A New Trend in Vocational Education: Mechatronics Program and the Preference Factors

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Abstract

"Mechatronics" has been a discipline of engineering frequently talked about in Turkey as well as throughout the world in recent years. Mechatronics education given at postgraduate level, bachelor's level, associate degree and high school level has attracted attention in Turkey in the last decade. Particularly due to its intense preference, it showed progress the most rapidly in Mechatronics associate degree education by reaching 43 programs in total during the last decade.

This study aims at determining choice factors of students receiving associate degree education for Mechatronics program and the effects of type of high school and departments on choice factors. The main hypothesis that type of high school and department of students have an effect on preferring Mechatronics program was tested in the study. For this purpose, the study was performed on students of Dokuz Eylül University Izmir Vocational School Mechatronics Program. In this study, first of all, survey was implemented intended for designating choice factors of students enrolled to the program. Primarily, choice factors of students were determined via factor analysis and four factors were found. These factors were constituted respectively as "Consciousness", "Background", "School Preference" and "Expectation after Graduation" in grouping conducted with respect to questions that factors comprised. When the effects of their demographic characteristics and high school types and departments on choice factors were studied, the principal outcome that high school department has an effect on choice factors was attained.

Key Words: Mechatronics, Education, Choice Factors, Vocational School, Factor Analysis

1. Introductıon

The term "Mechatronics" was first introduced by a Yaskawa Electric Engineer in 1969 (Nobuhiro, 1996). Although definitions related to mechatronics were constructed in the subsequent years (David, 1996), the most commonly known definition of Mechatronics is that it is the synergistic integration of mechanical engineering with electronics and intelligent computer control in the designed manufacturing of industrial products and processes (Harashima, 1996). Due to the definition of mechatronics, mechatronics education incorporates the disciplines of Electrical and Electronics, Mechanics and Design, Computer and Control within itself (Figure 1).

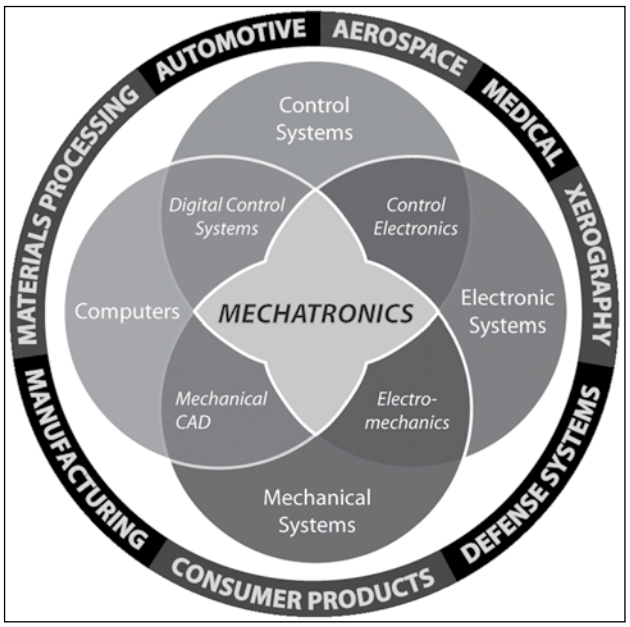


Figure 1. Mechatronics and its components

In Japan since 1983, Toyohashi University runs a regular ME course in Mechatronics Engineering and in Europe, mechatronics education commenced in the middle of 1980's (Acar, 1996). Mechatronics

engineering courses at undergraduate and graduate levels, as well as vocational training courses are rapidly increasing across the word (Acar, 1997). Today, Mechatronics Engineering education is given in many countries in the world. In the present day, studies have been carried out on philosophy of education of mechatronics engineering (Parasuraman, 2002), curriculums (Kayis, 2004 and Kaynak, 1996) and mechatronics' universal development as a branch of engineering (Grimheden, 2005) and mechatronics engineering education was virtually standardized universally. Although Mechatronics was brought to the agenda of Turkey in 1993 (Akpinar, 2006), at first the developments in this issue proceeded slowly. Mechatronics gaining prevalence in academic and industrial circles could be possible at the beginning of 2000's (Akpinar, 2004). Interest for the discipline of mechatronics has gradually increased in Turkey and throughout the world (Celik and Akkan, 2009).

2. Study objective and motivation

The objective of this study is to determine the choice factors of students for mechatronics program and examine the effects of variables such as type of high school and department, gender, consciousness, background, future expectation on designated choice factors. The main hypothesis that high school type and department of students in particular have an impact upon the preference for mechatronics program was examined in the study.

The world economy carrying on the transformation predominantly with information and technology at a great pace brings qualified human resource, which will professionally compete worldwide, to the fore (Karci, 2003). While rapidly improving technology and constantly altering market conditions demand for more affordable products with more quality, customer expectations prefer multi-functional and more responsive products. To meet these demands, Mechatronics engineering philosophy is one of the emerged solutions. The share of automotive industry, which has been rapidly growing particularly in Turkey, in foreign trade reached to 21.3 billion dollars according to the 2007 data. The share of automotive sector in total exports was 20.1% (The prime minister's office, 2008). The growth in Turkey's industrial sectors primarily in automotive increases the need for qualified manpower in mechatronics. Vocational schools (VS) are the schools that can meet the needed intermediate manpower except engineers in this field. Consequently, this study's main motives are the significance of mechatronics education for Turkey and the rest of the world and also the lack of literature related to preference for mechatronics program.

When the literature examined, it was observed that studies related to the discipline of Mechatronics, of which their significance gradually increases in vocational and technical education, were applications with empirical and engineering basis and national and international studies pertaining to education and curriculum were quite limited.

It can be asserted that studies related to Mechatronics education and curriculum in Turkey were carried out in 2000's and they were quite a few in numbers. Gurbuz searched for an answer to the question of how Mechatronics education in VSs should be in his study performed in 2004 and recommended a sample curriculum for branch education. Adaptation problems of students, who studied at the department of Mechatronics teaching in Technical Education Faculty, were studied by Tuncalp et al. in 2005. Studies analyzing the development of mechatronics education in Turkey and the definition of the discipline of mechatronics as a new branch of engineering were performed by Akdogan in 2004 and Akpinar in 2006. Goren and Baser (2008) examined how mechatronics engineering education was carried out in Turkey and the world and how ideal engineering education should be and discussed whether ideal mechatronics engineering education is given in four years.

Celik and Akkan conducted a study in 2009 exhibiting the development process of Mechatronics education in VSs in Turkey. They arrived at the outcomes that technical background was not taken into account in opening Mechatronics associate degree programs, Mechatronics programs opened up in industrially less developed regions and they negatively affected the quality of education. In another study performed by Celik and Akkan in 2010, curriculum structures and problems of mechatronics programs in vocational schools were examined. They offered solutions such as standardizing curriculums and the requirement for

Mechatronics programs to give education with an option of "electronics" to students with electrical and electronics background and with an option of "mechanics and manufacturing" to students with mechanical background.

Expectations and fears of students receiving education at the department of Mechatronics teaching in Technical Education Faculty related to the closing down of Technical Education Faculties and the establishment of Technology Faculties was studied by Yilmaz et.al in 2010. They emphasized outcomes such as the requirement for eliminating the discrepancies in title and diplomas between students and graduates of Technical Education Faculty and graduates of Technology Faculty.

When the literature examined, it was realized that there weren't any adequate studies putting forward reasons for preference. There should be many reasons why this program rapidly turned into a preferred program although not much time has passed. This study was intended to make up for the deficiency in this respect.

3. Method

A research was carried out on students studying at Dokuz Eylul University (DEU) Izmir Vocational School (IVS) Mechatronics program to determine the choice factors of students for Mechatronics program. This study was performed on students, who enrolled at DEU IVS Mechatronics program, in 2009. The study consists of two stages.

In the first stage, the data regarding preference sorting of students, who enrolled at the program in 2007, 2008 and 2009, in the database of the Student Selection and Placement Center (SSPC) and the data concerning the types of high school and departments of students in the institution database were analyzed. In the second stage of the study, a survey was conducted intended for designating the choice factors of students. This survey was implemented on 129 students out of 167 students, who enrolled at DEU IVS program, in December 2010. Questionnaire form used in the survey incorporates two parts and questions consist of 30 questions in total including demographic characteristics and choice factors. Questions in the first part comprise questions regarding students' gender, age, department and type of high school they graduated; questions in the second part comprise twenty questions, in which students' reasons for preference for Mechatronics program and DEU IVS were questioned. Questions were prepared as behavior sentences and assessed by a 5-point Licert scale.

In the part, where the obtained data were evaluated and analyses were conducted, factor analysis was performed to determine the choice factors of students after frequency distribution for answers given by students and their demographic structures were attained. Reliability analyses were applied to four choice factors arose after factor analysis and choice variables were attained with respect to factor structures. Descriptive statistics were obtained regarding four choice factors dealt with and the effects of independent variables on the designated choice factors were analyzed by performing statistical comparisons in terms of demographic structures of students, their views towards IVS Mechatronics program and opinions concerning employment and post-graduation with respect to types of high school and departments from which students graduated.

4. Present day situation of mechatronics education in Turkey

Mechatronics entered into the agenda of Turkey in 1993 has been discussed in many platforms in recent years. Middle East Technical University (METU) has been holding an 'International Conference on Mechatronics Design and Modeling' since 1993 in Turkey. Again, METU started to publish an international journal named 'International Journal of Intelligent Mechatronics: Design and Production' about Mechatronics in September 1994. Mechatronics education in Turkey commenced with Mechatronics Engineering in Sabanci University in 1994. In 2003, the department of Mechatronics teaching was established in Marmara University Technical Education Faculty. In 2010, Mechatronics Technology Engineering education commenced with the establishment of faculties of technology and cessation of student intake to Technical Education Faculties in 2009. Mechatronics associate degree programs commenced in Sakarya University VS and Kocaeli University Gebze Vocational School in 2001. First

mechatronics departments in high schools commenced education in Balgat (Ankara), Cayirova STFA (Kocaeli) and Bursa Hurriyet Anatolian Vocational High School (AVHS) in 2003.

Sabanci, Bahcesehir, Atilim, Okan and KTO Karatay Universities as private non-profit foundation universities and Kocaeli, Yildiz, Erciyes and Firat Universities as state universities give Mechatronics Engineering education as of 2010. Faculties of Technology, which commenced their education life in 2010-2011 academic year, within Firat, Karabuk, Marmara and Sakarya Universities give Mechatronics Technology Engineering education. Counterparts of technology engineering are present in United Kingdom, Japan, Germany, U.S.A., South Korea and other countries and their graduates receive the title of application engineer (Vocational Education, 2010). The Graduate Schools of Natural and Applied Sciences of Sabanci, Kocaeli, Bahcesehir, Istanbul Technical, Dokuz Eylul, Erciyes and Karabuk Universities give Mechatronics Engineering postgraduate education. The departments of Mechatronics teaching in Technical Education Faculties of Marmara and Suleyman Demirel Universities were closed down by the cabinet decision (Official Gazette, 2009). Legal personalities of Technical Education Faculties will be ceased to exist as of 2015-2016 academic year.

First Mechatronics associate degree programs commenced in Kocaeli University Gebze VS and Sakarya University Sakarya VS in 2001. As of 2010, Mechatronics associate degree education is given in 43 vocational schools. Among these schools, Sakarya University Adapazari Vocational School has been giving Mechatronics associate degree education with its internet based distance learning model since 2003.

5. Dokuz Eylul university Izmir vocational school mechatronics program

DEU IVS was established in 1982 (Izmir VS, 2010). Izmir VS Mechatronics program started education in 2007. Specific experiences, which served as a basis for the program during the period until Mechatronics program started, were attained. Education, which started as Instrumentation Program during the first years after the establishment of Izmir VS, turned into Control Systems Technology Program afterwards and the program carried education on with this name since 2002. In 2002, "Control Systems Technology" program within the context of Program Development Project in VSs was transformed into Industrial Automation program (Balci, 2003). This program, which continued education since 2007, was turned into Mechatronics program taking the sector's demands for qualified man power in this field into consideration in 2007. The program that commenced education in 2007 admits 90 students with 45 students for formal education and 45 students for evening education. At the same time, this program is the first Mechatronics associate degree program set up in the Aegean region.

6. Admission percentages in Izmir vs and respective statistical information

It was mentioned above that Mechatronics students' interest for the program increased rapidly. It can be observed that this interest reflected to preferences. When preference sorting of students admitted into Izmir VS Mechatronics program presented in Table 2 was examined, it can be seen that preferences for students concentrated in first choice.

As it is presented in Table 1, when the percentages of students, who gained admission to their first choice, were checked, it can be observed that they were 85.00% in formal education in 2007, 68.89% in 2008 and 73.33% in 2009. These percentages attract attention as quite high percentages. It can also be seen that students attending evening education putting their program in first choice were lower than students attending formal education. However, this situation stems from that students mostly used their first choice for evening education.

Table 1. Admission Percentages in First Choice

Year	Quotas	Normal Education		Evening Education	
		1. Preference	%	1. Preference	%
2009	45	33	73.33	13	28.88
2008	45	31	68.89	11	24.44
2007	40	34	85.00	6	15.00

Mechatronics associate degree programs in Turkey admit students from many departments of vocational and technical high schools. These departments predominantly consist of departments

giving electronics and mechanical based education. Distributions of students admitted into Izmir VS with respect to high school types and departments are presented in Figure 2. Distribution in terms of high school types is 40.72% for Anatolian Technical High School (ATHS), 29.34% for Technical High School (THS), 28.74% for Anatolian Vocational High School (AVHS) and 1.2% for Industrial Vocational High School (IVHS). Distribution in terms of high school departments is 36.53% for Electronics, 20.96% for Electrical, 19.16% for Automatic Control, 7.78% for Industrial Automation (Mechanics), %7.19 for Machinery, 4.79% for Industrial Automation (Electronics), 2.40% for Ship Machinery and 1.20% for Molding. The greatest percentage belongs to the department of Electronics among this distribution.

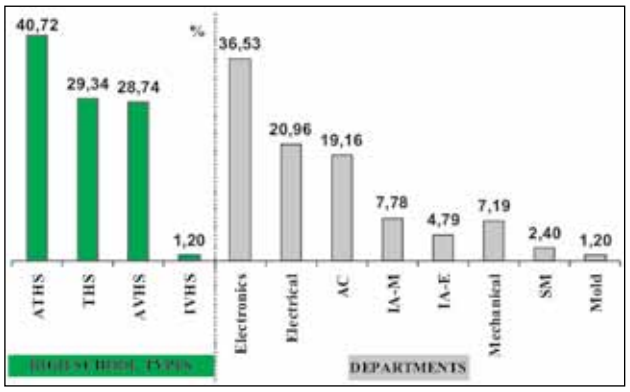


Figure 2. Admission Percentages for School Types and Departments

7. Demographic information

Demographic characteristics of people participated in the study are presented in Table 2. It was detected that 5 (3.9%) of study participants are girl students and 124 (96.1%) of participants are boy students. When they were evaluated in terms of high school types, it was observed that 45% of students came from Anatolian Technical High Schools (ATHS), 30.2% came from Technical High Schools (THS), 24% came from Anatolian Vocational High Schools (AVHS) and only 0.8% came from Industrial Vocational High Schools (IVHS). It was seen that Electronics had the highest percentage with 41.9% among high school departments of students and the departments of Automatic Control and Electrical followed with 19.4% for both departments.

8. Analysis and findings

In this section, first of all, questions asked regarding students' preferences for their departments and expectations were evaluated. Afterwards, factor analysis was applied to the scale with 17 behavior sentences aimed at determining the choice factors of students. Reliability analyses were performed on factors emerged after analysis and statistical variables were calculated for factors with adequate reliability levels and statistical analyses and evaluations were carried out concerning these variables. Subsequently, effect level of high school type and department of students on choice factors was studied by applying the t-test and variance analysis on handled choice factors.

8.1 Frequencies and Choice Factors

Answers given by students to questions about their reasons for preferring DEU IVS and Mechatronics program is seen in Figure 3. It can be seen that the first factor for school preference was DEU with 32.6% and the effect of Izmir VS remained

Table 2. Demographic Characteristics of Students (n=129)

Variable	Count	%	Variable	Count	%	Variable	Count	%
Gender			**Age**			**High School Department**		
Female	5	3.9	18	32	24.8	Electronics	54	41.9
Male	124	96.1	19	46	35.7	Automatic Control	25	19.4
High School Type			20	40	31.0	Electrical	25	19.4
IVHS	1	0.8	21	11	8.5	Machinery	9	7.0
THS	39	30.2	21>	0	0.0	Industrial Automation (Mechanics)	8	6.2
AVHS	31	24.0				Industrial Automation(Electronics)	5	3.9
ATHS	58	45.0				Molding	2	1.6
						Ship Machinery	1	0.8

at 12.4%. DEU is a significant motive for student preferences. Two factors came into prominence among reasons for preference for Mechatronics program. The first factor with 44.2% percentage was the perception that Mechatronics program has vast employment opportunities and the second one with 41.1% was that it is their favorite branch.

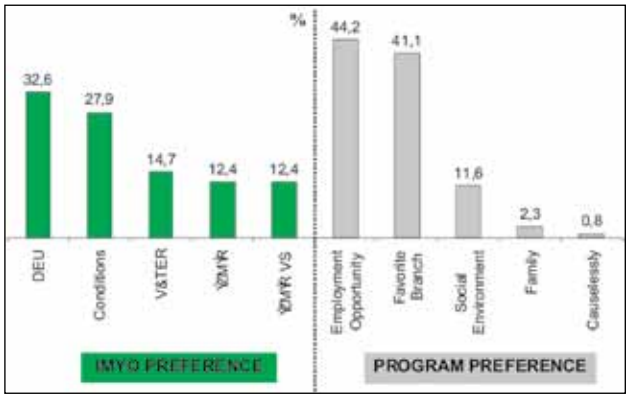


Figure 3. Reasons for Preference for School and Program

The question of "what is it that you want to do first after graduation?" was directed in order to measure expectations of students regarding post-graduation. 57.4% of the participants responded to this question as making vertical transfer to an undergraduate program, 21.7% responded as getting a job, 10.1% responded as setting up a business, 6.2% responded as re-entering the university examination and studying a different major and 4.7% responded that they haven't decide what to do post-graduation yet.

8.2 Determining the Choice Factors

First of all, common variance levels (communalities) were checked in factor analysis, it was observed that there weren't any variables having a value lower than 0.40 and factor analysis proceeded. Factors of which eigenvalues are greater than 1 were obtained as choice factors. As a result of factor analysis, a structure of 4 factors with 14 questions presented in Table 3 was attained. Eigenvalues of factors were respectively found as 3.563; 2.203; 1.361 and 1.225. The first factor explains 26% of total variability, the second factor expresses 16% of total variability, the third one explains its 10% and the fourth one explicates its 9% and all four factors explains approximately 60% of total variability in total. Factor rotation was performed to designate variables are situated under what factor and the acquired factors and questions they contain are presented in Table 3.

When the reliability levels of choice factors in Table 3 examined, reliability coefficient of Factor 1 was detected as 0.72, reliability coefficient of Factor 2 was found as 0.64, reliability coefficient of Factor 3 was found as 0.35 and reliability coefficient of Factor 4 was obtained as 0.49. It was determined that reliability levels of Factor 1 and 2 were acceptable. It is suggested for other factors that questions, which generated factors, should be reviewed by upgrading the scale for subsequent studies and if necessary, appropriate questions should be added to the experimental group. Factors were constituted respectively as "Consciousness",

Table 3. The Results of Factor-Reliability Analysis and Distributions of Factor Loads

Factors	Component	Extraction	Factors' Load	Eigenvalue	Change %	Cumulative Change	Alpha
Factor 1	Q30	0.582	0.713	3.563	25.447	25.447	0.721
	Q26	0.670	0.711				
	Q35	0.574	0.693				
	Q25	0.471	0.609				
	Q23	0.651	0.586				
	Q34	0.551	0.582				
Factor2	Q22	0.663	0.763	2.203	15.739	41.186	0.639
	Q21	0.590	0.749				
	Q28	0.561	0.650				
Factor 3	Q27	0.523	0.696	1.361	9.724	50.911	0.349
	Q24	0.545	0.645				
	Q33	0.595	0.637				
Factor 4	Q37	0.749	0.861	1.225	8.750	59.661	0.493
	Q32	0.627	0.574				

"Background", "IVS Preference" and "Post-graduation Expectation" in grouping conducted with respect to questions that factors comprise and they are presented in Table 4.

Six items constituted "Consciousness" factor. This factor was named as "Consciousness" factor because it consisted of questions including that students consciously preferred Mechatronics program, they intend to work in this field and if there is still a chance for preference, they will prefer this program again.

It was seen that questions that examine the suitability of vocational and technical backgrounds of students were situated in Factor 2. Three questions form this factor. Questions, which denote that high school type and department is suitable for mechatronics program and for this reason, education will be easier, were determined as "Background" factor.

When three items situated in Factor 3 examined, it was observed that they were particularly related to receiving education in Izmir VS. Therefore, Factor 3 was named as IVS. However, its low reliability put forward the need for improving this factor. It is recommended that researchers, who will use the scale, should improve this factor and adjust it with respect to institution, where research is conducted.

Two items are situated in Factor 4 and this factor was named as "Post-graduation" because these items contained students' opinions regarding after graduation from Mechatronics program. As in Factor 3, this factor had a low reliability as well. It is suggested that this factor should also be improved and if necessary, appropriate questions should be added to the experimental group.

At this stage, the effects of gender, high school type and department of students on choice factors were analyzed. "Consciousness" and "Background" factors, of which their reliability was found appropriate, were extracted as choice factors. Besides, comparisons in terms of gender couldn't be performed because almost all students are boys. In the study, the principal hypothesis that high school type and department of students in particular had an effect on preferring Mechatronics program was tested. This principal hypothesis were statistically expressed and tested with two hypotheses as given below.

H_1: High school type had an effect on choice factors (1)

H_1: High school department had an effect on choice factors (2)

8.3 The effect of high school type and department on choice factors- Hypothesis Testing

Variance analysis was conducted in order to determine the effect of high school type, from which students came, on "Consciousness" and "Appropriate Background" factors. It was found that high school type affected "Consciousness" factor (F_{test}=3.360; p=0.038) and did not have any effect

Table 4. The Results of Factor-Reliability Analysis and Distributions of Factor Loads

Factors	Component
Consciousness (Factor1)	**Q30** If I have a chance to choose again today, I would like to study this major again **Q26** I feel myself luck as a student studying Mechatronics program **Q35** I recommend Mechatronics program to those, who would like to study it **Q25** I consider that mechatronics technician is a suitable profession for me **Q23** I think that I consciously preferred Mechatronics program **Q34** I would like to work in a field related to Mechatronics after graduation
Background (Factor2)	**Q22** I suppose that department where I graduated from high school is compatible with Mechatronics program **Q21** I think that education I received in high school from where I graduated provided me adequate background to study Mechatronics program **Q28** I think that studying Mechatronics program is easy
IVS (Factor3)	**Q27** I encountered an educational environment suitable for my expectations in IVS **Q24** I wouldn't want to study at another VS other than IVS **Q33** I think that I will equip myself thoroughly to be able to perform my profession successfully after graduated from this school
Post-graduation (Factor4)	**Q37** It will be easy to get a job related to my profession after my graduation **Q32** I believe that I can find a job related to my profession after my graduation

on "Appropriate Background" factor (F_{test}=3.015; p=0.053). Charts of confidence interval with assessments of students on choice factors of "Consciousness" and "Background" with respect to high school type at a 95% confidence level are presented in Figure 5. As can be seen in charts, "Consciousness" factor is a greater reason for preference in comparison with other choice factors in every school type. At the same time, when comparisons regarding difference among school types were checked, a statistically significant difference (t_{test} = 2.445; p=0.019 < 0.05) was only found among THS and AVHS graduates for "Consciousness" factor. It can be argued that THS graduates made their choices more consciously compared to AVHS graduates.

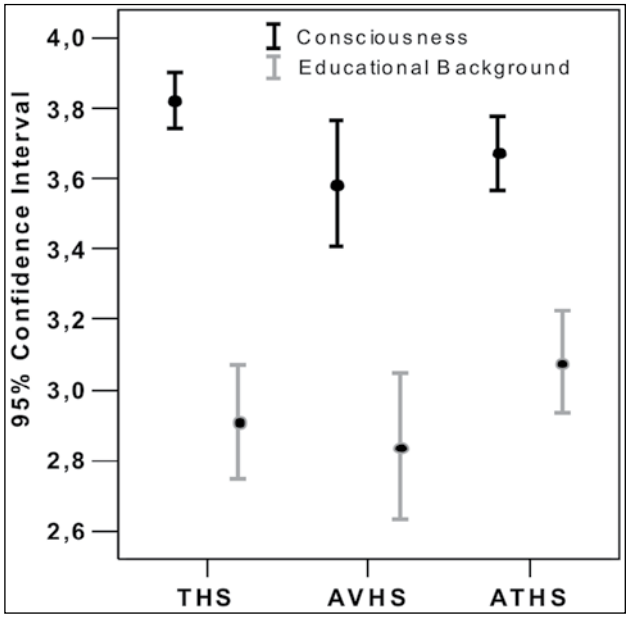
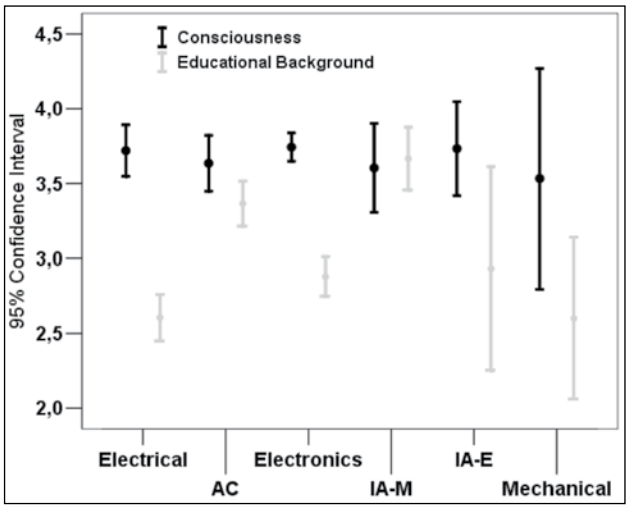


Figure 5. Choice Factors with Respect to High School Type

Variance analysis was conducted in order to determine the effect of high school departments of students on "Consciousness" and "Appropriate Background" factors. It was found that high school department affected "Appropriate Background" factor (F_{test}=14.664; p=0.000) and did not have any effect on "Consciousness" factor (F_{test}=0.577; p=0.718). Charts of confidence interval with assessments of students on choice factors of "Consciousness" and "Background" with respect to high school department at a 95% confidence level are drawn in Figure 6. Although there weren't any distinction among departments, as can be seen in Figure 2, it was found that "Consciousness" factor is a greater reason for preference in comparison with other choice factors for departments in general. At the same time, when comparisons concerning difference among high school departments were checked, statistically significant differences were attained among graduates from Electrical and Automatic Control (p=0.000 <0.05), graduates from Electrical and Industrial Automation Technology- Mechanics (IAT Mechanics) (p=0.000 <0.05), graduates from Automatic Control and Electronics (p=0.000 <0.05), graduates from Automatic Control and Machinery (p=0.000 <0.05), graduates from Electronics and IAT Mechanics (p=0.000 <0.05), graduates from IAT Mechanics and Machinery (p=0.000 <0.05) and graduates from IAT Mechanics and IAT Electronics (p=0.032 <0.05). In particular, it can be argued that students of IAT Mechanics and Automatic Control made their choices on the grounds of background compatibility.



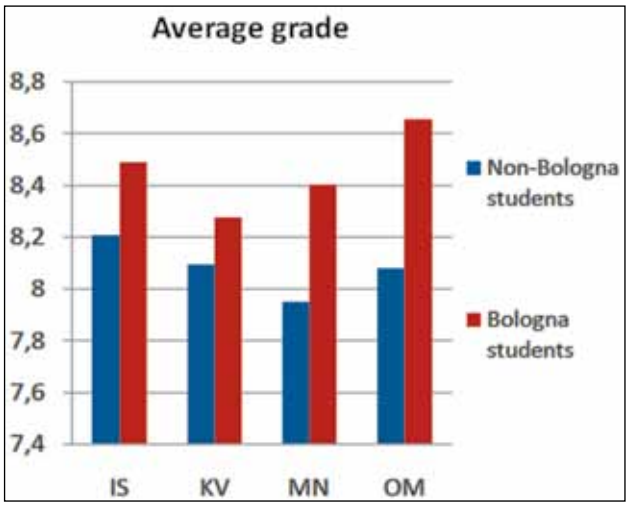


Figure 6. Choice Factors with Respect to High School Department

9. Discussion and conclusıon

It can be asserted that "Mechatronics" and Mechatronics education that rapidly develop in the world and Turkey are important subjects to be dwelt upon. The lack of literature draws attention on Mechatronics education, in which a lack of planning is still recognized although it is rapidly growing. These issues were tried to be clarified in the study. In particular, choice factors of students for Mechatronics program were studied and significant findings were acquired.

Students' reason for preference for DEU is understood from both the numbers of people, who preferred it, in 43 programs in Turkey and from the Student Selection and Placement Center (SSPC) statistics, in which it is ranked in first places with respect to placement scores, as well as findings of this study.

In the study, it was drawn a conclusion that students' choices can be explained by principal factors of "Consciousness", "Background", "IVS preference" and "Post-graduation expectation". It was put forward that scale is reliable for "Consciousness" and "Background" factors but scales of "IVS preference" and "Post-graduation expectation" are required to be upgraded and they should be adjusted regarding the experimental group.

It was seen that students made their preferences consciously and their vocational and technical backgrounds affected their preferences. This situation is summed up in Table 5.

Table 5. Table for Study Hypothesis Outcome Summary

	Consciousness	**Background**
High School type	Effects	No effect
Graduation department	No Effect	Effects

It was found that high school type had an effect on consciousness levels in student preferences. It can be argued that in particular Technical High School graduates made their choices more consciously than Anatolian Vocational High School graduates. It was detected that high school type had no effect on suitability of vocational and technical backgrounds of students in their preferences. In other words, it can be said that technical and vocational backgrounds of students that affect their preferences are independent of high school type. When students' factors that determine choices with respect to high school types were compared, it was ascertained that students being conscious is a greater reason for preference in comparison with other choice factors in every school type.

It was also found that high school department had no effect on consciousness levels in students' preferences. Although there wasn't any difference among high school departments, it was found that consciousness levels in students' preferences were greater than choice factor levels. Another significant finding is the outcome that students preferred Mechatronics program because it is suitable with background of departments from which students graduated.

High consciousness level of Mechatronics associate degree students and as a result, its reflection to placement preferences contains a quite striking outcome. In general, students being conscious of their preferences and they being able to be placed into their first choices are an expected situation for entire university education. When it is handled in terms of Mechatronics students, it is seen that guidance in vocational high schools affected university preference positively.

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