

Curriculum Innovation in Engineering Education: A Model for Future Pilots

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Abstract. Turkish Air force Academy (TurAFA) is a military higher education institution graduating leaders for the Air Force through a four-year program. In this paper evolution of TurAFA's undergraduate program will be examined in a historical perspective and the restructuring process of the undergraduate engineering programs at TurAFA will be described. The restructuring process was compelled by institutional needs and guided by faculty assessment of current practice and future needs. The program is designed to fulfill the prospective needs of TurAFA cadets and thus prepare the cadets for the challenging workplace tasks peculiar to Air Force installations. English language is not only essential in determining the success in business but also it is a major determinant of military operations' success. Thus English Language Education has become a core element in TurAFA programs like many other military academies all over the globe. Observing the individual needs of the learners, focal point in the new design has been the intense language courses embedded in the engineering curriculum. The model comprises engineering subject matter enriched by a variety of social science, humanities, and other professions courses in order to endow cadets with intellectual and warrior skills needed in dealing with future challenges presented in military contexts. The new program provides students with extensive experience through case based learning environments planned by the faculty to present cadets real life situations in engineering classes. As one of the major program outcomes, cadets' intercultural competence is increased through intensive language courses, and courses in history, literature, economics, business, law and a number of various subjects chosen in accordance with institutional and individual needs.

1. Introduction

Early 20th century witnessed the birth of Turkish Air Force which is the youngest military service of Turkish Armed Forces. Right after its foundation in 1911, in the year 1912 Turkish Air Force established its academy called the Aircraft School in Yesilkoy, İstanbul. Basic goal of this school was to educate pilot candidate officers and to provide Turkish Air Force with qualified manpower needed to develop it. During the first years, students of the Aircraft School were army and navy officers who were required to attend the school for three months. The first curriculum of the school consisted of subjects related to aircraft and engines. The courses were accompanied by flight training through which students were given the opportunity to fly aircrafts. Every four months, the school was

graduating 15-20 students who were qualified either as pilots or co-pilots. Candidates were required to be robust enough, cold blooded and have a strong mind in order to be eligible for the school [1]. The graduates of the Aircraft School took active roles in Balkan wars and made great contributions in the war. On the other hand problems emerged in dealing with the aircraft malfunctions pointed out an urgent need for maintenance officers. Hence in addition to pilot and co-pilot officer training, the Aircraft School also assumed the responsibility to train maintenance officers for Turkish Air Force. During the Turkish Independence War the Aircraft School moved to Adana, Konya and lastly to İzmir in 1922. During these years Turkish aviation industry witnessed new developments and in 1923 under the contracts signed by Turkish and French governments Turkish Air Force bought new French aircrafts and sent pilots and maintenance personnel to France to get pilot and maintenance training [2].

As the years passed the arising need for more qualified personnel changed the Aircraft School from flight training course to a two-year flight school in 1929. During the first year of the new curriculum students were offered courses pertaining to aviation theory and the second year flight training courses which were all applied and aimed at sharpening flight skills. In the year 1950, Turkish Air Force pilots started to fly their first jet engine powered aircrafts and eight Turkish pilots were sent to the United States to get jet aircraft training. Following this year Turkish Air Force decided to establish its own military academy and Turkish Air Force Academy was founded in 1951 [3]. Courses comprising the first curriculum of Turkish Air Force Academy were basically divided into two groups as general knowledge courses -military tactics, topography, history and law- and vocational courses pertaining to engine technology, aircraft mechanics, flight, navigation and meteorology. All these courses were naturally accompanied by physical training classes and summer encampment period during which cadets are supposed to take part in military training activities [1]. Presenting the evolution process of the Aircraft School and establishment of Turkish Air Force Academy as a military academy, focal point of this paper will be Turkish Air Force Academy and its undergraduate engineering curriculum. The academy's curriculum is quite innovative and comprises best practices in engineering education.

2. Turkish Air Force Academy

Turkish Air force Academy (TurAFA) is a military higher education institution graduating leaders for the Turkish Air Force through a four-year program. Vision of TurAFA is to educate and train modern Air Force officers equipped with knowledge, attitude, and skills, required by necessities of professional military service and 21st century air and space power; and to become an Air Force Academy which competes with its contemporaries with its capacity of graduate education both regionally and globally [4]. TurAFA offers undergraduate education in five academic majors i.e. aviation and aerospace engineering, electronics engineering, industrial engineering, computer engineering, and administrative sciences. Upon graduation, cadets are commissioned as a Second Lieutenant in the Turkish Air Force with Bachelor degree in engineering.

3. TurAFA Curriculum

Current TurAFA curriculum has been designed to fulfill the prospective needs of TurAFA cadets and thus prepare the cadets for the challenging workplace tasks peculiar to Air Force installations. TurAFA engineering education model regarding students as intellectual and social beings respects basic principles of learning and pursues the best practices in engineering classes. Major components of the TurAFA engineering curriculum is as follows: intense language education, applied engineering courses and a variety of courses scheduled to improve cadets' leadership skills. All these courses comprise the four-year officer development system which is basically designed to endow cadets with intellectual and warrior skills needed in dealing with future challenges presented in military contexts.

3.1 Foreign Language Education

Although there are almost 6000 languages spoken on the globe [5], English is now the official or dominant language for two billion people in at least 75 countries [6]. English language is not only essential in determining the success in business but also it is a major determinant of military operations' success. Thus English Language Education has become a core element in TurAFA programs like many other military academies all over the globe.

The main goal of the Department of Foreign Languages is to make the cadets master a mission oriented English language teaching program that covers all four language skills to enable the cadets to accomplish missions effectively [7]. In order to achieve this end, TurAFA Department of Foreign Languages launched a new intense English language teaching program in 2007 to recover the deficiencies in teaching English and redefined the role of English in the engineering curriculum of the academy. Observing the individual needs of the learners, focal point in the new design has been the intense language courses embedded in the engineering curriculum. Traditional teaching methods do not position students as the main stakeholders of education, and they also fail to improve students' comprehensive language competence [8]. Teacher-centred and drill based approaches are now considered obsolete. Teachers are supposed to use student-centered approaches and provide the learners with language input which is authentic, interesting and practical. Teachers should also use modern teaching technology to create a better learning environment and develop teaching resources [9].

The TurAFA English Language Teaching Program has been designed to address the shortcomings of a traditional English curriculum and it aims to create an opportunity for the students to learn and practice English while increasing their content awareness in the subject matters which will constitute crucial parts of their career. The students of TurAFA will have prearranged career fields with clear-cut definitions after graduation, which helped the designers of the syllabus while deciding on the content of the new system. All of the students need to learn and improve the language of English in four skills and they are getting educated and trained for almost the same career areas in which they will have to use English. Viewing the target language largely as the vehicle through which subject matter content is learned rather than as the immediate object of study [10]. TurAFA encouraged the curriculum designers in their effort to both form their own syllabus and produce their own materials. TurAFA English language teaching program mainly consists of three stages. During the first phase, commercial series of English course books written especially for adult learners are used. The series includes five different books starting from an introductory level and ending with an advanced level. All the books of the series contain thematically-based, four-skill-integrated units with critical thinking skills. Following this phase, all the students start studying the authentic books prepared by TurAFA staff in accordance with the principles of content based instruction (CBI). However, only the advanced and upper-advanced course students can have the opportunity to study the whole six books as the beginner and intermediate level students spend more time in the program improving their proficiency in general English to reach the prerequisite advanced level necessary for these books. In the final stage of the syllabus, all the students attending the first semester of the third year at the school are instructed in English in at least any two engineering courses until the last semester of the school. The TurAFA English Language Teaching Program is presented in Figure 1.

GRADE	SEMESTER	WEEKLY HOURS	LEVEL			
			BEGINNER	INTERMEDIATE	ADVANCED	UPPER-ADVANCED
1	1	20	General English	General English	General English	General English
	2	12	General English	General English	General English	General English
2	1	4	General English	General English	CBI Books	CBI Books
	2	4	General English	General English	CBI Books	CBI Books
3	1	3	General English	General English	CBI Books	CBI Books
	2	3	General English	CBI Books	CBI Books	CBI Books
4	1	3	General English	CBI Books	CBI Books	CBI Books
	2	3	CBI Books	CBI Books	CBI Books	CBI Books

At least two engineering courses are taught in English by content teachers.

Figure 1. The TurAFA English Language Teaching Program

The students taught in this program are evaluated by means of four-skill achievement tests. In addition, all the students are to keep a course portfolio for their authentic assignments. The portfolios are also officially taken into consideration during the assessment of the students. In 2012, TurAFA English Language Teaching Program was selected by the Ministry of European Union Affairs, from among 72 projects, to receive the European Language Label.

3.2 Engineering Courses

Engineering education is one of the best tools to meet the challenges of the 21st century. Since achieving qualitative i.e. deep learning has become an accepted form of learning and teaching in higher education [11], during the last decades there has been a paradigm shift in engineering education putting emphasis on more communication and leadership skills, teamwork, and systems thinking [12]. Furthermore proficiency in problem solving, interpersonal communication, teamwork, time management, and communication are the expected outcomes of higher education institutions

TurAFA as a higher education institution states its mission as to educate, train, and inspire the cadets in becoming motivated officers who will aspire to become combat pilots leading Turkish Air Force. This mission of the academy entails graduating qualified engineers equipped with problem solving, teamwork, and leadership skills. In order to achieve this end TurAFA faculty tried to design educational environments that will enable the cadets to deal with novel problems that they will face in various contexts. Hence TurAFA’s engineering curriculum has been designed under the guidance of distinguished educators and officers and senior instructors in such a way that it became a broad curriculum balancing the engineering courses, and social sciences through which students are forced to interact not only with each other but also with the instructor.

For the sake of adapting TurAFA engineering curriculum to the new era and to fulfill the needs of TurAFA cadets, the faculty has started a case-based learning project at the Turkish Air Force Academy in 2008. The project is still going on to promote critical thinking skills of the cadets and to ensure deep learning in engineering classes. Case-based learning (CBL) as an instructional design model has been chosen as the basic strategy to achieve the aforementioned goals in TurAFA engineering education. CBL is a learner-centered pedagogy making the students engaged in tailor-made cases/problems presented by instructors in accordance with cadets' careers. So, TurAFA cadets are provided with opportunities to interact and solve problems that really help them to activate the theory introduced by the instructors instead of passively listening to traditional lectures leading to only rote learning. Through the case based approach students are made participate discussions of specific scenarios derived from real world problems. Instructors play the facilitator role and lead the students deeply involved in discussions taking place in collaborative groups. The success of case based approach depends on precisely written problems stimulating collaborative discussions and teamwork guided by trained facilitators i.e. the faculty.

Implementing a new approach to teaching entails sincere efforts of the instructors. Therefore the issues like teachers' perceptions and pedagogical beliefs about the new approach, the prospective barriers and support that the teachers need while implementing the new pedagogy have taken into consideration. Add to these issues, teacher readiness in other words teachers' knowledge about the method of teaching in question is also one of the basic determinants of success in adopting an innovation in an educational setting. In order to empower the faculty to apply case based approach in TurAFA engineering classes, TurAFA instructors involved in a seven-week seminar led by a visiting professor experienced in case based learning practices. In service training program started with the theoretical background and continued with sample practices in different fields of study. The training program lasted for three months and it consisted of 21 hours face to face education and practicing the theory in classes namely doing the assigned tasks. Right after the training the instructors started to apply case based scenarios in engineering classes. Scenarios are written to present the cadets with real-life problems and make them practice the theory studied in lecture sessions. The two sample scenario sheets for Aerodynamics 1 and Material Science courses are presented in Figure 2 and Figure 3.

Duruma Dayalı Eğitim Uygulaması Örnek Olay İnceleme ve Problem Çözme (No: 4)		
Ders :	Aerodinamik-1	Amaç: Harbiyilerin Bir Boyutlu
Konu :	Bir Boyutlu Akımlar	Akımlar ile ilgili bilgilerini
Hafta :	6 ncı hafta	pekiştirmek.
Süre :	30 Dakika	
1. Durum :		
Bir kaza kırım ekibi içinde aerodinamik konusunda inceleme yapmak üzere görevlendirildiniz. Uçağın pitot tüplerinden birinin tıkalı olduğu tespit edildi ve sizden bu durumda olabilecek olaylarla ilgili inceleme yapmanız istendi.		
2. Görev (Problem) :		
Bir Boeing 757 bakırın sırasında pito-statik tüplerinin korumasız bırakılması üzerine tüplerden birinin toplam basınç kanalı bölgede yaşayan arılar tarafından tıkanmıştır. Girişi tıkalı olan toplam basınç kanalı içindeki hava, deniz seviyesi şartlarındaki basınca sahiptir. Statik basınç delikleri normal şekilde ortamın statik basıncını algılayabilmektedir. Bu durumda uçak deniz seviyesindeki pistte hızlanırken tıkalı pito-statik tüpüne bağlı olarak ve ortam yoğunluğunu da hesaplayarak uçağın havaya göre hızını gösteren 1 nolu hız göstergesi nasıl davranır? Aynı göstere fırtınalı sırada irtifa artarken nasıl hız gösterir? 2000 m irtifada uçağın gerçek hızı 500 km/saat iken 1 nolu hız göstergesinin göstereceği hız değerini hesaplayınız.		
		

Figure 2. Aerodynamics 1 Sample Case Sheet

Duruma Dayalı Eğitim Uygulaması Grup Tartışması ve Problem Çözme (No: 6)		
Ders :	Malzeme Bilgisi	Amaç: Harbiyelerin malzemelerin mekanik özellikleri hakkında öğrendikleri teorik bilgileri uçuşa yönelik temel bir uygulama üzerinde kullanmalarını sağlayarak öğrenmeyi pekiştirmek.
Konu :	Mekanik Özellikler	
Süre :	10 Dakika	
Hafta :	11 ncı hafta	
1. Durum :		
Mekanik özelliklerin incelenmesinden sonra, Harbiyelere, malzemelerin mekanik özelliklerinin uçak performansı ve stabilitesi (kararlılığı) üzerindeki etkileri örneklerle izah edilecektir. Tartışma geliştirilmesini için, farklı metal alaşımların mukavemet değerleri, bunların belirleme yöntemleri ve mukavemet/ağırlık oranının hava taşıtılarındaki esas faktör olduğu vurgulanacaktır. Tartışma sonucunda, önemli mekanik özellikler tekrar edilecektir.		
2. Görev (Problem) :		
Şekil incelendiğinde, yerde kırım geçiren ağır kargo uçağı görülmektedir. Kanadın üzerindeki yükler ve gövdeye bağlantısı detaylandırılacaktır. Asıl soru ise, muhtemel kırım sebebinin hangi faktör olduğudur:		
<ul style="list-style-type: none"> • Malzeme hatası, • Personel hatası, • Tasarım hatası. 		
		

Figure 3. Material Science Sample Case Sheet

After preparing the case sheets with clear description of the scenarios and the tasks to be accomplished instructors distributed them to the students prior to each class session. Each week students had at least one or two sessions discussing cases related to the subject matter of the week. The content of the case sheets was based on the units studied, and each problem presented real life situations. Students were supposed to attain the learning objectives through group discussions. During group presentation sessions, instructors acted as facilitators and kept students focused on learning objectives and they made sure all students participate group activities. In order to find out the effects of case based scenarios on student achievement, students' achievement scores in case based classes are compared to students' achievement scores in traditional lecture classes. Sample TurAFA engineering courses chosen for this study are Aerodynamics 1, Aerodynamics 2, Production Planning and Control, and Facility Layout all of which are junior-level courses taught by the same instructor in both lecture and active groups. The results are presented in Figures 4-7 [13].

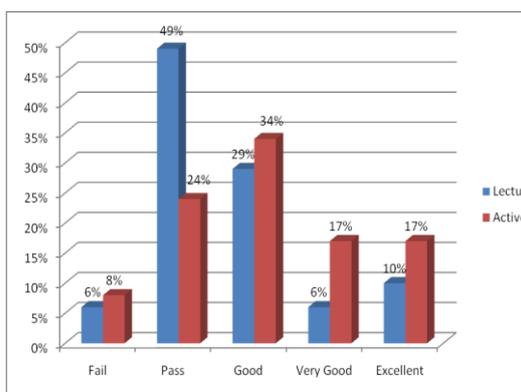


Figure 4. Aerodynamics 1

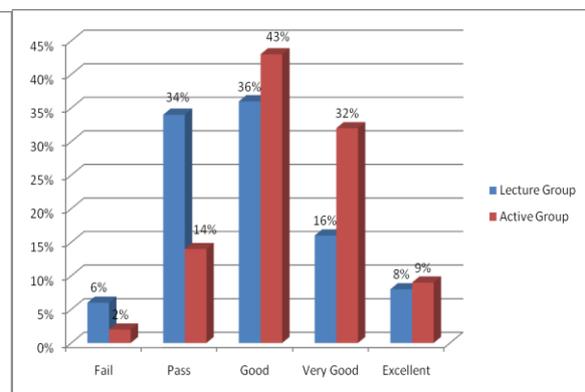


Figure 5. Aerodynamics 2

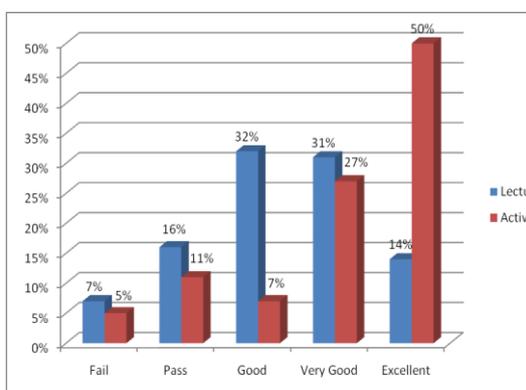


Figure 6. Production Planning and Control

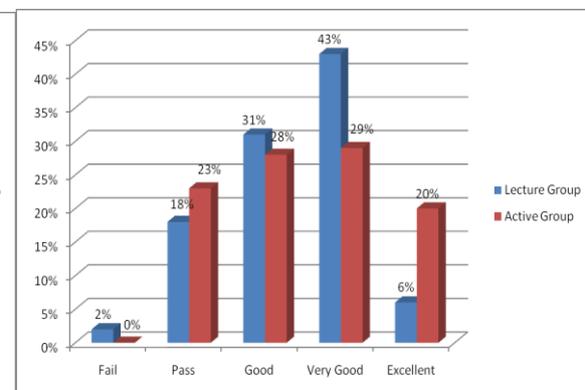


Figure 7. Facility Layout:

The results indicate that the students studied case based scenarios acquired higher achievement scores than the traditional lecture teaching approach. Case based scenarios provided the students with educational environments in which they were able to participate, act, react, and reflect both individually and in groups of three or four. The new approach to engineering curriculum in TurAFA context provides students with extensive experience through case based learning environments planned by the faculty to present cadets real life situations in engineering classes. The above results set strong evidence to support using case based learning to increase engineering students' success in engineering courses.

3.3 Leadership Skills

Leadership is accepting responsibility to create conditions that enable others to achieve shared purpose in the face of uncertainty [14]. TurAFA graduates need additional dimensions of knowledge and acquire leadership skills in order to be able to be actively involved in multi-national task forces and act as competent 21st century leaders. Observing this peculiar need and keeping the fact -leadership skills could be taught and acquired via educational practices [15,16]- in mind, the faculty assumed the responsibility to educate and train the cadets to deal with prospective challenges presented by constantly changing complex and diverse contexts. To achieve this end TurAFA launched a leadership development program through which cadets are provided with a variety of social science, humanities, and other professions courses i.e. military sciences scheduled to develop cadets' sense of social responsibility, communication and problem solving skills. The objective skills of those courses which are accompanying the core engineering courses are all applied in real life settings and cadet practices are guided by peers, senior cadets and instructors. TurAFA leadership development model is designed in such a way that during the four-year engineering undergraduate program cadets are presented with challenges in an order from simple to complex. During the developmental stages cadets act both as leaders and followers just like the officers do at various levels of service. Leadership training starts with the basic military training, and is reinforced with advanced military and leadership trainings within the academic year. The summer encampment periods offer opportunities not only to sharpen the leadership and warrior skills but also to put leadership theory in practice in unique settings.

4. Conclusion

TurAFA's undergraduate program evolved from Aircraft School is a unique and comprehensive engineering curriculum comprising intensive language courses, engineering courses, and courses in history, literature, economics, business, law and a number of various subjects chosen in accordance with institutional and individual needs. Turkish Air Force Academy assuming the responsibility to educate Turkish Air Force officers acting on a unique curriculum presenting engineering subject matter enriched by a variety of other courses in order to endow cadets with intellectual and warrior skills needed in dealing with future challenges presented in military contexts. Learning environments enriched by case based scenarios promote student learning and increase engineering students' success in engineering courses. TurAFA also faces the challenge raising future leaders for Turkish Air Force. In order to fulfill this responsibility the academy is running a leadership development program entailing ongoing collaborative efforts among the whole faculty members. Since the qualities depicting a successful air force officer constantly increasing, the academy's curriculum needs to respond this demand accordingly by changing not only the course content but also adopting the best practices in higher education.

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