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Applied and Cooperative Engineering Education Model in Turkey

Ahmet Yunus Cil[1], Ibrahim Cil[2*]

Abstract

Applied education is a teaching paradigm that attracts the attention of researchers. It is just beginning to spread in Turkey. In this study, the cooperative education model, which is a structured method that combines classroom-based education and hands-on work experience, is discussed. In particular, the paradigms of engineering education in the last hundred years were reviewed, and engineering education in Turkey was criticized. An evaluation will be made by giving information about the cooperative education model that has gained importance in Turkey in recent years. Evaluations are being made about the reflections of the "Applied Education Framework Regulation in Higher Education" prepared by the Council of Higher Education (CoHE) in 2021 in Turkey. Applied Engineering Training, which has been on the agenda in Turkey in recent years, was discussed. The Applied Engineering Experience Training (UMDE) applied in the engineering faculty of Sakarya University was mentioned and discussed in the context of its dissemination and sustainability of quality. This education model, which will meet the needs of young people who receive engineering education and the enterprises that will employ them, will make an essential contribution to the literature in terms of becoming widespread in Turkey.

Key Words: *Cooperative Education, Applied Engineering Education, 7+1 System in Engineering Education, Engineering Education Paradigms.*

1. INTRODUCTION

Today, the pressure exerted by the changing social structure because of population explosion and urbanization obliges the engineer to extend his knowledge and opinion beyond the traditional (ABET, 2003). On the other hand, society expects the engineer to solve vital problems. In this context, universities have an essential task. University is an environment where scientific superiority, academic ability, and management competence predominate. The education aims to provide individuals with scientific thinking ability and skills by having high-level teaching and research done and contributing to scientific and technological developments with the studies carried out. The educational philosophy of today's technology society is that instead of educating engineers who have only the ability to solve technical problems, it tends to train engineers who can comprehend the situation. Engineering education should broaden the student's horizons and help reveal fundamental issues.

Practical education has a significant place in the education programs of education faculties, medical faculties, and some faculties related to health. It is an excellent shortcoming that practical training has just been included in the education programs of engineering faculties. When a newly graduated engineer starts a job in a private company,

[1] Kocaeli University, Department of Industrial Engineering, Kocaeli /Turkey, ORCID: 0000-0002-1772-182X, ahmetyunustc@gmail.com
[2] Sakarya University, Department of Industrial Engineering, Sakarya/ Turkey, ORCID: 0000-0002-1290-3704 icil@sakarya.edu.tr
* Corresponding Author: Ibrahim Cil, E-Mail: icil@sakarya.edu.tr

it takes a long time to overcome their inexperience and become productive. This inexperience can sometimes lead to huge losses for the employer. Every day that a newly graduated engineer will spend as a beginner means an economic loss for the business, and these days also affect the morale and motivation of the engineer negatively. The fact that companies look for a particular year of experience and competence in their advertisements is a constraint that has been put in place for new graduates to find a job from the beginning. In addition, it is a fact that the continuous cooperation of the instructors with the enterprises will significantly increase the quality of education. In a report published by the European Commission in 2017, the importance of vocational training in businesses was emphasized for developing skills and a promising future.

In the report presented in the training symposium on “Historical Development and Current Situation Analysis of Engineering and Architecture City Planning Education in Turkey” (Historical Development and Current Situation Analysis of Engineering and Architecture City Planning Education in Turkey, 2017) by TMMOB in 2017, TMMOB members generally It is stated that approximately 1/3 of them work in the public sector and 2/3 of them work in the private sector.

The CoHE prepared the “Framework Regulation on Applied Training in Higher Education” to enable university students to develop professional knowledge, skills, attitudes, and behaviours, to get to know the sector, to adapt to business life, to gain professional experience, and to be trained in an actual production and service environment. The regulation also aims to increase the employment rates of graduates, contribute to the effective and efficient use of Turkey’s resources, train the workforce with the required qualifications, strengthen the education-industry cooperation, realize the goals included in the top policy document, fulfil the duties given by the laws and to solve the problems arising from the legislative gap (CoHE’s, Framework Regulation, 2021). Another critical point is that the Applied-Cooperative Engineering Education Model will contribute to employment. “When the national and international data are examined, it is observed that there is a relation between education level and employment. However, according to the data of OECD for 2019, the employment rate of university graduates aged 25 to 64 was 73.6% percent for Turkey, while this rate was 85.6% for the OECD average. The CoHE published this regulation to increase this rate. Increasing this rate is one of the main goals, and The CoHE believes it will contribute significantly to steady economic growth. The Regulation will contribute to the employability of university graduates” (CoHE’s Framework Regulation, 2021).

The Applied-Collaborative Engineering Education Model can significantly contribute to the training of engineers with the skills the industry needs today. For this reason, in this study, especially after the worldwide Engineering Education Paradigms in the last hundred years have been reviewed, the subject is evaluated within the scope of the "Applied Teaching Framework Regulation in Higher Education" prepared by The Council of Higher Education (YÖK) in 2021. A case study implemented at Sakarya University since 2014 is presented in this context. For this reason, the article is a study based on the research of applied engineering education and the case study method. This education model, which will meet the needs of young people who receive engineering education and the enterprises that will employ them, will make an essential contribution to the literature in terms of becoming widespread in Turkey.

The remainder of the article is planned as follows. In the second Section, Cooperative Education is explained as a method. Section 3 discusses Engineering Education Paradigms. In Section 4, the Applied-Cooperative Education Model in Turkey is described. The discussion is presented in Section 5. The final section offers conclusions and future work.

2. COOPERATIVE EDUCATION

When we look at the form of traditional engineering education today, students sit on their desks or chairs, listen to the lectures of the lecturer, and when they ask if they have any questions, it is expected that the one who catches the eye from the front rows will answer, and this continues until the end of the lecture period after that eye contact moment has passed. At the end of the course, a question about derivation or a subject that is not easily understood is asked and answered. This pattern continues when it comes to preparing solutions without being taken too seriously by the student or the delivery and evaluation of the given assignments after a few people's solutions are circulated from hand to hand. Based on the literature, engineering education's shape has begun to change in recent years (Froyd et al., 2012; Brahimi et al., 2013). For example, spreadsheets have been replaced by calculators, computers have replaced typewriters, pencils have replaced chalk, blackboards have been replaced by whiteboards or glasses, and even projectors.

Generally, when considering updating engineering programs, we discuss how to enable the programs and how to provide infrastructure and advanced technological equipment. Of course, it is necessary to research and update effective teaching methods here. Research is done on teaching methods in social units, especially in foreign language departments and/or high schools. The results are tried to be implemented in pilot classes, and the results are published. However, implementing the effective teaching method, in general, is not widely adopted, especially in engineering education. However, the teaching method is one of the most essential pillars of engineering education. Before discussing teaching methods, it will be helpful to state the learning objectives. Learning objectives are the demonstration of what knowledge and skills the students have acquired from the lessons taught, and it is possible to summarize them briefly as follows (Anderson and Krathwohl, 2001):

- Informing-learning the given by repetition,
- Understanding and explaining what you have learned,
- Application - applying what is learned to problems,
- Analysing - using what is learned in solving complex problems,
- Synthesis-Different designs can be made,

Measurement and Evaluation - evaluating the results by choosing the optimum from different approaches. The current education system, mainly shaped around technical courses in engineering education at universities, points out that efficiency depends on knowledge. Engineering programs in Turkey and all over the world are almost the same. It is well-known that engineering graduates are inadequate in terms of practice when they enter business life. Education can be defined as the transfer of specific skills to the trainee in the right amount, at the right place, at the right level, with the right tool, and to increase the application of these skills to a reasonable level of performance. The necessary steps for the best execution of an education system can be listed as follows: Identification of needs; determination of the required training procedures; determining the content, structure, and duration of the training; the choice of the trainer; selection of suitable facilities and special devices; determination of appropriate time and costs; Performing needs and benefits analysis (Çil et al., 2014). In addition to theoretical knowledge, the educator should also focus on practical studies that will increase experience and self-confidence. For example, hiring an engineer with extensive practical experience as an educator may be a smart choice. Engineering education aims to develop design skills and solve design problems. Engineering should be seen as a path from analysis to synthesis that solves the needs of society.

To define engineering education: To raise individuals who are equipped with basic knowledge and skills in their field, who have gained breadth in various subjects as much as depth, who can analyse, synthesize, and design, have the ability of written and oral expression, and gain the habit of lifelong learning (Froyd et al., 2012). ABET defines engineering as “the profession in which a knowledge of mathematics and science acquired through experience and practice is put into judgment and practice to develop ways to economically use nature's materials and powers for the benefit of humanity.” Since the engineering programs in developed countries have developed to meet the industry requirements of the country, different structures have been formed in each country today. Today, a good engineer is expected to have an infrastructure that can adapt to developments and innovations, is self-confident, can think freely, has leadership qualities and communication skills, respects people, the human mind, and dignity, and can think economically, socially, and legally together. The main goal of engineering education is to train staff who have the qualifications to create solutions for the needs of society today and tomorrow. Engineering education also gains importance here. The main goal of engineering education is to train staff with the qualifications to create solutions for the needs of society today and tomorrow. The mentioned training process should also be parallel to the practice. In modern engineering education, it is accepted that it is insufficient to provide the student with a narrow technical knowledge.

Although there have been significant paradigm shifts, the impact and importance of collaborative teaching on engineering education have always existed in the last century. One hundred years have passed since the co-educational program was launched at the University of Cincinnati in the United States (Sovilla and Varty, 2004; Aman and Marsudi, 2013). About 50 years after this first application, the Co-educational program started at the University of Waterloo in Canada. These two programs expanded very quickly and became successful. They were soon used as models for the other universities that began implementing collaborative education in their engineering programs (Froyd et al., 2012; Cengiz Toklu, 2016).

In the twentieth century, industrial expansion in developed countries brought rapid growth in engineering education. The industry's need for better-prepared engineers motivated interest in these programs. Many educators were involved in the creation of these programs. Most of the early studies in the literature in the 60s, 70s, 80s, and 1990s have limited coverage. Cooperative education programs were originally established to bridge the gap between theory and practice in engineering education and meet new industrial needs developments. This stage in the development of cooperative education is still ongoing. The early 2000s began a third phase in collaborative education research. There have been calls to rethink collaborative education (Wilson et al., 1996), restructure collaborative education (Ricks, 1996), and implement a paradigm shift (Schaafsma, 1996).

After reviewing the evolution of cooperative education, this study will emphasize the collaborative engineering education approach, which gained importance with the statement published by the Higher Education Council for universities in Turkey in 2021.

The UMDE is also a type of cooperative education. With cooperative education, students reinforce their theoretical knowledge with applied education. The purpose of the UMDE is to reinforce the theoretical knowledge gained by the students about the engineering programs they are studying, to improve their skills and experiences in laboratory studies, and to enable them to recognize workplace organizations, production processes, and new technologies in the sector.

3. ENGINEERING EDUCATION PARADIGMS

Engineering Education Paradigms can be considered as developments covering the pre-1950, 1950-1990, and post-1990 periods in terms of time. Pre-1950 focuses on engineering applications, design according to codes and well-defined procedures, and limited use of mathematics; many faculties characterize them with strong ties to industrial experience and/or industry. The 1950-1990 period focused on engineering sciences, a basic understanding of phenomena, and analysis; many faculty members were trained for academic research. The post-1990 period focusing on teamwork, communication, integration, design, production, continuous improvement, and maintaining analytical power are key features of this period.

Over the past one hundred years, five paradigm shifts have occurred in engineering education, from curriculum-based practice to technology-based tools, mathematical modelling, and scientific analysis. Changes in engineering education are in five groups (Froyd et al., 2012).

1. Transition to applied and intensive engineering science and analytical emphasis.
2. Transition to results-oriented education and accreditation such as ABET.
3. Transition to an education emphasizing the idea of engineering design.

4. Transition process of education, training, and social sciences research.
5. Transition to an education that integrates information, computation, and communication technology in education.

3.1. First major shift: engineering science, analytical emphasis

The first major change in engineering education in the United States occurred during 1935-65 when "Stanford and other American engineering schools began replacing the machine shop, surveying, and drawing courses with science and math courses" (Seely, 2005). Engineering curricula have moved from an applied, practice-based curriculum to those emphasizing mathematical modelling and theory-based approaches. This shift towards more math and science led to World War II when engineers often did not perform as well as physicists at solving unusual problems. It accelerated with the experiences of World War II.

3.2. Second major change: towards results-based accreditation.

Accreditation programs such as ABET provided quality control for engineering education and sought to prepare graduates of accredited programs for professional practice" (Prados et al., 2005). Criticism was made against his important achievements. It is explained that engineering education needed to change significantly to support the new quality-oriented environment and that ABET's implementation of strict accreditation criteria was a major obstacle to the innovations needed in engineering education.

3.3. Third major change: renewed emphasis on design.

The third major change is the increased emphasis on design as an important and distinctive element of engineering (Dym et al., 2005). One reason for the change was that the emphasis on science and mathematics in engineering education had gone too far (Seely, 2005). It is a graduation design course in the engineering curriculum, or this emphasis has been brought to life with its courses. The EAC has promoted these within ABET through the engineering criteria.

3.4. The fourth major transition: practice education, learning, and social-behavioural sciences research

The effects of research in education, learning, and social-behavioural sciences have led to changes in engineering education (Lohmann and Froyd, 2010). In this context, learning outcomes are now integral to the ABET Engineering Criteria and many other accreditation models. Teaching approaches that increase student participation and are characterized as active learning, interactive learning, and especially cooperative learning are adopted. Inquiry-based learning methods, including problem-based and project-based learning, approaches to developing conceptual understanding and integrated course design approaches, cognitive psychology, and research based on education and learning sciences, are experiencing change.

3.5. The fifth major change: the impact of information, communication, and computational technologies (ICCT) on engineering education

In this context, technologies have provided paradigm shifts (Cheville, 2012). Some major technologies and their applications are content distribution (television and internet), Programmed instruction, computational technologies, clickers, Smart teachers, simulations, games, etc.

4. ENGINEERING EDUCATION IN TURKEY

Engineering education in Turkey started mainly in the first quarter of the 1800s. In the beginning, education developed very heavily and was limited in the number of schools opened and the number of people placed. There was an acceleration in the 1940s, and a breakthrough was achieved by opening new schools and developing existing ones from the 1960s onwards. This development got out of control in the 1970s, and then it started to settle into a certain order again with the pressure of the public. While deep-rooted faculties in our country provide very good education and train engineers of international quality, there are also faculties that try to provide engineering education with a very weak structure.

Like medicine, engineering is an important profession requiring special and practice-oriented education and can directly affect the country's economy and human life. For this reason, the members of this profession need to be well-educated and trained. Just as an ill-trained and well-trained physician can endanger a patient's health and even cause death due to lack of knowledge, skills, and experience, engineers who graduated from our universities without gaining sufficient knowledge, experience, and skills will also have to deal with the collapse of buildings, roads, bridges, the crash of planes, the accident of vehicles, etc. It can cause great harm to both the country's economy and human life.

Organizations that employ engineers choose the easy way and want the information that should be taught by them to be taught at the university. In addition, some faculty members choose the easy way by explaining only the subjects they know very well. In engineering, an applied branch, except for vocational high school students, others avoid experiments and try to pass them off. Students cannot present themselves adequately in the lesson, exam, or graduation project. Due to economic and bureaucratic reasons, purchasing materials for teaching and research is very difficult. Therefore, only theoretical studies are carried out in a computer environment instead of experimental research. Engineering graduates have general engineering concepts as they are placed to work in design, research, and development. However, when they start working, they are subjected to certain training by the workplace. Especially in parallel with the rapid changes in electronics and computers, the urgent requirements in the workplace bring some problems. The engineer, who has not received the necessary training for a newly developed system in the industry, may have doubts about the training he received. For this reason, it is necessary to take measures that will easily adapt to the developing technology of the day in education.

First of all, the objectives related to engineering education should be determined. Since reaching the level of modern countries is not about purchasing technology but producing it, necessary measures should be taken to reduce the negative conditions listed in the previous section. In engineering education, theoretical education should be considered sufficient, and practical education should be given due importance in preparing students for the duties they will take in the industry. Internships and the UMDE should be kept more serious and ensure that it reaches its goal (Bucciarelli and Kuhn, 2018).

5. APPLIED-COOPERATIVE EDUCATION MODEL IN TURKEY

Engineering education in our country is mainly carried out in a theoretical, face-to-face, and classroom environment for 4 years. The theoretical knowledge learned in the courses is applied in the laboratory and/or workshop environment. However, these applications are very insufficient. The real-world applications of the training are limited and can be encountered only as observations in summer internships. It takes a long time for engineers who have completed their education and started to work to adapt to the job to develop their application skills and problem-solving and solution production abilities. This result shows that engineering education cannot be carried out by its full purpose. As a Chinese proverb states, "I forget what I hear, I remember what I see, I understand what I do." applied education is more permanent and effective.

Students studying in engineering programs have a total of 8 semesters of education; they will complete seven semesters in the faculty and one semester in the industry to strengthen their application skills under the name of "Workplace education." In this context, workplace training provides a common benefit to all parties; It can be expressed as the partnership of employer, student, and educational institution. The objectives of workplace training can be summarized as follows:

- To train qualified engineers needed by the industry,
- To prepare the student for real business life and to raise awareness in the working environment,

- Contributing to the student's theoretical knowledge in his field,
- To contribute to the development of the skills necessary for employability,
- To gain the ability to use and transfer theoretical knowledge into practice.

In this section, the UMDE program, which was developed by Sakarya University Engineering Faculty and first implemented in the Industrial Engineering Department, is explained. The applied (joint) education model is not new and has been implemented in many universities worldwide for years. The first application in Turkey started in 2005 at TOBB University of Economics and Technology. The applied education model may differ in practice from country to country, according to the dynamics of the countries or according to the internal policies of the universities, under the same main purpose.

The UMDE, a new model for training more qualified engineers by Sakarya University Industrial Engineering Department, has been implemented since the fall semester of the 2013-2014 academic year. With the UMDE program, students work in enterprises as a Candidate Engineer for one semester. The UMDE program is carried out during the education and training periods. The UMDE program starts and ends during the education and training periods determined in the university's academic calendar. The UMDE is an elective course in the last semester, and students who will choose the course:

- To have taken and succeeded in all the courses that were required to be taken from the lower semesters of the semester in which they will participate in the UMDE program (except Internship1, Internship2, and university common courses)
- The weighted grade point average determined by the department at the end of the sixth or seventh semester in the lesson plan must be (2.50) and above.

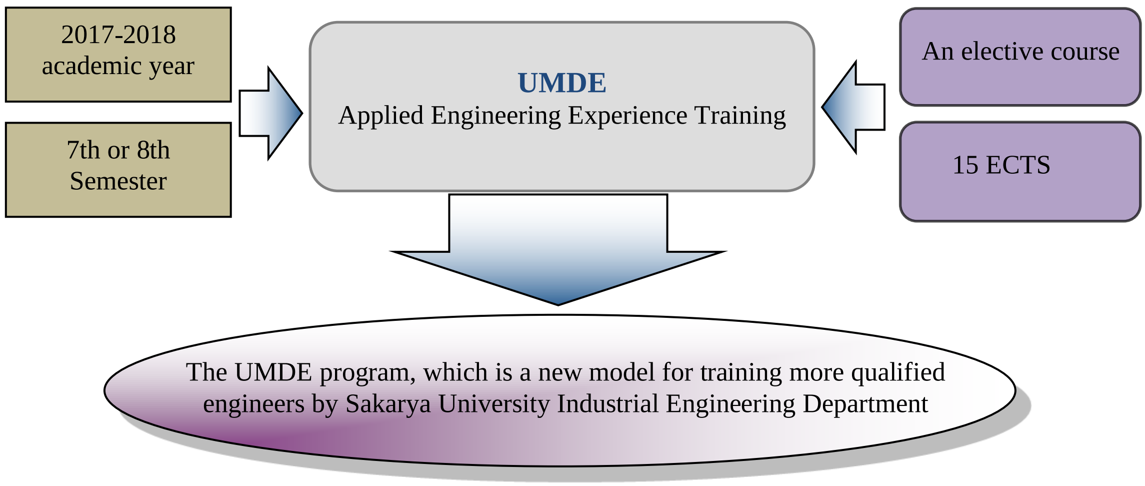

Figure 1. Basic properties of UMDE program Sakarya University Industrial Engineering Department

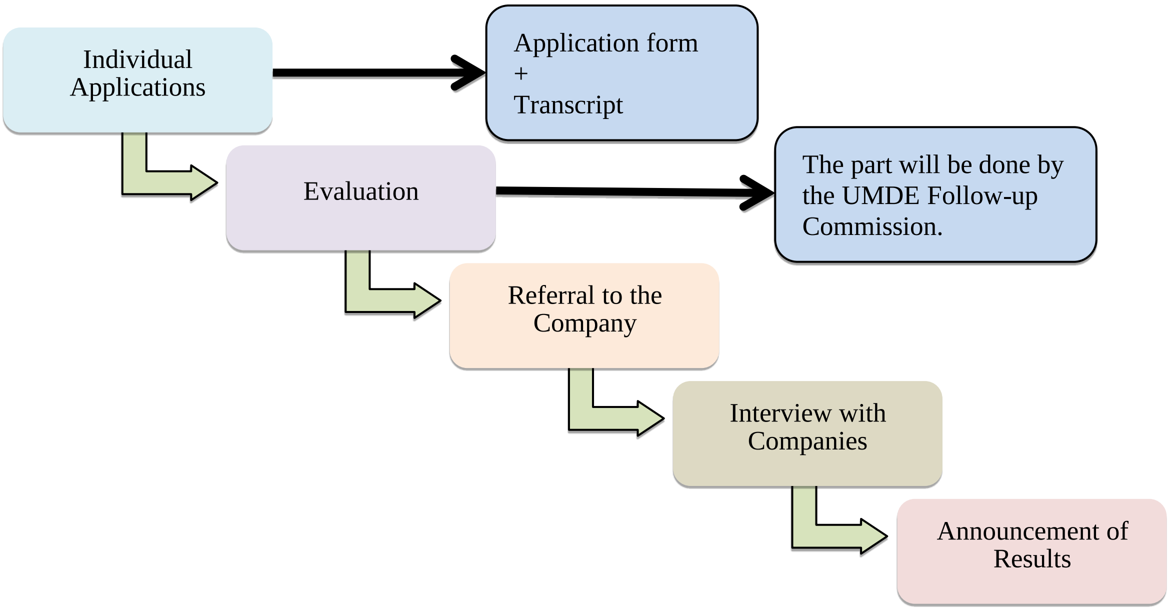

Figure 2. Placement of students in businesses

Table 1. Courses to Take in the 7 and 8th Semesters in the UMDE Program

Courses To Take in the 7th and 8th Semesters			
Status 1		**2. Case (UMDE)**	
Technical Elective Course	5 ECTS		
Technical Elective Course	5 ECTS	UMDE Course	15 ECTS
Technical Elective Course	5 ECTS		
Final Work	10 ECTS	Final Work	10 ECTS
University Co-op Elective Course	5 ECTS	University Co-op Elective Course	5 ECTS
Total	30 ECTS	Total	30 ECTS

Businesses have been included in the UMDE program since the fall of 2013-2014. New businesses continue to be included in each period. Some enterprises participating in the UMDE program are listed in Table 2.

Gaziantep University, Manisa Celal Bayar University, and Toros University continue this study under the name of the "Intern Engineering" program. Namık Kemal University started implementing the Department of Food Engineering intern-engineering program in the 2017-2018 academic year. When the literature about the applied education model is examined, some studies describe the model, and its benefits are mentioned. Blair et al. (2004) examined the students who received the engineering education model. While Weisz and Smith (2005) talk about the benefits of applied education, the same time, this model for academics, they also discuss the difficulties of controlling all workplaces, such as the workload, insufficient funding, and not being reflected in the academic promotion processes. Haddara and Skanes (2007) examined the development of applied education in North America over the past 100 years. The benefits of co-education to students, employers, and institutions compared to traditional education are explained (Dehing et al., 2013; Wolff, 2018). The model has multifaceted benefits for the student, the industry, the teaching staff, and society. It is planned that the applied education model will be required to be implemented in many universities and faculties in Turkey with the encouragement and policies of the Higher Education Institutions (Yavuz, 2019).

Table 2. Businesses participating in the UMDE program

Business Name		
AGDAŞ	FORD OTOSAN	PIRELLI
AKGIDA	GAZİ METAL	SAKARYA BÜYÜKŞEHİR BEL.
AKPA ALÜMİNYUM	GİSAN	SAKARYA TEKNOKENT A.Ş.
AKPRES	GOODYEAR	SAMİB
ALİMEX SUNPARADİSE	GÜNEŞOĞLU	SATSO
ALKAN GRUP	HENDEK BELEDİYESİ	SEYİT USTA TREYLER
ALNAL	HYUNDAI	SIEMENS
AMCOR	ISILSAN	STANDART PROFİL
ANADOLU ISUZU	İETT GENEL MÜDÜRLÜĞÜ	ŞEN PİLİÇ
ASAŞ	İSMAK GRUP	TALU TEKSTİL
ATERMİT	İSU	TAVSAN
AYDIN ENDÜSTRİ	İZ REKLAM	TEM KABLO
AYDIN ÖRME	KAİM KARDEŞLER	TIRSAN
BAŞAK TRAKTÖR	KARMETAL	TOYOTA
BOSHOKU	KORDSA	TOYOTA TSUSHO
BRİSA	KROMEL	TOYOTETSU
CANCAN MEYVE PRESLERİ	MAGNA	TÜRK HAVA YOLLARI
CARREFOUR	NEUTEC	TÜRK PİRELLİ LASTİKLERİ A.Ş.
COCA COLA DAMLA SU	OPTİMAK	TÜRK TRAKTÖR
DAIKIN	OTOKAR	YAZAKİ
ENKA	ÖZBİR	YILGENCİ
FEDERAL ELEKTRİK	PEPSICO	YILKA
FGİ	PERİ KALIP	…... and more

6. DISCUSSION

The applied education model is not new and has been applied in many universities worldwide for years. The applied education model was implemented at the University of Cincinnati in 1906 and at the University of Waterloo in Canada in 1957 (Anderson and Krathwohl, 2001). The first application in Turkey started in 2005 at TOBB University of Economics and Technology. The applied education model may differ in practice from country to country, according to the dynamics of the countries or according to the internal policies of the universities, under the same main purpose. When the literature about the applied education model is examined, some studies describe the model, and its benefits are mentioned. Blair et al. (2004) examined the students who received engineering education at the University of Mississippi, participated and did not participate in the applied education program in terms of GPA, graduation time, and starting salary per job criteria, and revealed the effects of the model. At the same time, Weisz and Smith (2005) talk about the benefits of applied education and, at the same time, this model for academics. They also discussed the difficulties of controlling all workplaces, such as the workload, insufficient funding, and not being reflected in the academic promotion processes. Haddara and Skanes (2007) examined the development of applied education in North America over the past 100 years. The benefits of co-education to students, employers, and institutions compared to traditional education are explained. The model has multifaceted benefits to the student, the industry, the instructors, and the society. Aktaş and Erden Özsoy (2015), in their study, focused on the relationship between vocational education and employment and talked about increasing the quality of the vocational education system and the graduates' having the skills and competencies needed in the labor market, and listed the solutions that can be brought to the problems related to vocational education. It is planned that the applied education model will be required to be implemented in many universities and faculties in Turkey with the encouragement and policies of the Higher Education Institutions.

The UMDE has three pillars: Students, Lecturers, and Industrialists (Figure 3). Since the cooperative education model includes three partners as students, lecturers, and institutions, they make versatile contributions to each separately. The aims and benefits of the UMDE are summarized in Table 3.

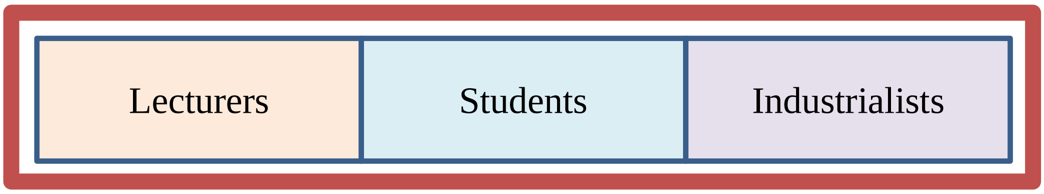

Figure 3 Applied Engineering Education has three pillars.

Table 3. Aims and benefits of the UMDE

Objectives of Applied Engineering Education	**Benefits of Applied Engineering Education**
Preparing the student for real business life	The student is insured and receives a fee determined by law.
To train engineers with the quality required by the industry	The students see the strengths and weaknesses of the industry.
Bringing academicians and industrialists closer	The student finds a job more easily.
To be aware of the innovations in applications and to see the deficiencies in the industry.	The industrialist chooses the more suitable engineer.
Putting theoretical knowledge into practice	The industrialists benefit from the opportunities of the university by meeting with academic staff.
	Industrialists and faculty members can make joint projects.

Applied education is one of the university-industry cooperation activities. In the applied education model, students gain work experience before graduating, and they also become an intermediary in finding solutions to the problems of the industries on an academic basis by ensuring the cooperation of the university and the industry. In this way, university-industry cooperation can continue issues such as changing the department's course curriculum with current issues, industrial projects, consultancy, and implementation of undergraduate and graduate theses. In engineering education, in addition to theoretical education, practical education should be given due importance to prepare students for the duties and responsibilities they will undertake after graduation. Short-term internships are not sufficient at this point. The fact that the student spends at least one semester full-time working in the relevant field greatly benefits both the student and the industry in identifying potential human resources. The importance and necessity of the applied education model, especially in engineering education, has gained importance both in universities and countries' education policies. In Turkey, the importance of this issue is emphasized with state policies, and incentives are provided.

The support of all stakeholders is important for the sustainability of this system. These supports are briefly discussed below:

Supports Public Institutions, Organizations, and Private Enterprises to Participate in the System: One of the most important pillars of the system is the enterprise where engineering education will take place. In particular, the business manager and the education officer are primarily responsible for the supervision and training of the student. For this reason, the system must be adopted voluntarily rather than out of necessity. The education authority of the enterprise should be in constant cooperation with the consultant teaching staff. They should convey the deficiencies and suggestions they see in the system directly to the advisor instructor. Only in this way can the system be improved and become optimal.

Support of Faculty Members and Students: The system should be owned by all department faculty members. Otherwise, it is not possible to continuously improve the system. All faculty members in the department should monitor the system and convey the deficiencies, mistakes, and suggestions they see to the relevant people. For this reason, periodic meetings should be held in the departments, and opinions should be exchanged until the system is established. The meetings held in the departments should be continued based on faculty as well. The advisor instructors must supervise the students in the enterprises themselves. Therefore, this control should be maintained at regular intervals. In addition, online inspection is also possible in the system. With a Skype-like video communication program, it is necessary to organize online meetings in which the consultant lecturer, the business education officer, and the student will attend. The student's performance, which is one of the basic pillars of the system, by the instruction, is, of course, important. But the main thing here is the support the student will give the system with his own will and effort. The student should provide constructive feedback to the advisor instructor. The student should understand the importance of engineering education and act to ensure maximum achievements until the end of this education.

Support to be Provided by Professional Chambers: Support is especially important in finding and incorporating engineering education enterprises into the system. It is particularly important to discuss the system in the meetings organized by professional chambers, to announce it on web pages and media organs, and to encourage the businesses they own to enter the system.

Support of the CoHE and Relevant Ministries: This issue was brought to the agenda by the CoHE and the Ministry of Science, Industry, and Technology in 2017. In this sense, it has been reported that the Department of Science, Industry, and Technology Education, established within the ministry, will assist the CoHE. At the beginning of the project, universities were released, and willing universities were supported to implement them.

Financial Support: Although the CoHE has cited the Unemployment Insurance Fund as a source for the system's financial support, the financial support issue has not been clarified yet. For this reason, employers, one of the most important stakeholders of the project, do not look at the issue very warmly. In this regard, with Law No. 6111, the private sector employers can cover the entire insurance premium employer's share calculated over their earnings based on the insurance premium from the Unemployment Insurance Fund for the insured persons hired until 31/12/2020.

Infrastructure, Administrative, Scientific, and Technical Supports of Universities: The administrative support of the university, which is one of the main stakeholders of the system, is particularly important.
Although workplace training may seem like an extra burden to businesses from the outside, it will certainly bring some benefits regarding its results. These: Students participating in on-the-job training may be considered potential candidates for technical staff for the workplace regarding their capacity, reliability, and abilities as if they are in the trial period without a risk-free hiring guarantee. At the end of the trial period, the workplace will be able to meet the need for engineers with the appropriate knowledge and skills for their field of work. The potential future human resources will be introduced to the employer. A practicing engineer will contribute to the workplace and the country's industry by training engineers who can operate at the beginning of production in enterprises. Since the student will be responsible for ensuring during the workplace training at the university, this obligation will not be on the enterprise. The obligation to employ interns, which is expected to become compulsory in enterprises, will be fulfilled with the support of workplace training.

The UMDE program applied in Sakarya University Industrial Engineering Department has an evaluation system not shared with others except the stakeholders. More than 10 ready-made forms and questionnaires were answered based on companies, institutions, and students, and mutual evaluations were made. Some of these forms are available at the link below: https://ie.sakarya.edu.tr/tr/icerik/20086/103083/degerlenen-sistemi#. The main purpose of these evaluations is to ensure the continuous improvement of the system. The evaluations are for internal evaluation and must be kept confidential within the system. In addition, when the system is generally evaluated, it is a significant success. Most students start their professional lives in these companies by receiving job offers from the companies they work with at the UMDE. Academics and companies carry out many joint studies and projects. Companies are located within an area of 60 km around Sakarya University. Sakarya region is very lucky in terms of the density of industrial establishments.

7. CONCLUSION

Applied-Cooperative Engineering Education is not new in the world as an education model. Historically, different models have always been applied, but it is a new model for Turkey. The applied education model was implemented at the University of Cincinnati in 1906 and at the University of Waterloo in Canada in 1957. This study reviews the evolution of cooperative education as an experiential learning methodology. The development of the collaborative educational learning experience has gone through different stages. Regarding the future of cooperative education, cooperative education needs to be restructured as an academic discipline. Practical applications related to engineering education in Turkey are carried out through summer internships. Applied Engineering Education, Workplace Education, or Intern Engineering differs from summer internships. Students at Sakarya University studying in Industrial Engineering departments complete 7 semesters of 8 semesters in our faculty and one semester in their workplaces (industry) as a compulsory practice. There is no doubt that collaborative training programs provide employers with great opportunities to recruit an enthusiastic, young, and vibrant workforce at less cost. Additionally, most large companies use cooperative employment as a recruiting tool: one study period offers an opportunity for a four-month job interview. Applied education is spreading rapidly in universities at undergraduate levels, and positive results are obtained. It has different applications, such as Cooperative Education in engineering fields in developed countries. To prepare the students for the industry and to train the personnel needed by the sector together with the sector, an application that will be a model for Turkey is carried out; since workplace training is an important part of the training process, how to measure the achievements in the workplace should also be discussed in the evaluation process. Future studies can be done on reporting successful or unsuccessful points related to the UMDE.

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Statement of Publication Ethics

There is no unethical problem and publication ethics.

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Conceptualization, I.C., and A: Y.C.; methodology, I.C.; investigation, I.C., and A: Y.C.; writing and draft preparation, A: Y.C.; visualization, A: Y.C. All authors have read and agreed to the manuscript.

Conflict of Interest

No conflict of interest.

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