**Educating Engineering Students in Egypt.**

**III: Learning From the World of Engineering Education**

**Ibrahim Shaaban, Ph.D., F.HEA., M.ICE., F.ICE.**

Senior Lecturer, Civil Engineering and Built Environment, University of West London, UK (corresponding author)

Email: ibrahim.shaaban@uwl.ac.uk

**Hanaa El Sayad, Ph.D., MBA.**

Professor, Faculty of Engineering at Shoubra, 108 Shoubra St. Cairo, Egypt

Email: [ayamalak@gmail.com](mailto:ayamalak@gmail.com), hanaa.elsayad@feng.bu.edu.eg

**Ashraf Elsafty, DBA., MBA., BSc.**

Adjunct Assistant Professor, ESLSCA Business School - Egypt Branch, Egypt

Email: ashraf@ashrafelsafty.com

**Abstract**

This is the third and final part of a series of three papers examining engineering education, provided by the state (government funded) faculties in Egypt. After concerns from several stakeholders about the graduates’ knowledge and skills, a fresh look at the phenomenon is attempted. In the first part, an analysis of government engineering education providers indicated the constraints imposed on those institutions by internal and external elements. In the second part, stakeholders’ views were collected to identify their pressing concerns and the improvements they would like to see. Four clear requests became evident from the responses: the application of modern innovative teaching methods; soft skills training; modern software applications training; and practical technical or industrial training. In this manuscript a literature scan was conducted to find ways for fulfilling these aspirations of Egyptian stakeholders regarding engineering education. By taking into account the constraints outlined in part I of this series, and by selecting suitable practices from worldwide engineering education providers, recommendations are provided for application.

**Key words:** Higher education, Egypt, Engineering Education, Quality Improvement

**Introduction**

In the first part of this series of three papers, the Egyptian governmental engineering education providers were analysed using the Business Anatomy Model proposed by Elsafty (2018). The analysis revealed several internal and external constraints imposed on these institutions that have adversely affected their efficiency and effectiveness. In the second part of this series the stakeholders aspirations were collected and consolidated into four main improvements that they would like to see. These were: the application of modern innovative teaching methods; soft skills training; modern software applications training; and practical technical or industrial training. This paper is devoted to investigating experiences from engineering education providers worldwide, where such improvements are being practiced with success. At the end of the paper recommendations are made to realize the stakeholders aspirations within the current constraints in Egypt.

**Innovative Teaching Methods in Engineering Education**

In the following sections, an overview about the application of innovative learning techniques in engineering education shall be given. In the authors view, the suitability of any learning technique will depend mainly on the type of course taught, subject matter involved, preparation by the course instructor and how the students are presented with the technique.

**Active Learning**

Lefebvre and Prakash (2018) described active learning as: “the process of students’ engagement in activities such as reading, writing and classroom discussions. Such activities usually require problem-solving skills and hence inculcate the ability to analyze, synthesize and evaluate the topic being taught”.

Petty (1983) argued that most engineering courses do not encourage creativity and innovation. He pointed out that active learning is the vehicle to teach creativity. To further develop creativity design projects provide practice. Projects involving real life problems with industrial involvement lead to training creative engineers. Daly, Mosyjowski, & Seifert (2014) pointed out the open ended projects which ask students to design a not so strictly defined product related to actual problems fosters the development of creative abilities.

**Cooperative or Collaborative Learning**

Rugarcia et al. (2000) argued that the new millennium presents challenges to engineering educators due to several external environment developments that will profoundly impact engineering practice in the coming years. These include:

* Flood of information due to the accelerating rate in academic publishing and greater visibility through the internet.
* The multidisciplinary nature of technological developments; which means that engineers from different specialties and other scientists need to collaborate in innovation.
* Globalization of markets; industries having to compete worldwide.
* Environmental sustainability concerns which has become crucial for all industries.
* Emerging social responsibility trends; giving back some of the profit for the benefit of society, using resources efficiently and sharing in informed societal decision making.
* Participatory corporate structures, where middle management jobs are being eliminated empowering the first line managers.
* Rapid change in science and technology, needing continuous long life learning.

To teach engineers able to tackle the above challenges, Rugarcia et al. (2000) suggested using techniques such as: “cooperative (team based) learning, inductive (discovery) learning, the assignment of open-ended questions, multidisciplinary problems and problem formulation exercises, the routine use of in-class problem-solving, brainstorming, and trouble-shooting exercises, and other methods designed to address the spectrum of learning styles to be found among students in every class”. They pointed out that their recommendations are useful for developed and developing countries.

Göl and Nafalski (2007) defined collaborative learning as “small group learning where the group members actively support the learning processes of one another. Collaborative learning is increasingly recognized as giving students an opportunity to engage in discussion and to exercise a positive influence on the group’s learning outcomes by assuming responsibility for their own learning. Critical thinking and reflective evaluation are implicit in the approach.” In other words students are “individuals working together with the intent of enhancing learning outcomes for all involved”. Prince (2004) pointed out that may take place in the form of students sharing the learning process, but then assessed individually. Pendergrass, et al. (2001) carried out cooperative learning experience at the University of Massachusetts Dartmouth. The students were even housed together in dorms to promote group study. Malm, Bryngfors and Mörner (2016) described the organized cooperative learning arrangement at Lund University in Sweden. Students in difficult courses attend discussion sessions about the material covered in lectures. The discussion is facilitated by an older student who already passed the course. The facilitator does not provide answers, he just directs the conversation. The students attending these discussion sessions scored higher in the course grade.

Students who went through collaborative learning at the University of Hong Kong reported that it helped them develop a sense of responsibility, teamwork skills and interpersonal skills (Chan and Sher, 2014).

**Experiential Learning**

Dutson et al. (1997) noted that the final year project “provides an experiential learning activity in which the analytical knowledge gained from previous courses is joined with the practice of engineering in a final, hands-on project” .

Rouvrais and Le Bris (2018) described an innovative experiential learning course introduced at Université Bretagne Loire in France. During the week between semesters, engineering students along with others from non engineering majors participate in a “Navigation and Sea Risks” course where they were taught some skills used by seamen. The course was designed to address some challenges in engineering education for the future and “to reinforce student confidence and efficacy, such as decision-making abilities in uncertain complex situations”. The course was offered to first year engineering students. The course also served an important purpose which was motivating young students to continue with the engineering program of study.

**Simulation Games**

Alanne (2016) argued that today’s engineering students have grown up with computer games. It is possible that these students would be more motivated and engaged by specially designed educational simulators involving “game-like features such as competition and rewarding through virtual promotions or achievement badges”.

Hamzeh, Theokaris, Rouhana and Abbas (2017) listed a number of simulation games used in teaching aspects of construction management for civil engineering students. They reported that the games help student develop problem solving, communication, decision making, team work, and cooperation. They selected 5 games to be played by their students at the American University in Beirut, namely: “Learn Airplane Simulation Game, The Silent Squares Game, The parade of Trades Game, The Red-Green Simulation Game and the Helium Stick Game”. They reported student satisfaction with this teaching methodology as well as better exam performance for those who used the games. They attributed this to the high level of understanding of the course topics due to the simulation games.

**Problem Based Learning**

Larsy (2008) noted that “Problem-Based Learning (PBL) is a pedagogical approach that uses meaningful, lifelike situations that students can learn from. With PBL, students make sense of the everyday context presented and work in small groups to not only discover an answer, but to first determine the question to solve. PBL requires students to distribute tasks and share expertise amongst themselves. The problems are designed to enable students to enquire and work collectively to construct understanding. In PBL, students don’t just learn the course content, they learn how to learn!”. “There are two different types of PBL. The main difference is whether the PBL problem comes before or after instruction. In the original McMaster version of PBL, students were presented with a problem before any formal instruction had taken place. In trying to solve the problem, students learned about the topic. The PBL problem in this approach drives the learning (Woods, 1994). In the second version of PBL, problems are presented after some formal instruction. Therefore, the problem is not used to build understanding, but rather to tie in different bits of knowledge and act as a synthesis activity(Heller et al., 1992). Both approaches have proved to be effective, so it is left to the individual instructors to choose which is best suited for their classroom and institutional constraints”. Klegeris, Bahniwal and Hurren (2013) reported that PBL can be applied to large student groups. However, Mohd-Yusof et al. (2011) pointed out that PBL is better combined with cooperative learning, by dividing medium to large classes of 40-60 students into teams consisting of 3-5 students, aided by a floating facilitator. Similar recommendations were made by Yusof et al. (2012) for a class of up to 100 students.

Yadav et al. (2011) pointed out that the goals of PBL include fostering active learning, interpersonal and collaborative skills, open inquiry, real-life problem solving, critical thinking, intrinsic motivation, and the desire to learn for a lifetime”. Several studies have demonstrated the merits of problem based learning in engineering and other disciplines (Woods et al., 1997; Smith et al., 2005; Klegeris et al., 2013, and Kuimova, Burleigh & Trofimova, 2016). However, there has been some debate about the applicability of PBL to engineering education. Perrenet, Bouhuijs and Smits (2000) pointed out that the technique has some limitations and is suitable for the early few years of engineering education. However, in the final years, project based learning is a better alternative. Radcliffe and Kumar (2016) concluded that problem based learning will deliver superior learning outcomes for the top 5-20% high school achievers, who now study engineering, and with allocating considerable resources.

**Project Based Learning**

Chowdhury (2015) noted that “The PBL projects are designed based on challenging questions or problems that involve students in project design, problem solving, decision making, investigative activities and provide students the opportunity to work independently over an extended period of time”.

The difference between project based learning and problem based learning is that the problem is usually open ended and the students seek the knowledge and resources needed to solve the problem. By contrast, in project based learning, students are asked to deliver a product of some defined specifications. However, it is essential that the projects assigned to students are real world cases. If this is not done, the project will simply be an assignment that would not prepare students to the complexities of practice after graduation (Chan and Sher, 2014).

One of the novel examples of student projects is that of the mechanical engineering department at the University of Kansas. Students in Kansas work on an extensive final year project, called capstone project. The project is required by an actual industrial client or the sponsor of the project. Two faculty members act as project managers whilst the students handle the conflicting requirements of the two project managers and the sponsor. Students deliver the end result of the project to the sponsor, after learning many lessons on how real projects are carried out. Capstones are a unique collaboration arrangement between industry and engineering academia (DeAgostino & Dougherty, 2018).

**Soft Skills Training in Engineering Education**

**English Language Ability**

To improve English language ability engineering students in Egypt are taught a course called “Technical language” in the preparatory year. However, secondary school leavers usually have a low level of English competency. The student numbers are very large in the preparatory year and there are no language laboratories on campus. As a result the instruction covers mainly basic language skills. This course used to be taught by instructors from the Department of English Literature in the Faculty of Art, but this resulted in little progress in language abilities. It is now taught by engineering faculty staff members. However, engineering staff are not trained to teach English language and full benefits are not realized. Pritchard and Nasr (2004) suggested that new course material should be prepared for teaching English to undergraduate engineering students. This would be in line with “English for special purposes” trends. There are now courses under the names: English for Petroleum, English for Tourism, English for Business …etc. This proposal, along with establishing language labs will transform English education at the faculties of engineering.

Another elective course is offered during the third year in engineering faculties in Egypt under the name “Technical Writing”. The course has always been taught by an engineering staff member. Most graduates have poor report writing skills (Osman, 2011); therefore it would seem that they are not benefiting from this course. In the authors view, technical writing should be integrated with all engineering courses. Students should submit writing assignments, not only solved mathematical or design exercises as part of their course work. This will probably help much more than an English course not directed towards any specific practical technical content. A similar view was reported by White and Hastings (2018) who surveyed 126 deans of engineering from around the world. The results of the survey indicated that 72% of the deans believe that all types of communication should be developed within engineering courses.

**Communication, Team, Multidisciplinary and Interpersonal Skills**

Students are rarely asked to give presentations during studying engineering in Egypt. The large class number makes this difficult. However, students must present an individual or group project before graduation during the fourth and final year. Most projects end up with a presentation or a discussion with and external examiner. Those who study specialties that require individual projects will not have a chance to develop communication and team skills. Even when students work in teams, these skills are not assessed when the project are submitted, as the assessment is based on mainly technical criteria. In addition, teams are formed from students in the same department studying the same specialty. Teams are almost never multidisciplinary.

Passow and Passow (2017) reported that engineers spend 55-60% of their working day communicating. One third of the work time is oral communication and a quarter in written communications.

In Malaysia Yuzainee, Omar and Zaharim (2011) carried out a study on which skills need to be possessed by graduate engineers. They used questionnaires and interviews with 337 employers as a data collection method. They reported that employers mostly desire graduates to have good communication and team work skills. In fact these skills ranked higher than technical competency skills. Zaharim et al. (2009) conducted a similar study on employers from Malaysia, Japan, Singapore and Hong Kong and reported similar findings.

Martin et al. (2005) interviewed 13 graduates from chemical engineering from the

University of Cape Town in South Africa about how they perceive their preparation for work in industry. The results showed that the graduates were adequately, if not well, prepared to face the challenges of work in industry, including key technical and non-technical areas of competencies. However, graduates have had little or no exposure, to multidisciplinary teamwork, management, and practical experience. They also pointed out the need for communication, team-work and interpersonal skills in the workplace.

To work effectively in teams, Downing (2001) found that the most important skill that students need to learn is listening. He also reported that this skill should be learned through mentoring by faculty staff members with industrial experience.

Klein and Newell (1997) defined interdisciplinarity as “a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession”. Lattuca et al. (2017) carried out an extensive study on acquiring interdisciplinary skills by engineering students in the USA. They emphasized the importance of “Faculty Culture” and co-curricular activities in developing this skill in students. The faculty staff should support the idea of interdisciplinarity. In addition, students participating in service or humanitarian projects were more likely to posses this skill as work in these projects require interaction with various members of the community as well as other engineering disciplines.

Dirsch-Weigand et al. (2018) recognized that it is expensive and difficult to set up interdisciplinary programs. They described the experience of Technische Universität Darmstadt in Germany in introducing multidisciplinary projects for first and final year students in mechanical and process engineering. They reported positive outcomes in student skills and recommended that these types of projects should be introduced to other departments.

**Leadership**

Leadership in not an intended learning outcome in any of the courses offered in engineering faculties in Egypt. However, this skill may be fostered in extra-curricular activities and voluntary work outside the university. Knight and Novoselich (2017) pointed out that leadership is an important trait that must be developed in future engineers. Their research on 5,076 undergraduate engineers from 150 undergraduate engineering programs from 31 colleges in the USA concluded that: “Although students’ involvement in various co-curricular activities may contribute to leadership skill development, faculty members and administrators would be misguided in assuming that these experiences should be the primary avenues for fostering the development of student leadership skills, possibly because they cannot guarantee that all students will engage in those experiences. Rather, faculty members and administrators should carefully consider their treatment of leadership and professional skills more broadly within courses or leadership-specific co-curricular programs if they want to optimize the development of technically adept engineering leaders.”

Bayless (2013), described the leadership program at the “T. Richard and Eleanora K. Robe Leadership Institute (RLI)”. It is an annual program given to the promising students in Ohio University’s Russ College of Engineering and Technology. It is not part of any course; however, it helps students understand the context of leadership. Students are given summer reading assignments and they are asked to write autobiographies about themselves. This is followed by a series of lectures on leadership. They then undergo team building activities. In addition guest speakers are invited to talk to students about real life cases and the students are allowed to interview the speakers. Students reflect on these experiences and they are given an exist interview to assess what they have learned at the end of the program.

**Ethics**

The Egyptian Syndicate of Engineers has a charter for professional conduct. It outlines how engineers should practice and what are the consequences of not abiding by the charter. One of the accreditation criteria set by the National Authority for Quality Assurance and Accreditation of Education (NAQAAE), the body that accredits education establishments in Egypt, is “Credibility and Ethics”. However, only a few faculties of engineering offer a separate elective course on ethics.

Colby and Sullivan (2008) studied the way ethics is being taught at 11 engineering programs in USA. The noted that ethics educations helps students deal with ethical dilemmas. They recommended active teaching methods (i.e. learning by doing) and deep faculty involvement in ethics education. They also found that combining ethics with other education goals, such as technical, would be beneficial.

Doorn, and Kroesen, (2013) pointed out that it is possible to use teaching techniques such as “Role Play” to teach students not only about ethics, but also social responsibility and communication skills. Therefore, ethics education need not be based on academic text which may not be well received by engineers.

**Global, Sustainability and Social Awareness**

These elements of soft skills are not addressed in a number of engineering programs in Egypt. However, some emphasis is placed upon them in programs like architecture and renewable energy. For students to become aware of these issues they should be trained in a similar manner as in the practical service training programmes of Delft and Purdue Universities discussed in the section below. In other words, these skills are acquired in conjunction with practical technical training.

Alternatively Pokholkov, Chervach and Zaitseva (2018) reported about the experience of Tomsk Polytechnic University- Russia in introducing “Responsible Resource Management (RRM)” to their engineering education programs. They wrote about specific training programs for faculty staff, changes to the curriculum by introducing new courses and different assessment methods for the skills to be acquired by students.

**Software Training in Engineering Education**

Ardebili and Manenti (2012) argued that students should learn both a programming language and the use of commercial software packages. The reason given for that is the fact that some commercial packages may not provide results for some applications.

Researchers from Spain and Colombia (Echeverríaet al., 2017), proposed a collaborative teaching-learning approach to help teach non computer sciences engineering major students to write computer programs. Their approachleads to a positive enhancement of student performance.

[Hundt](http://08101iye7.1104.y.http.www.sciencedirect.com.mplbci.ekb.eg/science/article/pii/S0743731517300060" \l "!), [Schlarb](http://08101iye7.1104.y.http.www.sciencedirect.com.mplbci.ekb.eg/science/article/pii/S0743731517300060#!) and [Schmidt](http://08101iye7.1104.y.http.www.sciencedirect.com.mplbci.ekb.eg/science/article/pii/S0743731517300060#!) (2017) described a free web application for teaching parallel programming. The “System for AUtomated Code Evaluation” (SAUCE) helps students write correct source codes and reduced the needed teaching time.

# Bangash et al. (2017) utilized spreadsheets to teach students seismic energy partitioning Knott–Zoeppritz equations. They reported that spreadsheets are better for the educational purpose than hand calculations and professional software since spreadsheets provide a good learning opportunity for students without carrying out tedious hand calculations or playing a passive role whilst using readymade packages. In addition, to generate reliable results when using commercial software, the user must know the source code and should have programming skills. Since this is not the case for students, the spreadsheets provide a way to carry out step by step solutions for the benefit of learning.

Yanase (2017) fromFukuoka University in Japan noted that finite element analysis professional software is suitable as an analysis tool in many engineering applications. However to teach mechanical engineering students, he preferred to use an Excel – Visual Basic Application to solve simple problems to introduce students to the fundamentals of the finite element technique. Sana (2017) from Sultan Qaboos University in Oman also used Excel – Visual Basic Application to teach coastal engineering fundamentals to undergraduate students. He chose this method and not commercial software because this “not only allows the user to follow the calculation steps but also easily modified by the user to incorporate the latest information available”.

Yetilmezsoy (2017) described the use of MATLAB, downloadable software package, in engineering education in Turkey. Students wrote codes in this package to solve cylindrical, conical, and spherical water tanks. This novel educational methodology was effective in increasing students’ understanding of the tank problems and in addition has introduced students to the versatile tool: MATLAB, which will help them solve other problems in the future. Researchers from Greece (Nikolaou and Pitilakis, 2017) also utilized MATLAB in helping students analyze and design shallow foundations. They made their developed tool: SOFA freely available on the Internet. It has received worldwide positive feedback as it attracted students and educators alike.

Niazkar and Afzali (2017) from the University of Shiraz in Iran acknowledged that robust commercial programs such as EPANET and WaterGem provide efficient solutions for the hydraulic modeling of water distribution networks. However, the use of these programs does not allow students to become familiar with modeling fundamentals. They introduced their students to solving such problems using MATLAB and Excel spreadsheets to enhance their understanding of the basic concepts and prepare them to use the commercial software in their future careers.

Joseph et al. (2017) developed a Windows Store App to help teach an introductory course in Digital Signal Processing (DSP). The App has helped in reducing the effort needed to teach mathematical and algorithmic concepts. The student feedback to teaching using the App was positive.

Nagrial (2002) described the structure, contents, evaluation methodology and statistics of a course entitled “Engineering Software Packages and Applications”. The course was delivered at the School of Engineering and Industrial Design in the University of Western Sydney - Australia. The students were provided the opportunity to analyze, design and implement a number of projects from the areas ranging from PID control to Speech Analysis, Operational amplifier to Microprocessors and Filter Design to Pipeline Flow Analysis using a number of selected commercial software packages. The students found the course very useful for their employment.

Peterson et al. (2011) described the advantages of introducing Building Information Models (BIM), which is a project management commercial software, in construction engineering project management courses. They reported that this helped instructors simulate realistic project management situations to the benefit of the students.

Mukherjee, Neogy, and Nandi (2017) described the use of a commercial package called ADAMS in teaching an undergraduate dynamics course at the Indian Institute of Technology in Delhi. They reported increased student understanding due the simulations produced by the package. They also noted that students generated solutions manually for comparison.

Barbero and Garcia (2011) applied improvements to the way 3D CAD is taught at the Universidad de Burgos in Spain. They introduced advanced training on object simulations and provided in depth instruction on the theory behind the package.

**Practical Technical Training in Engineering Education**

Hamzah, Aziz & Ayub (2011) evaluated the training program for students enrolled in Universiti Malaysia Perlis. Students complete 12 weeks of field or industrial training at actual work setting. The training is conducted during semester breaks. They reported that workplace setting requires that students acquire soft skills besides technical skills.

Lee (1995) described the practical training program for engineering students at Nanyang Technological University in Singapore. He said that the training program was 10 weeks and it included organizing students in a company to carry out various roles, simulating work conditions. The civil engineering students constructed a pre designed structure and their work included spending the allocated budget to complete the project. Students in electrical engineering worked in factories, operated machinery and were trained to use a variety of computer systems.

Renganathan, Abdul Karim and Li (2012) noted that the Universiti Teknologi PETRONAS requires its undergraduate students to undergo an eight-month internship programme before graduation. This exceeds the minimum requirement set by the Board of Engineers Malaysia. The students who completed the 8 month training provided positive feedback as they were able to apply theoretical knowledge and gain soft skills. However, the authors recommended improvement to the training by structuring it since at the moment the student learning is incidental in real life work settings.

After studying the current training program offered at Nanyang Normal University in China, Xinzheng (2012) recommended that the training should be at least 3 months during summer holiday instead of the current duration of 2 months. He also stated that students should not be allowed to study any summer courses during the training. He suggested that the training should become a credit hour course under the supervision of faculty staff. Some of the respondents to his questionnaire actually recommended training between 4 to 6 months to realize the full benefits from the process.

Tapia, Manokhoon and Najafi (2004) compared the practical training program required by the universities of Florida and California in the USA, a leading university in Chile and another in Thailand. They noted that Florida offers students training for 3 semesters, while California requires training for 6 months. The universities in Chile and Thailand require only 60 days or 240 hours of training, respectively. In addition, students are usually paid by the companies in which they train in the USA.

Rompelman and Vries (2002) listed the aims of practical training for engineering students in general “in order of educational interest:

1. Acquiring insight into the engineering profession.

2. Social/psychological goals: learning to ‘survive’ in a different culture.

3. Learning to apply as well as broadening technical knowledge and skills.”

However, to provide better training for their students as global and European practitioners, their university decided that students should train in other countries to learn to communicate in global teams and appreciate different cultures.

Huff, Zoltowski, & Oakes (2016) described a training program conducted in Purdue University since 1995. It is the “Engineering Projects in Community Service (EPICS)”. Helping in this project is welcome from all engineering disciplines and from all students across the university. “EPICS is an engineering-centered, multidisciplinary, service-learning design program where students earn academic credit for partnering with nonprofit organizations to meet local or global community needs. The program is explicitly multidisciplinary, and it encompasses students from all undergraduate classifications, from first-year students to seniors. The curricular structure is designed to allow students to enroll multiple times in different academic terms and supports long-term, reciprocal community partnerships. The long-term student participation allows projects to be developed over several semesters or years and enables students in EPICS to solve complex and compelling problems in the community that do not fit within the traditional academic term.” The way this operates is as follows: “Each section of the course typically consists of 8 to 24 students and is student-led, with a faculty or industry mentor (referred to as an advisor) and a graduate teaching assistant. A course section is generally partnered with a nonprofit entity in the community, such as Habitat for Humanity, a local elementary school, or a children’s museum. Every course section comprises multiple sub-teams, each one of which undertakes a single design project. Once a completed project is delivered, a new project is then identified by students under the guidance of their faculty, staff, or industry mentor(s) and community partner(s). Projects have included designing assistive technology for people with disabilities, developing database software for human services agencies, and developing energy-efficient and affordable housing solutions.” The researchers concluded that EPICS as an example of service – learning strategy provided students with a good opportunity to practice real engineering and had adequately prepared them for engineering professional work.

Oh and Kim (2018), described the training program at Korea University of Technology and Education. They reported that intensive courses related to the major are taught during seven and a half weeks of a summer semester. This is followed by 4 to 6 months on practical on site work-training. Students return to the university and then before they graduate they attend another 4 months of practical training.

**Conclusions and Recommendation Based on Findings from International experiences**

1. Due to the various constraints on engineering education in Egypt, it is not possible to totally change the delivered curriculum to adopt for example CDIO proposed by Berggren et al. (2003), and has been successfully running in many countries for many years as documented by Crawley et al. (2007) and Crawley et al. (2014). However, some changes to the current practices can be introduced; leading to improvements in graduate skills.
2. Alternative Innovative teaching methods have been successfully applied in many countries. Egyptian faculty staff can apply these methods if they receive adequate training and support to do so. It is suggested that staff from the faculty of education mentor engineering staff and help them select and apply innovative teaching techniques suitable for various engineering courses based on the international experiences shown herein. This would greatly enhance students’ learning outcomes and skills.
3. A new “English Language Curriculum for Engineering” suitable to Egypt should be designed to help students acquire suitable language understanding abilities, as suggested by Pritchard and Nasr (2004). Investing in English teaching facilities and software would greatly help verbal communication. Adding report writing to assignments required from students would enhance written communication.
4. Egyptian engineering staff members can help students work on practical real life design projects, as suggested by Chan and Sher (2014). Most engineering faculties in Egypt have an “Engineering Consultancy Service”, which offer industrial consultation to clients from the local community for a fee. The consultancy service can assign projects to final year graduation project students. Students then work on the projects under the supervision of faculty members. Students working on actual client projects will be similar to the practice in Kansas University (DeAgostino & Dougherty, 2018). These projects can also include teams from different departments. This will help students acquire multi disciplinary team skills, as suggested by Dirsch-Weigand et al. (2018). There is nothing in the current curriculum that would prohibit multi-departmental collaboration in graduation projects.
5. Investing in large computer laboratories is not going to be too costly. Students in the preparatory year should be introduced to practical hands on applications on computers. Thereafter, most courses should encourage students to use Excel applications in solving problems, as shown in the experiences cited in this report. There are also many special purpose open source packages that course instructors can help students to utilize in problem solving. The students can be simply asked to solve the homework using the software package instead of by hand. This would provide a good basis in terms of software training if the faculties are unable to purchase modern software packages.
6. Currently the period of technical training cannot be extended for students in Egypt as this is part of the curriculum. Egyptian employers are unlikely to pay students any money during training. Students cannot be trained abroad due to financial and logistical difficulties. However, practical training, societal awareness and soft skills can be cultivated through service projects. Each faculty has a community service vice dean. Most of the time, the nature of activities for community service is short term humanitarian relief events. However, for the purpose of training students, these activities can be extended to long term practical engineering projects, like those carried in Purdue University (Huff, Zoltowski, & Oakes, 2016). Students spending time and effort on such projects, dealing with various stakeholders, would gain excellent experience. Student societies, administrative departments and academic staff can make a great difference by helping in the development of Egyptian rural areas. So even if increasing the period of practical training in the current curriculum is not a viable option, service projects can fill both the technical and soft skills training.
7. Student trips can be an opportunity for experiential learning exercises to help students gain important soft skills, leadership and problem solving abilities instead of being just for recreation (such as the experience described by Rouvrais and Le Bris (2018). Students can learn a lot by going, camping, mountain climbing, fishing or navigating. Such activities will be fun and beneficial to character building. The student support department available in all faculties should be restructured and its operations updated to gear trips towards cultivating much needed learning outcomes.

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