General View of Mechatronics Education in Turkey

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Özet*—Mekatronik kavramı 1969 yılında Japonya'da ortaya çıkmış ve öncelikle Japonya, Amerika ve Avrupa'da yaygınlık kazanmıştır. Türkiye gündemine 1993 yılında girmiş olmasına rağmen Mekatronik alanında ilk düzenli eğitim 1999 yılında Sabancı Üniversitesi'nde Mekatronik Mühendisliği ile başlamıştır. 2002'de Atılım Üniversitesi Mekatronik Mühendisliği eğitimine başlamıştır. 2003'te Marmara Üniversitesi Teknik Eğitim Fakültesinde Mekatronik Öğretmenliği Bölümü açılmıştır. 2009'da Teknik Eğitim Fakültelerinin öğrenci alımının durdurulması ve Teknoloji Fakültelerinin Kurulmasıyla birlikte 2010'da Mekatronik Teknoloji Mühendisliği eğitimi başlamıştır. Mekatronik önlisans programları ise 2001'de Sakarya Üniversitesi Sakarya Meslek Yüksekokulu ve Kocaeli Üniversitesi Gebze Meslek Yüksekokulu'nda başlamıştır. Lise düzeyinde ise ilk mekatronik programları 2003'te başlamıştır. Türkiye'de düzenli mekatronik eğitimi başladıktan sonra geçen kısa süre içerisinde belirli bir mesafe kaydetmiş ve mekatroniğe olan ilgi yıllar itibariyle artmıştır. Bu çalışmada Türkiye'deki Mekatronik Mühendisliği, Mekatronik Teknoloji Mühendisliği, Mekatronik Öğretmenliği ve Mekatronik önlisans eğitiminin gelişimi ve bu alanlardaki en son gelişmeler değerlendirilmiştir.

***Keywords*—Turkey, Mechatronics, Engineering, Education, Vocational School.**

I. INTRODUCTION

The term "Mechatronics" was first introduced by a Yaskawa Electric Engineer in 1969 [1]. Even though some definitions have been done about Mechatronics for the years ahead [2], the most common definition is; "Mechatronics is the synergistic integration of mechanical engineering with electronics and intelligent computer control in the designed manufacturing of industrial products and processes" [3]. The range of applications of mechatronics as an interdisciplinary engineering branch is shown in Figure 1.

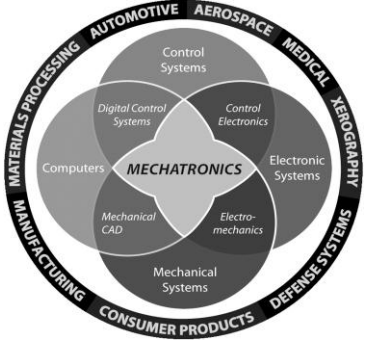

Figure 1: Mechatronics and its components [4]

Even though the concept of Mechatronics appeared at Japan in 1969, the first regular education on Mechatronics began in 1983. In Japan since the year of 1983, Toyohashi University runs a regular Mechanical Engineering (ME) course in Mechatronics Engineering, in Europe, starting the education on mechatronics reached in mids of 1980's [5]. Mechatronics engineering courses at undergraduate and graduate levels, as well as vocational training courses are rapidly increasing across the world [6].

Recently, mechatronics engineering education is being performed in many countries. Today, lots of studies are done on Education philosophy of Engineering [7], programs of curriculum [8, 9], also the evolutionary of development as the engineering branch [10] and the education of Mechatronics is standardized nearly on universal base. Although the Mechatronics come order of Turkey in 1993 [11], the progress of it was fairly slow. Becoming prevalent of mechatronics on academic and industrial areas has happened just on the beginning of 2000's [12]. Middle East Technical University (METU) has arranged an assemblage on an international basis "The meeting of international design and modeling on Mechatronics". Also again METU in 1994 on an international basis on mechatronics began to issue a journal named 'International Journal of Intelligent Mechatronics: Design and Production' [13]. In 1988, METU Mechanical engineering has started the education on mechatronics as its branch [14].

In Turkey, education of mechatronics started in Sabancı University with Mechatronics Engineering on 1999 [15]. This process was followed Atılım University's Mechatronics Engineering. In 2003 the Marmara University Technical Education Faculty, the department of profession of teaching on mechatronics has been open up. In 2009 by the decision of council of ministers was decided to close up the Technical Education Faculties and stopping the receiving students. By the same decision, the faculty of technologies has been established and in 2010, the education for technology engineering of mechatronics was started. Associate degree of mechatronics education was started on vocational high school of Sakarya University and Vocational High School of Kocaeli University in 2001 [16]. On high school degree, the education of mechatronics started in 2003. Within the Balgat (Ankara), Çayırova STFA (Kocaeli), Hürriyet (Bursa) Anatolian Vocational High School (VHS), since the beginning of 2003-2004 years of study, education of mechatronics is being performed. [17].

In Turkey, chronological progress of mechatronics education is shown on Table 1.

Table 1: Chronological Progress of Mechatronics Education

Year	Explanation
1999	Sabancı University Nature and Engineering Faculties. Mechatronics Engineering Department was opened.
2001	Sakarya University Sakarya Vocational High School and Kocaeli University Gebze Vocational High School Mechatronics Associate Degree Education started.
2003	Marmara University Technical Education Faculty Mechatronics Teachers' Training Department opened. High School Level Mechatronics Department Education started.
2009	The closing decision of Technical Education Faculties was taken and students entrance was stopped. Technology Faculties were founded.
2010	Technology Faculties started the education of Mechatronics Technology Engineering

In Turkey on the study of literature for the education of mechatronics it was met the studies of in vocational high schools the education of mechatronics [18]; the new circle of professional and technical education: mechatronics [12]; mechatronics, as a new discipline the mechatronics and the education of mechatronics in Turkey[19], compliance problems of education of mechatronics branch's students [20], Mechatronics Education in Turkey [17], Ideal Mechatronics Engineering and Hydraulics Pneumatic [21], Development and present situation of Mechatronics Associate's Education in Turkey [16], and Curriculum Analysis of Mechatronics Associate Degree Programs in Turkey [22] about the accordance, the studies.

II. MECHATRONICS ENGINEERING EDUCATION

A. Mechatronics Engineering

The first branch of mechatronics engineering had been established in 1999-2000 academic year of study within the Sabancı University and in the faculty of Natural Sciences. The students that were accepted by the Faculty of Natural Sciences have been educated for one year for the prep class of foreign language and for the next following two years of the basic engineering education. The selections about the branches of engineering are done at the third class in accordance with students' interests. At the end of this process, Mechatronics Engineering branch of Sabancı University had chosen 27 students. After Sabancı University, Mechatronics Engineering had been established at Atılım University in 2002. Thus in Turkey, in the area of Mechatronics Engineering the leadership was done by Foundation Universities. According to the data of the year of 2010, the education of Mechatronics Engineering is performed in nine universities with the inclusion of 5 foundation universities. The branches of Mechatronics engineering and the establishing years of them in Turkey are shown at Table 2.

Table 2: The branches of mechatronics engineering and the establishing years of them in Turkey [23]

Mechatronics Engineering	Opening Year
Sabancı University*	1999
Atılım University *	2002
Kocaeli University	2003
Bahçeşehir University *	2005
Fırat University	2008
Erciyes University	2009
Yıldız University	2009
Okan University *	2010
KTO Karatay University *	2010

* Foundation University

Quota of the count of the students is accepted for the Mechatronics Engineering is shown in Figure 2. Number of schools and the Quota has a continuous accrual in the year of 2010 and is seen the number of mechatronics engineering branches are reached nine and the quota of the students also increased to over of 700.

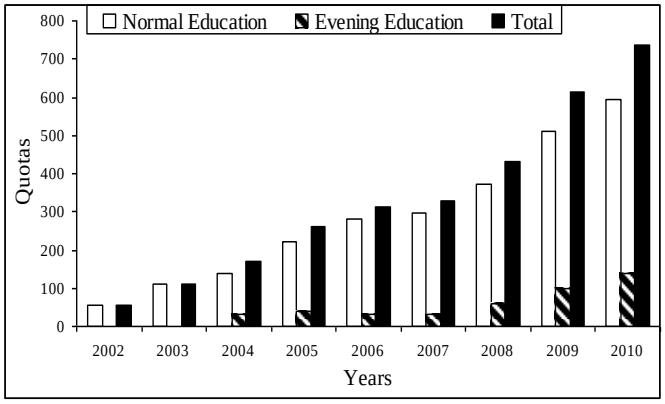

Figure 2: Quotas of Mechatronics Engineering according to the years.

B. Mechatronics Technology Engineering

The technology faculties began to education in 2010-2011 academic years and the first students were accepted. In the technology faculties of Fırat, Karabük Marmara and Sakarya Universities have the mechatronics technology engineering branch.

The similar branches of technology engineering occurs in; England, Germany, USA, South Korea etc. and it is given the appellation of application engineer to them. The comparison of engineering and the technology engineering according to criterion of ABET is shown in Figure 3.

The engineering branches of technology faculties that were established in Turkey are separated from the classical engineering faculties with this following characteristics of their;

- A student will get at the least 240 ECTS of credits of the lesson along all his/her educational process

- The students get higher abilities about applications of the subject with their first quarter (year) office education and the summer office education about 72 days.
- About the law status, there will be no difference between the engineer graduate from engineering faculty and the engineer graduated from the technology faculty [25].

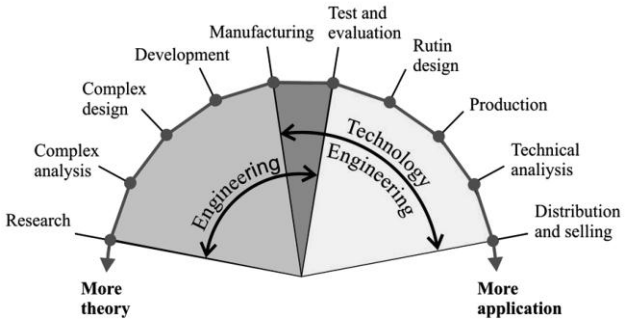

Figure 3: Comparison of engineering and technology engineering [24]

In 2010 the capacity of mechatronics branch of four faculty of technology increased to 420 that have accepted/received the students for the first time (Figure 4). The students are accepted to branch of Mechatronics Technology Engineering in two separate kinds of points and also two separate kinds of quota. The first choice is the one that the graduates of the general high school could choose the quota of Normal Education (NE) and Evening Education (EE), the second choice is the one that the graduates of the Vocational Technical High School (VTHS) could choose.

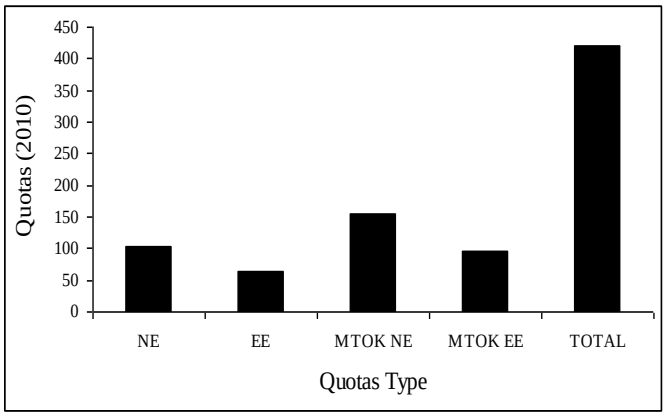

Figure 4: Quotas of the mechatronics technology engineering in 2010.

C. Mechatronics Minor Program Education of Machine Engineering

The minor program education of mechatronics in mechanical engineering in Turkey was begun in 1988 at METU Machine Engineering. Faculty of engineering offers a Minor Program on Mechatronics for undergraduate students of the Faculty of Engineering. The main purpose of this program is to provide the successful and motivated students within broad knowledge of mechatronics that will enable them to practice their profession in an interdisciplinary manner [26].

D. Mechatronics Engineering Postgraduate Education

The education of Mechatronics Engineering is performed in Turkey in the levels of postgraduate and doctorate. The universities that perform the education of Mechatronics Engineering in the level of graduate, postgraduate and doctorate are shown in Table 3.

Table 3: The universities in the of graduate, postgraduate and doctorate education of Mechatronics engineering in 2010

Universities	Graduate	Postgraduate	PhD
Sabancı	*	*	*
Kocaeli	*	*	
Bahçeşehir	*		
İTÜ		*	
Dokuz Eylül		*	*
Erciyes	*		
Karabük		*	
Fırat	*		
Yıldız	*		
Atılım	*	*	
Okan	*		
KTO Karatay	*		

As clearly seen in table, there are 3 different statements:

- The universities that performs only in the level of graduate
- The universities that performs in the level of graduate and postgraduate
- The universities that performs only in the level of postgraduate

In Turkey, well known universities have strong substructures about the technical and academic areas do perform graduate and postgraduate education in the Mechatronics Engineering. METU only has the education for branch of mechanical engineering; ITU is limited just with graduate education. Also it is seen that some universities have no education or no branch of Mechatronics Engineering as Boğaziçi, Bilkent, and Hacettepe etc.

E. Mechatronics research centers

In Turkey, Mechatronics research centers only exist in Boğazici and Istanbul Technical Universities.

- Boğaziçi University Mechatronics Application and Research Center was established in 1995. It is a unit that's making the researches to find the newest technology and providing the application of the new found last technologies. Grand targets of the unit are; providing the fast and update information transfer about the Mechatronics, making the scientific issues, arranging the scientific assemblages [27].
- Istanbul Technical University Mechatronics Training and Research Center: was established in 2008.Gives the chance of the working with the applications to the several of the students as the Mechanical and Electrical and Electronics faculties are ahead [28].

III. TECHNICAL EDUCATION FACULTY

The technical education faculties that are providing the teachers for the professional and technical high school education associations have been established in 1937. The branch of profession of teaching about Mechatronics for the first has been established in Marmara technical education faculty and following was established in Suleyman Demirel University technical education faculty. The both branches of those two universities have accepted the students till the year of 2009 (Figure 5). On the date of 2/11/2009 by the decision of Council of Ministers was [29] decided to close up the technical education faculties and stopping the receiving students. By the same decision, the faculty of technologies was established and in 2010. The technical education faculties will not accept any students for more from the year of 2010 and will maintain the education till 2015-2016. At 2015-2016 seasons, their community will be ended [25].

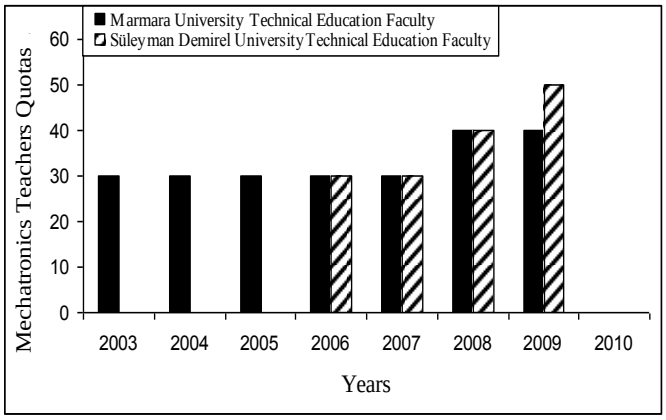

Figure 5: The quota of Mechatronics Teachers' Training

IV. VOCATIONAL SCHOOLS

In Turkey, the associate degree of Mechatronics education began in 2001 in the Sakarya University MYO and Kocaeli University Gebze MYO. Between the years of 2001-2010, numbers of schools and quota for the students were increased rapidly. The education started in 2001 with from two vocational high schools and quota of 55 students. In the year of 2010, it was increased to 43 programs, 1917 evening education, 805 primary education and with 150, totally quota is 2272. The names and the establishing dates of Mechatronics programs of Mechatronics are shown at Table 4 in the year of 2010. The increasing on the number of programs especially seems in the years of 2009 and 2010.

Table 4: The establishing dates of Mechatronics associate degree programs

Number	University and Vocational School	Open Year
1	Kocaeli U. Gebze VS.	2001
2	Sakarya U. Sakarya V.S.	
3	Gantep U. Gaziantep VS.	2002
4	Namık Kemal U. Tech. Science VS.	
5	G.O. Paşa U. Turhal VS.	
6	Sakarya U. Adapazarı VS*	2003
7	Giresun U. Şebinkarahisar V.S.	2004
8	Kocaeli U. Karamürsel V.S.	
9	G.O. Paşa U. Zile V.S.	
10	Uludağ U. Technical Science VS.	2005
11	Selçuk U. Ereğli V.S.	
12	Selçuk U. Faik İ. Kadınhanı VS.	
13	Balıkesir U. Edremit V.S.	2007
14	Çanakkale 18 Mart U. Çan V.S.	
15	Mustafa Kemal U. İskenderun V.S.	
16	Dokuz Eylül U. İzmir V.S.	
17	Kastamonu U. Kastamonu V.S.	2008
18	Celal Bayar U. Soma V.S.	
19	Bahçeşehir U. V.S.**	
20	Kadir Has U. V.S.**	
21	Karadeniz Tech. U. A.Kanca V.S.	
22	Adnan Menderes U. Söke V.S.	2009
23	Afyon Kocatepe U. Bolvadin V.S.	
24	Nevşehir U. Hacı Bektaş V.S.	
25	Gediz U. V.S.**	
26	Kırklareli University V.S.	
27	Ahi Evran U. Kırşehir V.S.	
28	Dumlupınar U. Gediz V.S.	
29	İnönü U. Arapgir V.S.	
30	Ağrı İbrahim Çeçen U. V.S.	2010
31	Artvin Çoruh U. Hopa V.S.	
32	Bitlis Eren U. V.S	
33	Çankırı Karatekin U. V.S.	
34	Erzincan U. Refahiye V.S	
35	Anadolu U. Porsuk V.S.	
36	Dumlupınar U. Kütahya V.S.	
37	Sinop U. V.S.	
38	Cumhuriyet U. Sivas V.S.	
39	G.O. Paşa U. Niksar V.S.	
40	Fatih U. Gedik V.S.**	
41	Gazi U. Atatürk V.S.	
42	Gazi U. Ostim V.S.	
43	Gümüşhane Unv. V.S.	

* Distance Education ** Foundation University

The dispersion of Mechatronics programs of vocational high school differs according to on the base of geographical areas, the cities and the boroughs (Table 5). The numbers of schools are more in Marmara region, Black Sea Region, Middle Anatolian region, Aegean Region and East Anatolian region than South east Anatolian Region and Mediterranean region. Mechatronics programs exist in all geographical regions of Turkey.

Table 5: Geographical dispersion of Mechatronics Programs

Geographic Region		Number of VSs	City	Town
1	Marmara	11	7	4
2	Aegean	7	3	4
3	Mediterranean	1	-	1
4	Central Anatolia	8	5	3
5	Blacksea	9	6	3
6	Southeastern Anatolia	1	1	-
7	Eastern Anatolia	5	3	2
Total		42	25	17

*Distance education is not included.

Considering the quotas between 2001 and 2010, in the last 3-4 years by the increasing of number of schools, the quotas were seriously getting the higher level (Figure 6).

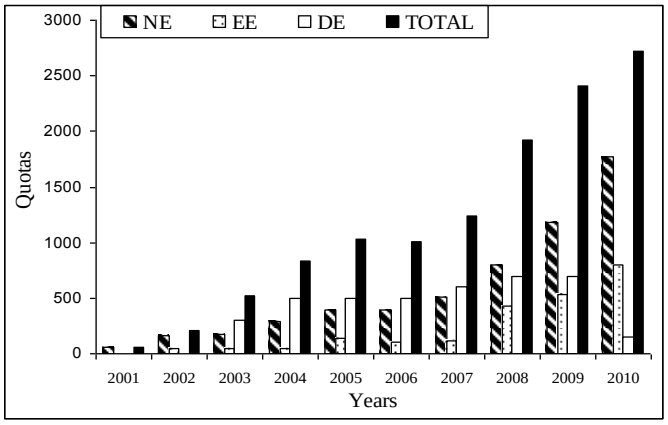

Figure 6: The quotas of Mechatronics Programs of vocational high schools according to years.

The dispersion of quotas of vocational high schools on the base of cities, borough, NE and EE is shown in Figure 7. The quotas are predominantly more in the cities in parallel with the number of schools and together with it, the quotas of NE and EE is nearly at par as it seems.

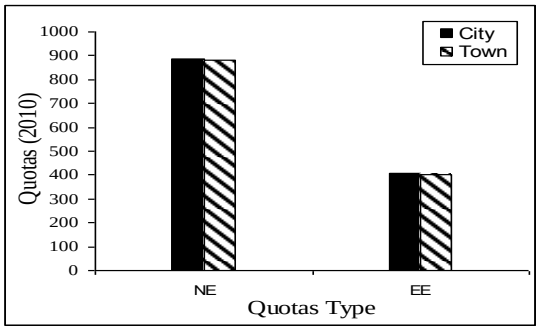

Figure 7: The distribution of quotas of Mechatronics Programs of vocational high schools on the base of NE and EE.

The dispersion according to the geographical regions is shown in Figure 8. Marmara, Black Sea and Aegean regions are front according to the other regions as it seems.

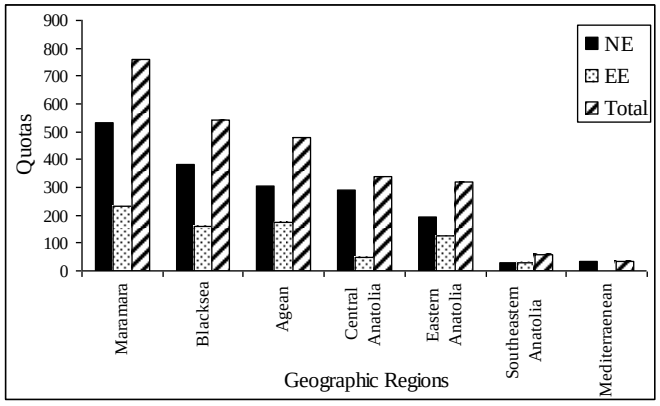

Figure 8: The dispersion of quotas of Mechatronic Programs of vocational high schools according to the geographical regions.

A. Distance Learning Education

Internet based distance learning model became widespread in last ten years. The first distance learning of Mechatronics Programs in Turkey was started in 2003 in Sakarya University Adapazarı vocational high school that has the only program providing the distance learning for the year of 2010. In literature, there has been met to no study for the program's educational system, quality and the level of success of it. The educational method this school applies is as follows;

- The lesson materials are downloaded from the internet by the students, studies individually and the topics that are not understood is commented in forums mutually and its firmed. The control of access from the long distance for the electronic platforms is done; the student could ask the questions to the teachers and get the special help from then by forums, e-mails or chats. The index of main lesson could be reached from the internet. The short exams weekly and the mid exams are executed on internet. All the final exams at the end of the periods are done at University campus. The students join the condensed campus course at the end of the first year [30].

B. HRD-VET Project

The Human Resources Development Through Vocational Education And Training Project (HRD-VET) conducted by the Project Coordination Center of the Ministry of National Education and financed in the purview of European Unions IPA program, is a two year Project with the aim of promoting the development of human resources through modernizing and increasing the quality of vocational education in the view of lifelong learning by assuring association between the labour market and secondary and post-secondary vocational education and training schools with the objective of employment [31].

A lesson pool has been prepared for the mechatronics program within the context of project and the elasticity was made of building up the lesson plans according to the schools' possibilities and demands. As to be general principle, in the plan of education that occurs in four halves, is offered, reaching the ECTS credit of 100 and the credits of % 15-20 of those consist of optional subjects. In the scope of HDR-VET project, the lesson curriculum of mechatronics is prepared with the others is to be applied in the 2010-2011 academic year been noticed by YOK to the universities.

V. CONCLUSION

In this study, it was assessed the improvement in education of mechatronics in Turkey from 1993 to the year of 2010. Although the education of mechatronics engineering began later on according to Japan, Europe and USA, especially in the last 3-4 years was grown further. Is seen an improvement starting the education of high school till doctor's degree. License education of mechatronics engineering the foundational universities seem more brave. But the governmental universities lead about especially in

postgraduate education and researching areas. The faculties that started to accept students within in 2010 are not working with full capacity. The progress of these faculties and mechatronics technological engineering needs more time. At the same time, if the definition about appellation and authorization of the engineers that graduated from these faculties is not properly done, have potential problems within.

In mechatronics education, the mechatronics associate degree is the fastest step. The number of programs and the variety on the areas where the program is performed was gradually increased. For the opening of associate degree programs, the industrial development level of the regions should be taken into consideration and also should be searched whether the schools have enough technical fixture and academic staff to performs the regarding education about mechatronics. The mechatronics programs that were prepared within the context of HRD-VET project, and began to perform from the year of 2010 on, in the universities. Even though with this study the standardization was made on study plan and curriculums, according to the under work statements of the schools on their own and the regional demands, there could be specific claims and the requirements of the change as well.

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