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What Are Foresters Taught? An Analysis of Undergraduate Level Forestry Curricula in Türkiye

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Abstract: As the forestry profession evolved from extractive management to sustainable forest management, forestry education and curricula had to reflect these changes. While forestry education and curriculum have been extensively analyzed for different countries, no such analysis exists for Turkish forestry. This study analyzes the curriculum and course contents of all undergraduate-level forest engineering programs across Türkiye. The study employed content analysis to explore disparities among the schools. The courses are classified into disciplinary fields depending on their contents. Verbs used in learning outcomes were analyzed using Bloom's taxonomy. Mandatory and elective requirements of forestry programs are quite similar, indicating little disparity among schools in different regions. Course categorization reveals that forestry education emphasizes biophysical and technical sciences. Learning outcomes focused heavily on the low-level thinking dimensions of Bloom. We conclude that the Turkish forestry curriculum needs a reformative change to equip students with skill sets to practice sustainable forest management.

Keywords: forestry education; curriculum; courses; Bloom's taxonomy

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1. Introduction

Changing societal values eventually reflect on the management of forest resources. At first, forest management primarily focused on meeting the needs of society for timber sustainably. Later, the diversified and increased demand of society as a result of population growth and urbanization imposed multifunctional management of forests. With the prominence of social, cultural and ecological functions, a sustainable forest management approach has been adopted. Global environmental and climate problems have also required consideration of the transboundary benefits of forests. Management paradigm changes in Turkish forestry have followed similar steps but more slowly.

The shifting management philosophy of forestry leads to the changes in the qualifications demanded from technical staff practicing in forestry. More diverse skill sets and abilities have been demanded in the profession of forestry. Consequently, undergraduate degree programs in forestry had to review and make changes to both their curricula and program names. Many forest colleges evolved into the broader academic units of Natural Resources [1]. Forestry programs in these schools include natural resources management, natural resource conservation, forest resources, bio-products and bioenergy, forest wildlife management, forest hydrology, urban forestry, forest recreation and park management, fishery and environmental governance.

All universities in Türkiye are in a transformation called the Bologna Process due to the country's candidacy for the EU. The Bologna Process, a higher education framework in the European region, provides the opportunity to work and study in Europe for citizens of the countries within the higher education area, to the end that Europe will become a preferable place in terms of education and job opportunities. Turkish universities have been redesigning their programs and curricula to facilitate the recognition of their graduates [2].

The Council of Higher Education (CoHE) is the supervising body responsible for planning, assessing, coordinating and governing the higher education and activities of related institutions. CoHE has a vast amount of directive power over both state and private (established by non-profit foundations) universities ranging from setting minimum course hours to graduate to opening or closing new departments or faculties. The Higher Education Quality Board assesses higher education institutions and authorizes and recognizes national and international accrediting bodies of programs. There is no special accreditation body for forestry programs in Türkiye. Association for Evaluation and Accreditation of Engineering Programs (MÜDEK) has accredited two of the forestry programs in Türkiye, İstanbul University-Cerrahpaşa and Karadeniz Technical University.

In Turkiye, 12 state universities offer forestry education at the undergraduate level. All of these universities have a faculty of forestry, and the name of the departments where human resources are trained to work in the management of forest resources is "forest engineering". All of these are four-year programs in state universities. Even if the name of the department is engineering, students study the ecological, social and economic issues surrounding forest resource management. Graduates of the program earn the title of forest engineer and have a wide range of professional competencies ranging from establishing new forests to the rehabilitation of existing forests, from wood production to wildlife, watershed and pasture management to protection and development of forest resources. There are also 2-year forestry and forest products programs in vocational schools of 34 state universities across Türkiye.

There are numerous studies on the assessment of forestry education and curricula. Forestry programs curricula in Colombia were assessed for their inclusion of social sciences [3]. Undergraduate curricula of Society of American Foresters (SAF) accredited forest programs in the USA were examined for their deficiencies of social sciences [4]. Regional and disciplinary differences among the courses offered by SAF accredited forestry and forest management programs in the USA were analyzed [5]. Various studies [6–8] focused on the individual forestry program curriculum or learning outcomes. Some studies [9,10] surveyed graduate attributes of forestry programs.

While education and curriculum have been widely analyzed in other programs, no such analysis exists in forestry in Türkiye. Most of the studies focusing on forestry education in Türkiye [11–14] surveyed the perspectives and understanding of various stakeholders such as students, academicians, and foresters employed by state forest agencies. Few studies dealt with the curriculum or education program of undergraduate forestry programs. Most curriculum studies [15–19] examined individual programs.

None of the earlier studies examined the curriculum of all forest engineering programs in Türkiye. The main objective of the current study is to make a comparative analysis of the curricula of forestry engineering programs across Türkiye. The paper mainly explores the readiness of forestry programs for producing foresters to practice sustainable forest management. Research questions the paper focuses on include (i) Which courses form the backbone of forestry education in Türkiye? (ii) What are the similarities or disparities among forestry programs? (iii) How are the different disciplinary fields are represented in the curricula? (iii) What are the skills or competencies students expected to acquire upon graduation? (iv) How are skills distributed into the Bloom's cognitive levels?

2. Materials and Methods

This study is a social research attempt in the field of forestry education. It adopted a qualitative content analysis, a research methodology commonly used in sociology, psychology, education etc. The study analyzes "the text", which for our purposes refers to written materials of forestry curricula (education programs and course syllabi). We used the formal texts written by the forestry programs to make inferences about the forestry education in Türkiye. We examined the textual data as a medium of expression that reflects the formal forestry education practices. The manuscript included process of categorizing qualitative

textual data into clusters of similar categories. Following this analytic method, we were able to reduce our textual data and derive meaning about the forestry curriculum.

We conducted a content analysis of curricula and syllabi of undergraduate-level forest engineering programs in Türkiye. Content analysis is a research method, widely used in psychological and social sciences, that aims to make replicable and valid inferences from texts to the contexts of their use [20]. We employed software (MAXQDA) to make comparative curriculum and syllabus analyses.

The material of the study was composed of the curriculum and all of the course syllabi offered at the undergraduate level in 12 universities teaching forest engineering in Türkiye (Artvin Çoruh University, Bartın University, Bursa Technical University, Çankırı Karatekin University, Düzce University, İstanbul University-Cerrahpaşa, Isparta University of Applied Sciences, İzmir Katip Çelebi University, Kahramanmaraş Sütçü İmam University, Karabük University, Karadeniz Technical University (Trabzon) and Kastamonu University). Figure 1 shows the geographic location of forest engineering programs. The majority of the programs are located in the Black Sea Region at the northern part of the country. We will refer to these universities/programs with their provincial names throughout the text. Most of these data were readily available on the web pages of the universities. We compiled and categorized the syllabi, learning outcomes and other data about mandatory and elective undergraduate courses.

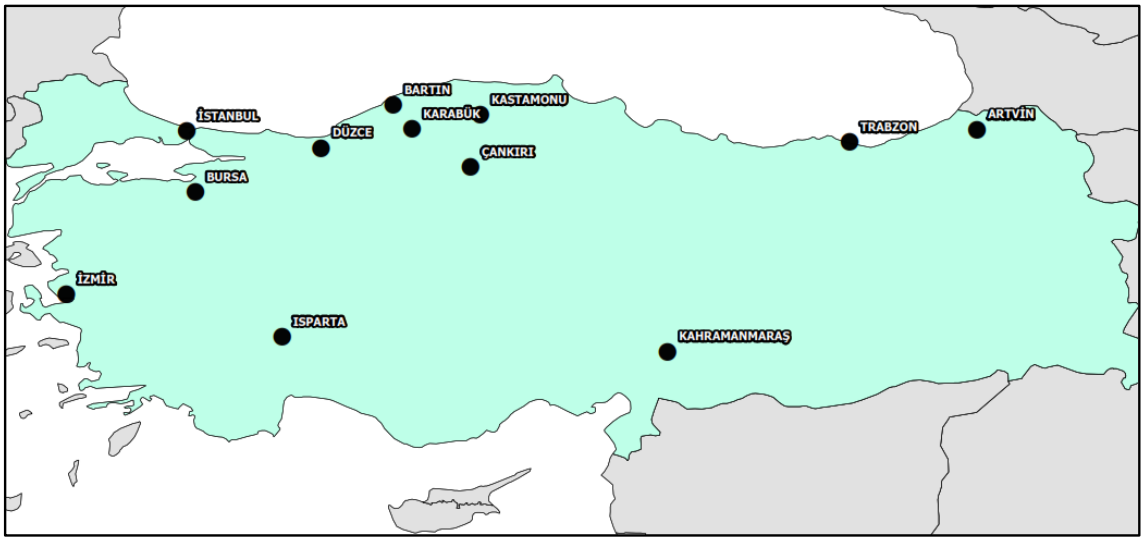

Figure 1. Locations of forest engineering programs.

First, the study data were examined to detect the similarities across the curriculum of forestry programs by analyzing the course titles and topics covered in each course. We assumed that the courses are equivalent to each other if 75% or more of the topics covered converge. We examined the course titles and delved into topics in the course syllabus to determine the similarities. Some courses have different names, though they cover nearly the same topics. For example, most of the programs have a course Forest Transportation Technique while one program has Timber Harvesting. Courses with different titles but with largely the same content are reported under the most common course title in the Section 3. Some programs offer two different courses while others combine them into one course. These courses are depicted with the most common course title.

All students pursuing an undergraduate degree in Türkiye must complete a common core curriculum list defined by CoHE. This list includes The Principles of Atatürk and History of Turkish Revolutions, Turkish Language and Literature and Foreign Language. All programs must offer these courses at least in two semesters as per Law No. 2547.

Second, we conducted an overall similarity analysis across 12 programs' curricula. The analysis was based on the courses included in the curricula. We collected the data of each program into document groups in MAXQDA to create a similarity matrix. Mandatory and elective courses were analyzed separately. We manually coded each course regarding the title and topics covered. Similarity matrix, then for mandatory and elective courses were created based on their codes. The similarity values in the matrix refer to the rate of overlapping codes/courses between two programs' curricula.

Third, we analyzed the breakdown of the curricula of forestry programs by subject matter or discipline. The categorization of courses into the disciplinary fields involved the judgment of whether a course falls into forestry or other disciplines. The other disciplines included science, computation and social science and humanities. The courses in the forestry discipline were further categorized into (i) biology and ecology, (ii) forest policy and economics, (iii) forest measurement, (iv) planning, harvesting and engineering and (v) protection and conservation. The assignment of courses into the categories required a thorough examination of course topics since some courses cover topics of two or more forestry disciplines. Each course is assigned to one forestry discipline category that most of their topics fall into. Courses outside the defined categories are presented in the miscellaneous section. We analyzed the mandatory and elective courses separately.

Fourth, we explored the learning outcomes section of the syllabi based on Bloom's taxonomy of cognitive functions. There are six categories of the cognitive process dimension: remember, understand, apply, analyze, evaluate and create. The revised version of taxonomy defines these dimensions in verb form [21]. Learning outcomes as a statement of educational objectives contains a verb and a noun. The verbs used in the learning outcome often characterize the intended cognitive process. We reviewed the learning outcome statements and identified the poorly structured ones [22]. Learning outcomes without verbs, or with unclear, unmeasurable or ambiguous verbs were omitted. We coded the verbs with the six major categories of cognitive dimensions. The courses missing the syllabus or learning outcomes were excluded from the analysis.

Bloom's taxonomy provides a useful framework for analyzing the types and distribution of cognitive goals in the curriculum. Thus, it is possible to determine the strengths and weaknesses of the curriculum and to identify areas that are open to improvement. In Bloom's taxonomy, cognitive steps are depicted as a pyramid from the lowest level of the remember to the highest level of the create. From a lesson-oriented perspective, lower-order thinking skills (remember and understand) or higher-order thinking skills may be weighted in a lesson. For the whole program, however, a more balanced distribution among different cognitive dimensions is expected.

3. Results

The findings of the study are presented in four different themes: the common core courses of programs, curriculum similarity analysis, breakdown of courses into disciplinary categories and analysis of learning outcomes using Bloom's cognitive dimensions.

3.1. The Common Core Courses of Forestry Programs

Mandatory and elective courses in the forest engineering department curricula were analyzed separately. Table 1 shows on the left side the courses mandatory in all forestry programs. There are no elective courses taught in all 12 departments. Public Relations in Forestry, Non-timber Forest Products, Plant Biodiversity and Urban Forestry are the most commonly offered electives.

Table 1. The common core course list across programs.

Mandatory Courses	Elective Courses *
Afforestation	Public relations in forestry (11)
Angiospermae	Non-timber forest products (10)
Forest ecology	Plant biodiversity (10)
Forest entomology	Urban forestry (10)
Forest growth and yield	Climatology (9)
Forest law	Plant sociology (9)
Forest management planning	Operations research (9)
Forest mensuration	Professional English (8)
Forest policy	Entrepreneurship (8)
Forest protection	Social forestry (8)
Forest resource economics	Plant nutrition (8)
Forest roads	Ecology of arid and semi-arid regions (7)
Forest transportation	Protected areas (7)
Gymnospermae	Accounting in forestry (7)
Introduction to botany	Agricultural forestry (7)
Mathematics	Environmental protection (7)
Nursery technique	Management of forest pests (6)
Principles of silviculture	Management/conservation of water resources (6)
Principles of surveying and mapping	Plant genetics (6)
Remote sensing in forestry	Seed technology (5)
Silviculture technique	Forest vegetation of Türkiye (5)
Soil science	Ornamental plants (5)
Statistics	Tree physiology (5)
Watershed management	

* The number in brackets depicts the number of programs offering electives.

The share of the mandatory courses available in all programs in the total hours of mandatory courses in schools varies between 47% and 74%. These mandatory courses seem to construct the backbone of forest engineering education in the country. Most of these courses have maintained their place in the curriculum for many years with little or no changes. Eleven of the programs offer mandatory Geographical Information System (GIS), Chemistry and Zoology courses. Economics and Wildlife courses are mandatory in ten of the schools.

The analysis of the forestry curriculum revealed that most of the courses are covering conventional forestry issues and they hardly offer a mandatory course on the current forestry issues of climate change, bioenergy or biodiversity. The forestry program in Bursa offers a mandatory course titled Sustainable Green Energy. Some of the widely offered electives are mandatory in other schools' curricula. For instance, Public Relations in Forestry is mandatory in one school, which makes it available in every forestry program.

3.2. Curriculum Similarity Analysis

The rate of similarities of curricula among forest engineering programs in terms of mandatory courses is given in Table 2. The comparison matrix shows the percentage of overlap of mandatory courses. The values in the table indicate that the similarity between the schools is quite high. Most programs have more than 70% similarity. The greatest rate of similarity of 89% for mandatory courses is between Kahramanmaraş and Düzce programs.

Table 2. Curriculum similarity matrix for mandatory courses *.

	Artvin	Bartın	Bursa	Çankırı	Düzce	Isparta	İstanbul	İzmir	Kahramanmaraş	Karabük	Kastamonu	Trabzon
Artvin	1.00	0.75	0.78	0.78	0.84	0.83	0.78	0.88	0.84	0.69	0.77	0.74
Bartın	0.75	1.00	0.73	0.72	0.77	0.74	0.76	0.78	0.80	0.63	0.73	0.74
Bursa	0.78	0.73	1.00	0.80	0.80	0.82	0.74	0.84	0.86	0.66	0.78	0.75
Çankırı	0.78	0.72	0.80	1.00	0.84	0.83	0.77	0.83	0.87	0.70	0.78	0.78
Düzce	0.84	0.77	0.80	0.84	1.00	0.83	0.83	0.88	0.89	0.74	0.83	0.82
Isparta	0.83	0.74	0.82	0.83	0.83	1.00	0.76	0.89	0.88	0.66	0.82	0.77
İstanbul	0.78	0.76	0.74	0.77	0.83	0.76	1.00	0.82	0.80	0.68	0.81	0.69
İzmir	0.88	0.78	0.84	0.83	0.88	0.89	0.82	1.00	0.86	0.70	0.86	0.77
Kahramanmaraş	0.84	0.80	0.86	0.87	0.89	0.88	0.80	0.86	1.00	0.72	0.83	0.81
Karabük	0.69	0.63	0.66	0.70	0.74	0.66	0.68	0.70	0.72	1.00	0.68	0.67
Kastamonu	0.77	0.73	0.78	0.78	0.83	0.82	0.81	0.86	0.83	0.68	1.00	0.83
Trabzon	0.74	0.74	0.75	0.78	0.82	0.77	0.69	0.77	0.81	0.67	0.83	1.00

* The darker the shade of the cells, the higher the similarity.

Karabük, the newest program, has the lowest similarity values. The lower similarity might be attributed to Karabük's requirement of more courses and credits/hours for graduation compared to the other programs. Among other programs, it is remarkable that the least similarity is between the two oldest forest schools in Türkiye, İstanbul and Trabzon.

The results of the curriculum similarity analysis based on elective courses among forestry schools are given in Table 3. The analysis results have shown that the similarity among programs is quite high in terms of elective courses. Similarity rates are generally over 70%. İzmir and Isparta have the highest similarity of 93% for elective courses. İzmir, one of the newest programs, is located in the same region as Isparta. The lowest similarity is between İstanbul and Düzce. İstanbul is the program that differentiates the most among the schools in the context of elective courses. Istanbul offers the greatest number of elective courses (76) and total hours (156). Istanbul has the highest number of academic staff and the most subject-based departments under the forest engineering program.

Table 3. Curriculum similarity matrix for elective courses *.

	Artvin	Bartın	Bursa	Çankırı	Düzce	Isparta	İstanbul	İzmir	Kahramanmaraş	Karabük	Kastamonu	Trabzon
Artvin	1.00	0.88	0.86	0.82	0.81	0.87	0.74	0.88	0.80	0.87	0.83	0.89
Bartın	0.88	1.00	0.85	0.83	0.81	0.87	0.75	0.89	0.81	0.87	0.83	0.86
Bursa	0.86	0.85	1.00	0.82	0.78	0.85	0.72	0.86	0.77	0.85	0.81	0.84
Çankırı	0.82	0.83	0.82	1.00	0.77	0.84	0.70	0.84	0.76	0.83	0.80	0.82
Düzce	0.81	0.81	0.78	0.77	1.00	0.82	0.68	0.82	0.73	0.81	0.76	0.80
Isparta	0.87	0.87	0.85	0.84	0.82	1.00	0.74	0.93	0.79	0.86	0.83	0.86
İstanbul	0.74	0.75	0.72	0.70	0.68	0.74	1.00	0.76	0.72	0.76	0.73	0.72
İzmir	0.88	0.89	0.86	0.84	0.82	0.93	0.76	1.00	0.81	0.88	0.84	0.86
Kahramanmaraş	0.80	0.81	0.77	0.76	0.73	0.79	0.72	0.81	1.00	0.81	0.80	0.78
Karabük	0.87	0.87	0.85	0.83	0.81	0.86	0.76	0.88	0.81	1.00	0.84	0.84
Kastamonu	0.83	0.83	0.81	0.80	0.76	0.83	0.73	0.84	0.80	0.84	1.00	0.81
Trabzon	0.89	0.86	0.84	0.82	0.80	0.86	0.72	0.86	0.78	0.84	0.81	1.00

* The darker the shade of the cells, the higher the similarity.

3.3. Classification of Courses into Disciplinary Categories

The courses in the forestry curriculum are classified into five categories: Science, computation, social sciences and humanities, forestry and others. While there are courses such as biology, chemistry, geology, physics and botany in the science category, there are courses such as mathematics, statistics, basic information technologies and operations research in computation. Social sciences and humanities involve courses such as economics, Turkish language, English, accounting, marketing and law. The other or miscellaneous category includes graduation thesis, internship, technical trip and sectoral training package.

The field-based classification of mandatory courses and their weights (percentage) within the total mandatory course hours are given in Table 4. All schools require more mandatory forestry hours than the other fields. Düzce is the program with the highest rate of forestry disciplinary hours. Most universities require the most hours in biology and ecology among the forestry categories. Total hours of biology and ecology are nearly one third of the total mandatory course hours in Düzce. Bartın is the only program with the highest share of courses in the planning, harvesting and engineering category. Biology and ecology have the same weight as the planning, harvesting and engineering in Isparta. The groups with the least share in forestry disciplinary components are forest policy and

economics and protection and conservation. Among the non-forestry disciplines, social science and humanities have the greatest share in most programs.

Table 4. Breakdown of mandatory courses into disciplinary categories.

Schools	Total Hours	Science	Computation	Social Science and Humanities	Forestry					Misc.
					Biology and Ecology	Forest Policy and Economics	Forest Measurement	Planning, Harvesting, Engineering	Protection and Conservation	
Artvin	147	11.56	8.84	13.61	17.69	5.44	9.52	8.84	7.48	17.01
Bursa	159	7.55	5.66	12.58	19.50	6.92	8.81	18.24	5.66	15.09
Bartın	175	13.14	13.71	10.29	16.00	6.86	12.57	16.57	7.43	3.43
Çankırı	160	10.63	5.63	11.88	25.63	6.25	12.50	15.00	9.38	3.13
Düzce	121	9.09	4.96	11.57	28.93	7.44	10.74	15.70	9.09	2.48
İzmir	158	9.49	10.76	11.39	17.09	8.86	10.13	11.39	4.43	16.46
İstanbul	151	12.58	11.92	14.57	16.56	7.28	11.92	15.89	7.95	1.32
Isparta	134	10.45	7.09	10.45	18.66	8.21	9.33	18.66	8.21	8.96
Karabük	188	18.09	5.32	12.77	22.87	9.57	7.45	9.57	8.51	5.85
Kahramanmaraş	138	13.04	4.35	13.04	21.74	6.52	10.14	16.67	10.14	4.35
Kastamonu	143	9.79	6.29	12.59	20.98	7.69	9.79	15.38	7.69	9.79
Trabzon	131	16.79	7.63	9.92	17.56	6.87	8.40	12.98	7.63	12.21

Subject-based classification of elective courses is given in Table 5. The miscellaneous category for electives includes the courses focusing on the utilization such as forest industry courses, recreation, ecotourism and wildlife. The Istanbul program, the oldest program with the largest personnel, has the most elective courses. Karabük offers the least elective course hours. Forestry schools differ more in the distribution of elective courses to the disciplinary categories compared to the mandatory courses. However, as is the case for mandatory courses, in most of the programs, biology and ecology-focused courses have the highest weight in forestry discipline categories. Almost half of the electives offered in Karabük's curriculum is in the biology and ecology. It is striking that the protection and conservation category, which has a low share in mandatory courses, has the most forestry elective course hours in the two programs. The lowest elective course hours in forestry disciplines are in the field of forest measurement.

Table 5. Breakdown of elective courses into disciplinary categories.

Schools	Total Hours	Science	Computation	Social Science and Humanities	Forestry					Misc.
					Biology/ Ecology	Forest Policy and Economics	Forest Measurement	Planning, Harvesting, Engineering	Protection and Conservation	
Artvin	80	2.5	0	15	42.5	5	2.5	15	15	2.5
Bursa	94	8.5	2.1	8.5	25.5	8.5	14.9	8.5	14.9	8.5
Bartın	70	2.9	2.9	20.0	20.0	11.4	2.9	17.1	14.3	8.6
Çankırı	134	7.5	0.0	2.2	20.9	14.2	10.4	14.9	21.6	8.2
Düzce	130	9.2	7.7	10.8	27.7	10.8	6.9	10.0	10.8	6.2
İzmir	60	6.7	0.0	13.3	33.3	20.0	3.3	0.0	16.7	6.7
İstanbul	156	7.1	9.6	12.8	14.1	17.9	10.3	7.7	9.0	11.5
Isparta	78	10.3	5.1	12.8	25.6	12.8	7.7	0.0	17.9	7.7
Karabük	52	7.7	0.0	11.5	46.2	7.7	0.0	3.8	15.4	7.7
Kahramanmaraş	84	0.0	4.8	11.9	26.2	7.1	14.3	9.5	19.0	7.1
Kastamonu	92	4.3	4.3	10.9	15.2	10.9	15.2	15.2	21.7	2.2
Trabzon	96	12.5	10.4	10.4	20.8	12.5	8.3	16.7	6.3	2.1

3.4. Analysis of Learning Outcomes Using Bloom's Taxonomy

The results of the content analysis for the learning outcomes in the course syllabi of the programs are given in Table 6. The verbs used in the learning outcomes are classified

according to Bloom's new taxonomy. The most common category is the remember, the bottom cognitive process category, and the least common category is the create, the top cognitive process category. A great number of learning outcomes (about 750) were so poorly structured that they were excluded from the analysis. Table 6 also shows the most frequently used verbs in each of Bloom's taxonomy.

Table 6. Verb frequencies by cognitive dimensions and top verbs.

Cognitive Process Dimensions	Frequency	The Most Widely Used Verbs
1-Remember	2679	learn, know, perceive, describe, identify
2-Understand	1979	explain, grasp, interpret, understand, summarize
3-Apply	669	apply, use, calculate, execute, formulate, practice
4-Analyze	486	analyze, solve, develop, relate, differentiate
5-Evaluate	258	evaluate, determine, discuss, monitor, control
6-Create	242	plan, prepare, project, create, design

The verbs used in the learning outcomes of forestry programs are in an unbalanced distribution into cognitive dimensions. The bottom dimensions of remember and understand have a quite dominant weight in the learning objectives of the forestry curricula. The vast majority of the verbs used in learning outcomes were in the remember dimension, while the create dimension had the lowest share.

The distribution of the verbs in the learning outcomes according to Bloom's taxonomy in different programs is given in Table 7. In 9 out of 12 programs, the remember dimension weighed the most, while the understand step was the most dominant one in the remaining three programs. Apply, analyze, evaluate and create dimensions lagged far behind remember and understand categories across all institutions. While the program with the highest share of high-level thinking skills is Düzce (34.1%), the program with the lowest is Kahramanmaraş (15.9%). Forestry programs in Türkiye are very similar to each other in the context of teaching purposes.

Table 7. Bloom's taxonomy of verbs for forestry programs.

	Artvin	Bursa	Bartın	Çankırı	Düzce	Isparta	İstanbul	İzmir	Kahramanmaraş	Karabük	Kastamonu	Trabzon
6.Create	15	26	16	23	25	27	27	20	11	8	28	16
5.Evaluate	19	26	20	17	19	29	29	15	17	20	19	28
4. Analyze	27	54	27	43	38	41	44	66	19	36	38	53
3. Apply	33	86	49	56	46	89	59	73	42	25	57	54
2.Understand	86	298	140	228	71	373	128	160	107	127	124	137
1. Remember	123	172	360	101	175	54	556	199	365	225	184	165

4. Discussion

Besides the 6 CoHE courses, there are 24 mandatory forestry courses taught in all Turkish universities. Building the backbone of forestry education, these courses have remained in curricula without much change. Although the topics covered have been updated under societal change, there are no courses newly added to the core curriculum list. Though it is an elective in one program GIS course can be regarded as the only new addition to the mandatory common core list of courses.

The high rate of convergence on the mandatory courses across forestry schools is not the case for the elective courses. No elective courses are offered by all forestry programs. As administrations of the programs tend to hold on to the safety of the status quo [23], the undergraduate forestry curriculum remains unchanged over the decades [10]. Gilbert et al. [24] reported such resistance against the major revision of the forestry curriculum in the USA. Burns [25] argues the conservative character of the forestry profession and refers to the analogy of "moving the cemetery" for describing the slow nature of curriculum

change. Turkish forestry schools have made minor revisions in their curricula mostly by offering more electives covering the recent issues of forestry.

In contrast to the mandatory courses remaining almost unchanged, electives have been revised more frequently. Undergraduate forestry curricula in Türkiye offer elective courses on the current issues including climate change, bioenergy, certification, ecotourism, desertification and wildfire. The higher disparity in the distribution of the elective courses to the disciplinary fields might be explained by the disproportionate academic staff allocation among divisions of the forestry programs. If a division has a lesser staff, there would be fewer courses offered in that field. Kastamonu program has 33 academic staff; 7 of them are in the forest entomology and protection division [26]. Consequently, the program offers most elective course hours in protection and conservation category. A limitation should be noted for the elective courses. While every graduate has to complete all mandatory courses for graduation, they select from offered electives. Therefore, similarities among the programs for electives assumes all elective courses are demanded by students and offered by schools.

There are great similarities among forest engineering programs. This indicates that forestry education and curriculum structure in Türkiye are formed similarly. The absence of a system to compete among forestry schools, all of them in state universities, can be a reason for this much similarity. O'Laughlin [5] reported a similar result of a high-level consistency among the American forestry programs. Only two Turkish universities have forestry programs until 1992, namely İstanbul and Trabzon. Most of the academic staff of succeeding schools had completed their undergraduate and graduate-level education in these two schools. Therefore, succeeding schools might have inherited their curricula from mostly either one of the two oldest schools.

The majority of the demand for graduates comes from the state forestry organization. For this reason, curricula are shaped with the assumption that most graduates will take part in the management of state-owned forests. Since it is not clear in which eco-geographical regions that are quite different from each other graduates would be employed, it is not possible to differentiate the curriculum regarding the geographical region of the university, the forest structure and the problems of the region. Hence, graduates are demanded to have a general skill set of national-level forestry issues.

Previous studies analyzing the undergraduate forestry curriculum [3,4] concluded that social sciences are not well represented. Yet social sciences seem well represented in Turkish forestry program curricula. This is mostly because all core curriculum requirements of CoHE fall into the social science category. Turkish forestry has a high level of social interaction mainly due to the rural population of over 7 million dwell in forest villages. Thus, people skills are deemed vital for forest engineering students. Nevertheless, mandatory courses providing the skills to deal with forestry–society interaction, presented within the heading of forest policy and economics, have the lowest share in the five forestry schools.

As the engineering profession requires the application of scientific principles for practical uses, the share of the apply dimension is expected to be greater. Yolcu [27] analyzed the verbs in learning outcomes of the Material Science and Nano Engineering curriculum and found apply and remember as the most common dimensions. Swart and Daneti [28] analyzed the Electronic fundamental learning outcomes and found that two lower levels of Bloom's taxonomy had the majority (58%) in both universities in Romania and South Africa. Most of the verbs in learning outcomes are in low-order dimensions of Bloom's taxonomy in Turkish forestry programs. Apply dimension has a limited share although the forestry programs named as forest engineering. This result conforms to these programs are focused on natural resource management rather than engineering. Meda and Swart [22] found that understand, identify and know were the most common verbs in learning outcomes of the Electrical Engineering program. The most recurring verbs in Turkish forestry programs' learning outcomes are learn, explain and know. These verbs promote low-order thinking.

5. Conclusions

The forestry profession in Türkiye has evolved significantly throughout the last century. The conventional extractive nature of forestry inherited from the Ottoman Empire has continued to be the mainstream paradigm. Focusing mostly on timber management, this conventional paradigm has broadened as the awareness and demand for multiple ecological, environmental and social services of forests increased. Yet undergraduate level forestry education has been slow to reflect these paradigm changes and to incorporate current social, ecological and environmental issues.

Our study shows forestry programs in Türkiye offer quite similar curricula. The mandatory core curriculum list constructs the majority of the graduation requirements. These courses have been in the curriculum for a few decades with limited review and changes. Forestry schools often tend to avoid making radical changes in the curriculum. Offering more elective courses on the current issues is deemed sufficient for curriculum change. The forestry curriculum must adapt to meet the current broadened needs of the foresters. Further studies are needed to explore the factors hindering reforms in forestry curricula.

Turkish forestry programs offer more biophysical and technical course hours than political, economic and conservation. The prevalence of biophysical and technical requirements is often attributed to the fact that the forestry profession requires skills for manipulating the ecological and biological components of forest ecosystems. Evolving nature of the profession requires broadened approach for sustainable forest management involving human behavior, societal values and expectations. Thus, the biophysical and technical focus of curricula should be toned down to open up space for political and social sciences, communications, humanities, ethics, cultural studies, conservation and protection. Illuminating the disparities among curriculum and disciplinary components, our results provide a good basis for facilitating curriculum reform to best prepare forestry students to tackle current issues of the profession.

Our results revealed that forestry educators are not well equipped with the development and design of learning outcomes. They certainly need to refer to experts in education when designing learning outcomes of programs and courses. Bloom's taxonomy provides a valuable framework to assess and redesign the learning outcomes. Forestry programs should seek a more balanced distribution of verbs in the high- and low-order thinking skills.

As part of the Bologna Process, national qualifications framework for higher education was identified. This framework defined the qualifications what a person achieving forestry degree is supposed to know, do and be competent. Each program is required to associate their learning outcomes with national level qualifications. Law no. 5531, enacted in 2006, identified the boundaries of the professional forestry practices a forest engineering program graduate can perform. Final Statement of the forestry panel on the higher education in Turkish forestry acknowledged the need for reviewing the forestry curricula regarding the qualifications in national framework and Law no. 5531. Yet there is no special educational requirements or standard are available for undergraduate forestry programs.

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