning, helps develop positive attitudes, and fosters creativity and independent thinking.

Curriculum: The curriculum is an important factor in determining the types of knowledge, the skills, and the aptitudes students gain from their education. In the Region, curricula are drawn by the Ministry of Education in the respective state with no direct link to, or feed back from, the higher education sector. Existing barriers (rigid administration, red-tape, conflicting views) have deterred collaboration between the two parties (K-12 versus higher education administration). In the absence of a government mandate and/or guidelines for a working relationship, the burden falls onto educators on both sides of the isle to try to work together to help develop a framework for curricula design that ascertains fundamentals, allows for ease of transfer to the university (and engineering in particular), and helps instill those qualities deemed necessary for success of a

prospective student in an engineering college. It is also essential to maintain open lines of communications with our colleagues in the K-12 arena to ensure as transparent an interface as possible for students moving between the two venues.

Typical curriculum of primary high schools, in any of the Arab Gulf States today, is made up of blocks of information (assigned teaching material) that could be lumped into five different categories. These five categories are shown in Table 2 along with specific subjects within each category, and time or effort allocated for each of the five categories. Table 3 focuses on the Math/Science block and lists deficiencies and/or weaknesses within this category. In summary, this category (Math& Science) is in bad shape and needs major overhauling. Courses' content needs to be properly screened and updated. Information has to be organized, properly sequenced and effectively displayed. Often materials are fragmented- within a single course- and students struggle to identify the most important parts from the less important ones. From students' perspective, physics and chemistry courses are usually handled by "cramming" for a test, with hardly any solid base to build on in future courses. Learning math through worked-out examples (step by step examples of problem solutions) is a powerful way of learning. In China, courses in algebra are now taught with almost no lectures, but through worked out examples. ^(7,8)

World history, human endeavors and socio- economic issues are presumably contained within the Humanities& Social Studies' block of the curriculum. Under this category, courses are very few with no electives to choose from. Course content in most cases is rather narrow and extremely limited in scope. Courses in this category don't usually appeal to students planning to get into applied sciences and/or engineering. Students get through these courses by "cramming" and relying on short-term memorization. Table 4 is a tally of suggested modifications and improvements to present offerings within this block. The author is of the opinion that this category of compulsory coursework needs reform. Wider selection of courses, allowing for broader views, and appropriate delivery of course content, make these courses more appealing to students. World culture and civilization in a historical perspective ought to be included.

	<i>Components</i>	<i>Coverage (Areas)</i>	<i>% Time / Effort of Total</i>	<i>Comments</i>
1	Values/Culture/Religious Studies		20±5%	Outside the scope
2	Arabic Language and Literature		15±5%	Outside the scope
3	Math and Science	<ul style="list-style-type: none"> • Trigonometry, Algebra, Geometry, Calculus • Life Sciences • General Physics • General Chemistry 	45±5%	Requires major reform
4	Humanities and Social Studies	History, Geography, Research Methods	10±2%	Requires major reform
5	English Language	English as a foreign language	10±2%	Requires major reform

Table 2. Simplified Breakdown of Primary School Curriculum in the Arab Gulf States

- **Courses' contents are old material, often irrelevant, and improperly sequenced**
- **Poor text books**
- **Insufficient recitation and lab periods**
- **Very little, if any, hands-on laboratory experiments**
- **Technical terms, symbols, and notations should be presented in English, side by side with Arabic**
- **No help sessions on regular basis**
- **Class lectures are strictly out of the text book with no discussion or feedback**

Table 3. Some Cited Weaknesses and Deficiencies in Math/Science Component of a Typical Primary School in the Arab Gulf States

- **Modify offerings to allow for electives**
- **Widen selection of courses to cover additional areas such as: world history and culture, human psychology, sociology, anthropology, etc...**
- **Encourage group projects, library and internet search, and field-related projects**
- **Introduce one or two courses (per year) using simplified English. Thus, helping learners of English to improve their English skills**

Table 4. Suggested Modifications and Improvements in the Humanities and Social Sciences Component of a Typical Primary School Curriculum in the Arab Gulf States

Teaching Staff: Teachers in the Region are either nationals, and thus civil servants for life, or contracted individuals drawn from neighboring Arab countries for a specified duration. Marked differences in terms of: rights, duties, privileges, and financial compensations exist between the two groups. Nationals are far more secure and draw considerably higher salaries. Teacher's certification, a requirement in the US and other western countries, is not mandatory in the Region. Most teaching staff are university graduates, or have finished two-year teachers college. Opportunities for a teacher to advance academically (e.g. graduate work, work shop, in-service educational programs, etc) are extremely limited and not a requirement for maintaining one's job. Owing to values and culture, teachers are well-respected members of society. Teaching is perceived as a very noble profession by all segments of society irrespective of their income or social standing. However, the view expressed by concerned and well-informed educators in many arenas today is: in order to reform education, the teaching work force has to take a proactive role. Teachers, therefore, are called upon to abandon the old passive approach to transmission of

knowledge and adopt a more positive stance. Learning takes place in the minds of students and nowhere else. The effectiveness of teachers lies in what they can induce students to do. To start a transformation process, teachers need to be aware and concerned! They eventually have to do away with the “traditional and mundane” procedures and start dreaming up experiences for students: things that they want students to do and activities that will help students learn and acquire information and skills.

In the west, a paradigm shift is taking place in the academy, where the focus is moving away from teachers and traditional teaching towards students and their learning. The Arab Gulf States have to break barriers and begin to take “bold” steps to start a transformation process. Colleges of education in the Region should be “restructured” to graduate a new cadre of teachers, intone with modern views of the teaching/learning process.

Pre-Engineering “Prep-program”: The Status Quo

As previously stated, pre-college education in the Arab Gulf States has weaknesses and deficiencies that need to be addressed and rectified. The reluctance of decision makers to reform public education in the Region has continued to adversely affect outcome. Students finishing primary schools (high school), and applying to engineering, are only marginally prepared to get into first- year engineering. The challenge becomes greater when the engineering education in contention is modeled after the North American system, such as the case with the eight engineering colleges of the Region.

The deficiencies that are most apparent in primary school graduates, who wish to get into one of the eight engineering colleges of the Region, fall under three categories.

1) English

English programs in schools are ineffective to say the least! Teaching materials, methods deployed and prevailing attitudes are non-conducive to learning a new language. After six years of learning English in schools, students could hardly compose a sentence or read a paragraph. The limited knowledge acquired by students finishing high school (even the best students in the class) is well below the minimum knowledge necessary for a non-English speaker to attend college in English. Therefore, learning English as a foreign language is a priority for the students and the college as well.

2) Math & Science

Although mathematics and science courses are “rigorous” in most schools of the Region, the ability to apply this knowledge or build on what has been learned is very troubling to most students. It is as if what students have learned (in math& science classes) never happened, or what has remained in their minds is so “fuzzy” that they are unable to use it. There are different types of knowledge skills; knowledge meaning information (knowing **that**) and knowledge meaning how to perform tasks (knowing **how**).^(9, 10) The first is *declarative* knowledge while the latter is *procedural* knowledge. Knowing how to perform tasks, could be lacking in high school graduates of the Region.

3) Positive Attitudes and Critical Thinking

The combination of traditional approach to teaching and creativity- suppressing examination

system has profoundly affected students' learning abilities and attitudes. Positive traits deemed desirable in freshman engineering (e.g. intellectual curiosity, critical thinking, creativity, and self-confidence) can only develop in a proper learning environment where students can express themselves freely and the teaching/learning process is truly "two ways".

To correct weaknesses and address shortcomings in primary school graduates, who apply to get into engineering, universities and/or colleges of the Region have set up pre-engineering programs to help prospective students get over their deficiencies. Decision makers at the time (2 to 4 decades ago) came to the conclusion that once English weaknesses are addressed and rectified, students would have the ammunition to get into first year engineering, and move forward through the engineering program. As a consequence, the Region witnessed the emergence of four different types of pre-engineering programs. Three out of the four were instituted to teach English only. The fourth had a broader mission. In addition to addressing English learning, it (the 4th plan) paid attention to building up desirable traits derived through hands-on experience.

Plan One concerned itself with English only, outsourced its entire activities (curriculum, staff hiring, teaching, and testing) to the private sector. Students that complete the program with a passing grade are allowed to get into engineering. *Plan Two* is devoted in its entirety to learning English. Designed, administered and run by the English Language Unit on campus. Prospective engineering and non-engineering students alike are admitted to the program. Those who succeed in passing the two-semester course become eligible for admission to first year engineering.

Plan Three is basically an English program, run jointly by the English Language Unit and the college of engineering. Teaching material includes simplified, in-house engineering text, prepared jointly by engineering faculty & English teachers, specifically for the program. Students, who are relatively advanced in their knowledge of English, can take (or audit) one or more of the "gateway courses" (e.g. calculus, physics, chemistry, introduction to engineering). To qualify for entry into engineering, the student has to successfully complete the year, and at the same time, attain a passing score in a Standard English test such as TOEFL.

Plan Four focuses on English skills as its primary target, but attempts at the same time, to instill or develop positive attitudes. Several simplified engineering and or technology short-duration courses are offered. Students are encouraged to work together as a team. A physics course, with a major lab component, and a machine shop course provide opportunities for hands-on experience. This type of experience is totally missing in primary school education. To be accepted in engineering, students have to complete all courses successfully and achieve a passing grade in TOEFL or its equivalent.

In comparing the four existing plans highlighted above, it is apparent that the 4th plan has more in it for the students. In addition to its primary mission of providing English skills, it does address development of positive attitudes. The results of informal surveys during 1994 through 1998, targeting ex- engineering students at the University of Qatar, who left voluntarily or for academic reasons, support the view that much of the difficulties encountered by engineering students during the first two years in college, are attributable to *incompatibility* between their pre-college education and that of the college of engineering⁽¹¹⁾. Some felt that the gap between the two types of education was too wide to try to bridge it. Many felt that the solution lies in reforming the pre-college system, but were apprehensive whether it could actually be carried out in time. They have cited the slow bureaucratic procedures as a major deterrent.⁽¹¹⁾

The message from the industrial sector, with regard to academic issues in general and pre-college education in particular, lacks clarity, decisiveness, and articulation. The industrial partners (friends of the college) prefer not to meddle in the academic issues of the college, and, in particular, the pre-college (K-12) arena. Their concern is that it may be misinterpreted and could lead to friction and misunderstanding. However, industries views concerning desired attributes of engineering graduates (nationals & expats) is very clear: good communication skills, grasp of fundamentals, a good understanding of design and manufacturing, desire to learn, and ability to work as a member of a team. According to our industrial partners, the major responsibility of creating an educational environment, which produces graduates with these attributes, is that of the college of engineering. Engineering faculty are poised to take an active role in meeting the challenge head on. The nature of such an exercise requires synergies between faculty members within the college, members from different colleges, and between students and faculty members. Since students are the primary beneficiaries of reform, their input is vital to the success of the transformation process. Therefore, constructive dialogue between faculty representatives and students, in an informal setting with mutual trust and respect, where students can express their views freely, is highly encouraged.

Pre-Engineering “Prep-Program”: A Proposal

As stated above, the current pre-engineering “prep-programs,” intended to bridge the “gap” between the exit level of primary education and the entrance level of first year engineering, have fallen short of their declared mission. These “make shift” programs have, by and large, attempted to address acquisition of English skills and ignored to consider the need to bring about a change in “learning attitudes & traits” acquired over twelve years of pre-college education. The transformation process from “traditional” learning to a more appropriate “positively motivated” form of learning, can only take place in a proper learning environment.

In this endeavor, a well-designed curriculum with appropriate teaching materials is a priority. This implies that certain course material should be structured in a way that would link high school subjects at exit point, with comparable subjects at college entrance level. Academics on both sides of the isle have to work together to develop required teaching material. Aligning course content and syllabi, and introducing English terms, side by side with Arabic, would help to “bridge” between materials on the two sides. Curricula content and teaching tools need to be compatible with local conditions. Indiscriminate importation of teaching materials (textbooks, audio visual) should be gradually reduced, and efforts to generate more appropriate in-house materials ought to be encouraged.

The author’s proposal to reform the current “prep-programs” stems from a personal conviction of the inappropriateness of the “status quo” supported by other sources in the same vain, namely: limited data, informal reports, and opinions of concerned and involved individuals (teaching staff, students, graduates). All seem to unequivocally support the need for reform. Over and above the English component of the program, the proposed “prep-program” has four major objectives.

- 1) *To broaden the scope of the learning experience:* Although acquiring English skills is the primary object; it is proposed here that mathematics & science be added to the program.

- 2) *To focus on student learning*: It is extremely desirable to avoid “traditional” methods of teaching and adopt a more positive stance on learning. Student-teacher interaction ought to be encouraged. Innovative pedagogical approaches to learning ought to be explored.
- 3) *To help develop positive traits and attitudes*: The cumulative effect of “one way” teaching, passive transmission of knowledge, and creativity-suppressing examination system during the pre-college years, has adversely affected outcome and personal traits. Measures should be taken to overcome the negative effects of the “undesirable” traits, acquired during school years, and to encourage students to develop attributes for success in their college education.
- 4) *To expose students to engineering work environment*: In an attempt to create an awareness of the role of engineers in the work place, students in the program would be given the opportunity to perform engineering tasks, as junior members of a team. This type of experience would help students become more familiar with opportunities that await them, and help them decide on their future career objectives. This experience can also help build self-confidence and independent thinking.

The three components of the proposed pre-engineering “prep-program”, shown in Table 5, are detailed under three separate headings.

Component	Duration
<p><u>English Skills</u></p> <ul style="list-style-type: none"> • <i>Stage One</i>: Building up knowledge and skills from scratch to a “preset” level • <i>Stage Two</i>: Addressing writing skills, comprehension, and technical English 	<p>Two semesters</p> <p>One semester</p>
<p><u>Math and Science</u></p> <ul style="list-style-type: none"> • <i>“Prep” Math</i>: To link high school math with first year college math • <i>“Prep” Science</i>: General physics and/or general chemistry at high school level with hands-on laboratory experiments 	<p>One or two semesters</p> <p>One or two semesters</p>
<p><u>Practical Training</u></p> <ul style="list-style-type: none"> • <i>Field or Office experience</i>: To familiarize students with engineering work and help instill positive attributes 	<p>Eight weeks</p>

Table 5. The Three Components of the Proposed Pre-Engineering “Prep-Program”

Acquiring English Skill: Upon graduation from primary schools, an average student ends up with very little knowledge of English. Except for a few that attempts to undertake supplemental English classes on their own, most of the graduates are at a “starter” level. A two-stage English learning program is hereby proposed.

Stage One-(a building stage) a one year period of English learning that carries the student gradually forward, from virtually no prior knowledge to a “pre-set” level of English sufficiency. The parameters of what constitutes “sufficient English” have to be defined and agreed upon by English teaching staff in consultation with the College of Engineering.

Stage Two-(a capping stage) a one semester, or longer period of acquiring additional English to enable students to “sail through” first-year engineering with hardly any difficulties attributable to English. In this stage, students become familiar with technical terms (science& engineering), enhance their vocabulary, and improve their writing skills. Curricula structure and relevant teaching materials should be arrived at jointly by the English teaching staff in coordination with engineering faculty. Simplified math and science textbooks, or high school textbooks, would make a good selection at the start.

The process of learning a language such as English is best accomplished in a “caring environment”. A cohort of qualified and committed staff members is essential to the success of the process. Current indicators, show that certain conditions and/or factors could help speed up the process of acquiring English skills-particularly for slow learners. These factors include:

- maintaining relatively small class-size and encouraging slow learners to be in the same group with those that are more advanced. Students can be good teachers;
- don't object to the use of Arabic in class by students who have not attained sufficiency in English. Using Arabic, or translating into Arabic, may be the only feasible way of transmitting meanings to beginners. The old notion that “total immersion in an English environment” is required to learn the language, is neither affordable nor necessary for engineering students in the Region;
- encourage recruiting qualified teachers that are bilingual (proficiency in Arabic and English). Their primary role is in assisting beginners and slow learners of English;
- developing assessment strategies designed to serve the dual purposes of helping students achieve their goals more effectively; and simultaneously, help the “program” fine tune its collective efforts within the context of its broader mission.

Reviving Math & Science: Despite the wide exposure to math and science in primary schools; students' ability to apply knowledge gained in pre-college is extremely limited. In layman's terms, the knowledge acquired is either insufficient or incomplete. According to Bloom's taxonomy of educational objectives, there is a second level for the accumulation of facts or information: *comprehension*. In this context, if a student has comprehended a principle or a law then he should be able to apply the principle or the law properly to a problem. According to Gilbert Ryle “knowing how” falls in the category of skills where as “knowing that” is information. ^(9, 10) Knowledge retained by high school graduates tends to be more in the category of Ryle's “that” rather than “how”.

It is hereby proposed to tack onto the “prep-program” a “prep” math course and a “prep” science course: bridging to “gateway courses” (calculus, physics and chemistry). The intent is to help achieve the following goals: (1) to rekindle the tacit knowledge; (2) to expose students to technical English (e.g. style, notations, nomenclature, and technical symbols); (3) to help students develop links between courses in primary school and those that will follow in first-year engineering; (4) to provide opportunities to learn what may have been forgotten, to fill gaps, and reformat subject matter in an effective manner; and (5) to introduce students to laboratory experiments, through either general physics lab or chemistry lab, in order to develop an appreciation for the laboratory component in future courses.

There is evidence that laboratory experiments and “shop” courses, if properly handled, can positively influence students’ attitudes towards science and engineering as well as their attainment of knowledge in science courses. There is also evidence that properly prepared instructional material for each lab experiment, using simplified English and guiding students through experimental steps, leaves students with positive impressions about lab work in general.

Practical Training: An eight week period of “on the job training” as part of the “prep-program” would go far in reconstituting attitudes and creating awareness of the engineering work place (e.g. organization structure, the team, flow of information, decision making). Key partners in this exercise are the industrial sector and/or government agencies. At the start, the training program has to be set up properly, identifying essential ingredients for its success. Planning, training, supervising, and many other aspects of the program tend to fall on the shoulders of the industrial partners who have to allocate openings, have a tentative job description, and assign mentors or facilitators. Typically, a trainee would be assigned to a unit or a group that provides a service or a product. He would be assigned a mentor and be shown the specifics of the task or tasks he is to perform or contribute to. In a typical week, in addition to his assignments(tasks to be performed), the trainee would spend an hour or two with his mentor, or supervisor, meet with team members, and have an opportunity to come in contact with members of other groups or divisions to see the “bigger picture” of the company and/ or the firm.

Anecdotal evidence to date from other countries in the Middle East suggests that “on the job” training for students who finished high school and not yet in college, is very effective in: developing positive attitudes, building self-confidence, and enabling students to exercise better judgment in matters related to college education or career moves. Cooperative learning outcomes have been widely studied and have been related to: maturity, achievements, and development of “professional persona.”^(12, 13) The two cited experiences here appear to be viable indicators of the advantages of having a practical training period added to the proposed “prep-program.”

Discussion:

The ideas, views, and suggestions proposed to reform the current pre-engineering “prep-programs” in the Arab Gulf States, if carried out, would dramatically improve students’ readiness to pursue an engineering education. The effect of such a transformation would resonate through out the educational experience of engineering students; but its impact would be felt more distinctly during the first-year. The positive educational outcomes of this program will include:

- improved communication skills
- improved learning in the math science
- improved cross-disciplinary problem solving
- improved perception of the role of math and science in engineering
- improved teamwork skills
- better perception of the role of engineers in the work place
- more effective use of class time
- reduced attrition rate of first-year engineering students.

Typically, an average primary school graduate opted for engineering, under the present system, would spend two to three additional semesters to get through his baccalaureate. Many students, who “drag on through” first-year engineering, would continue to do so through the rest of their study years and finish with average or slightly below average academic standing. Therefore, a well-planned and executed “prep-program” is a “priority” since it addresses “deficiencies” and improves students’ academic “posture” in preparation for first-year engineering. Clearly, a well-perceived and well-executed “prep-program” is critical for both academic success and retention of engineering students.

Over the past decade, attrition out of engineering has been on the rise in a number of colleges in the Region. This decline has been attributed to three factors. **First**, there is a general *disenchantment* and *disappointment* with job opportunities for young graduates in the Region. Competition is tougher today than a decade or two ago. Well-seasoned and experienced engineers from neighboring countries are flooding the market, at salaries well-below the government salary scale for their young graduates. **Second**, the notable shift lately, away from engineering into careers in business and management, has adversely affected enrollment in engineering. **Third**, the luster that these colleges once had has faded. These colleges (colleges of the Region) are perceived by young high school graduates as “difficult and not rewarding”. Most of these colleges need to reach out and paint a *rosy picture* of engineering. There is need to sketch out the “contours” of the profession, remove ambiguity, embark on a campaign to correct “misunderstanding”, and help cast a proper image of engineering and the role of engineers in the service of communities. Unfortunately, professional engineering societies in the Region either do not have the “clout” or are non-existent. Therefore, colleges of engineering in the Region “have to proxy” for the engineering societies, by filling the vacuum: providing information and advice and counseling young high school graduates who desire to become engineers.

Education, irrespective of field or discipline, is an aggregate of both cognitive (knowing that=information; and knowing how=skills) and affective (attitudes& traits) processes. Engineering students begin their college journey, with a set of attitudes and perceptions about engineering and their *presumed* abilities to succeed. These initial attitudes and perceptions and their changes during “prep-program” and first-year engineering, affect students’ motivation, performance, and ultimately retention in an engineering program. There is strong evidence that among many factors studied, attitudes are the most correlated with retention. ^(14, 15) Why do students change their attitude in the middle of their course of study and decide to leave engineering? - is a question that can’t be answered without proper assessment methods and relevant data. The engineering education community in the Region would benefit from a “standardized instrument” that can be used to measure students’ attitudes at various points in their engineering education, including when they begin their journey. In a limited survey ⁽¹⁶⁾ carried out by the author (in one of the colleges of the Region) and aimed at the problem of attrition, and, involving small sample size, where the data was in the form of open-ended questions, has supported the following:

- students who left engineering in good standing, and began to like engineering subjects less and less with time, had lower appreciation of the profession and could not see themselves as engineers in the future;
- these same students began to like math and science subjects less and less with time;

- the same group of students had lower confidence with regard to their ability to succeed in engineering;
- the same group of students felt strongly that leaving engineering was a wise decision.

Most colleges of engineering in the Region have in place a mission statement, goals, and plans for achieving these goals. Tools for monitoring the progress toward these goals, within the college, by individual departments and units to the “overall” mission remain extremely limited. In time of constrained resources coupled with attrition problems, departments should develop their own strategic plans in the context of the “overall” mission and then devise self-assessment schemes to monitor and facilitate the desired outcome. Assessment schemes should not be onerous and bureaucratic, but should be properly designed to serve the individual departments and the college as a whole in generating useful data and viable indicators that would be relied upon to bring about a change and/or lead to “reform”. At present, colleges of the Region don’t have in place the capability to carry out meaningful assessments. The situation must be remedied in order to affect the systemic approach of “reform” outlined and discussed in this paper.

Summary:

Engineering colleges in the Arab Gulf States (Saudi Arabia, Kuwait, Bahrain, Qatar, United Arab Emirates, and Oman) - established in the sixties, seventies, and early eighties, and modeled after North American and/or British colleges, face many challenges today. Changes in the external environment (increased costs, reduced funding, technological innovations, and demands by industry for better prepared graduates) coupled with the quest to devise better programs of study, are forcing these colleges to “update” and “revise” current systems in a direction which addresses societal needs.

Pre-college education (K-12), a precursor to university education, is “key” in providing basic knowledge, imparting positive learning habits, and developing proper personal attitudes. Today, pre-college education in the Arab Gulf States has remained “old-fashion” sticking to the “traditional” concepts of teaching. It continues to be burdened with “creativity-suppressing” examination procedures and a passive approach to the transmission of knowledge. These systems have produced weaknesses in high school graduates over decades. Unless rectified, these weaknesses in pre-college education will continue to adversely affect outcome, including engineering graduates.

The paper addresses “deficiencies” in public schools, identifies causes, and prescribes remedies. Reform of the current systems, should consider introducing “innovative” pedagogical methods of learning: to replace “rote memorization” with cognitive learning, foster “creativity” and “critical thinking”, and help students acquire analytical skills. The paper also focuses on the “short-comings” of the “status quo” pre-engineering “prep-programs” which appears to have been created to help students who have opted for engineering, improve their English skills only. Unfortunately, these “make-shift” prep-programs, throughout the Region, have not been adequate, since they have neglected to address other deficiencies.

From the author’s perspective, and until the public school systems in the Region are reformed, a

well-structured, two-year pre-engineering “prep-program” is the plausible alternative. The proposed “prep-program” is aimed at: (i) building up English language skills to a pre-set level considered adequate to take up engineering in English; (ii) “revisiting” high school math and science to revive prior knowledge and link up with freshman “gateway” courses (e.g. calculus, general physics, general chemistry); (iii) creating an awareness of the role of engineers in the workplace through a short-duration “practical/hands-on” training period; and (iv) developing proper learning environment to help instill positive attitudes and desirable personal traits.

It is believed that a properly conceived and a well-run “prep-program” will aid in planting the seeds for creative thinking and other desired characteristics of engineering students such as: good grasp of fundamentals, good communication skills, curiosity and a desire to learn, and a profound understanding of the importance of team work.

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Biography:

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Dr. 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 Fahad 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. Dr. Akili's research interests include characterization of arid and semi arid soils, piled foundation, bituminous pavements, and concrete durability. He has been interested in contemporary issues of engineering education in the Middle East, and the Arabian Gulf Region in particular.