
The cooperation of Industrial Education and Engineering Education in Japan

-A look at university entrance examinations and curricula developed especially
for graduates of technical high schools-

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국문요약

일본의 공업고등학교 졸업생들은 자신의 전공 영역에서는 충분한 기능을 보여줄 수 있을지라도 국립 대학 입학에 위한 시험을 통과하기에는 어려운 실정이다. Niigata 대학, Nagasaki 대학 그리고 Toyama 대학의 공학부 교수들은 대학 입학 시험을 위한 과제를 마련하기 위하여 1994년부터 공동으로 노력을 기울이고 있으며, 학생들의 교육적 배경과 필요에 부합하는 일반 교육과정을 설치하고 보충수업을 제공하고 있다. 이러한 프로젝트가 공식적으로는 1999년 종료되었지만 Niigata 대학에서 계속적으로 진행되고 있다.

Abstract

While graduates of Japan's technical high schools might demonstrate skills in a given specialty, they would be hard-pressed in any attempt to pass national universities' notorious entrance examinations. In a collaborative effort begun in 1994, the faculties of engineering at Niigata, Nagasaki, and Toyama Universities set about the task of preparing entrance examinations, and a general curriculum geared to the needs and educational backgrounds of these students, offering them supplementary lessons. While the larger project officially ended in 1999, we are carrying the research forward in Niigata University.

주제어 : 대학입학시험, 공업고등학교

Keywords : University Entrance Examinations, Technical High School

1. Introduction

As the pace of Japan's development was quickening after the World War II, the standard procedure, in dealing with technical high schools' graduates was to send them directly to engineering firms throughout the country. So, Japan's technical high schools were useful for Japan's development until 60's and would be useful for developing countries even in the 21st century. But, these high schools were accorded a low academic status, which placed their graduates in a lower social rank, as well, leaving them little chance of entering national universities, while the trend nationwide was actually toward increased enrollment, by the general public in Japan. Then, in 1994 faculties of engineering at Niigata, Nagasaki, and Toyama Universities set about the task of preparing entrance examinations specially geared to the educational backgrounds of these students. Between then and 1999, the three universities collaborated in developing the curricula that would be used to teach technical high schools' students and in publishing a total of 5 reports on the subject.

By 1995, these three universities were admitting the graduates of technical high schools to their faculties of engineering. These three universities began providing students with supplementary lessons in English, Mathematics, Physics, and Chemistry in 1995, because research conducted in 1994 indicated that, while they might be quite well versed in their intended specialties, they lacked certain basic skills. Opinion polls of students and teachers conducted in 1999 and 2003, regarding the entrance-examination system and the courses taught at our universities including the supplementary lessons, bear striking similarities.

Over the last 10 years, Niigata University alone has accepted 406 students of technical high schools. Approximately 100 students attend the three universities mentioned above, each year. The data we have accumulated in the interim clearly indicate that technical high school graduates who have completed their university education in four years, and go on to postgraduate school, are every bit as capable as students, who attended "regular" high schools, as well as their records in their study. Their success strongly suggests that universities in developing countries could reap tremendous benefits by adopting admissions policies and teaching methods similar to ours; adapting curricula to suit the natural abilities and students who possess such a sincere desire to learn.

2. Background research prior to the year 1999

Students moving directly from junior high schools to technical high schools often do so on the advice of "former" teachers and administrators. They are classified according to the degree to which their scores on standardized tests fell below statistical norms, so the scholastic abilities of these students tend to be inferior to those of students entering regular high schools. However, it is in these schools, that many students discover their true calling. And some are so inspired, that they decide to pursue a university education, in order to continue research in a field of study they particularly enjoyed, or were introduced to, by a caring, interested teacher. At least two technical high schools in Niigata Prefecture can boast of having more than 50% of their graduates go on to colleges or universities, and some other schools.

Based upon research carried out in 1994, three universities began allowing students to take special entrance examinations, and provided them with supplementary lessons in English, mathematics, physics, and chemistry. We collected the records of both this-, and the regular-students groups, and were pleased to find that the marks on-file for students coming from technical high schools were in good agreement with, and in some cases even superior to, those of regular students cited in the 1999 research. We obtained similar results, in a survey conducted by now, as well. So, it becomes obvious that the results obtained in 1999 were not an aberration, but rather, a simple reflection of facts.

We at Niigata University compared our entrance examination system and supplementary lessons, with Nagasaki and Toyama Universities, sending out questionnaires to the students and to teachers in charge and obtained the results as shown below.

2.1 Answers from students in Niigata University

The majority of students who came to us from technical high schools in 1995 graduated from our faculty within the normal time frame, so they could easily appreciate the merits of our entrance examination system, as well as the supplementary lessons we provided. In their comments, the students expressed the greatest concern over the level of classroom lectures, especially with regard to English and mathematics. But, upon completion of the courses, they indicated a strong feeling of satisfaction, at having chosen our university, stating that the supplementary lessons had greatly eased the transition from the secondary-school work, to the curriculum offered by our faculty.

2.2 Supplementary lessons and "remedial classes" in Niigata University

In the students' first year, we provided fifteen 90-minute supplementary lessons in mathematics, physics and chemistry, as well as thirty 90-minute classes in English, using course materials specifically geared to the needs of students whose interests lay primarily in the area of technology. We also provided two remedial classes for them; one, a seminar in mathematics, -the other, in Basic English. When time was limited, mathematics took precedence over other studies, because of the students' need of a firm grasp of the principles of differential and integral calculus. Teachers we spoke with expressed considerable resentment at some students' apparent lack of interest in the classes, as evidenced by their chronic absence from them. Not surprisingly, evaluations of those who chose to attend described students' thinking as "positive", their motivation and level of engagement in discussions as "high". Some teachers opined that the fact of these students not having to face the prospect of going through a series of tough examinations might have played a part in their upbeat attitudes. Because the "Seminar in Mathematics" had the high attendance ratio, the teachers in charge of it pointed out "a marked disparity in the students-educational levels" within the students from technical high schools and the need of a special care.

3. Research from 1999 onward in Niigata University

3.1 Survey of their records

In the first stage of this survey (completed on March 31, 1999), we compared the records of students who came to us from either conventional or technical high schools, between 1995 and 1998. From 1999 onward, Niigata University has welcomed roughly 50 students per year from technical high schools, and continues this survey.

A check of their transcripts reveals a few surprises. For instance, as of the end of the 2000 academic year, not just one but all four top-ranked students in four classes from the first year to fourth year within the Department of Electrical and Electronic Engineering, were coming to us from a technical high school. Each class of the Department of Electrical and Electronic Engineering has 8 students from technical high schools within 80 students in total. While there could, of course, be any number of reasons for this, we suspect that it results from the students' own character; their strong motivation, and their ability to recognize the value of the supplementary lessons we offered. They simply chose to take advantage of them.

In our review of the students' transcripts, we made some interesting discoveries. There were more top-twelve ranked students and more bottom-twelve ranked students from technical high schools than from regular high schools in Nagasaki University as shown in Table 1. And, overall, nearly 28% of students from technical high schools obtained more than 100 units or credits, while 22 % of students were unable to complete 68 units or credits at the end of their second year (at the end of the 2001 academic year). By contrast, 14 % students from regular high schools obtained more than 100 units and 15 % students were unable to get as few as 68 units in Niigata University. So, while the many of technical high school graduates are indeed highly motivated, and demonstrate their abilities with ease, there are always those, however a few in number, who show a lack of basic skills or of interest in mathematics. Our main task is to find the method how to motivate the students who lack basic skills.

Table 1 Examples of educational levels of students
Nagasaki University, third year students at the end of 2001 academic year

Rank	Graduates of THS*
Top-twelve	44%(4 in 9 students)
bottom-twelve	22%(2 in 9 students)

Niigata University, second year students at the end of 2000 academic year

Units	Graduates of THS*	Graduates of RHS**
100 units and more	28%(13 in 46 students)	14% (66 in 471 students)
68 units or less	22%(10 in 46 students)	15% (70 in 471 students)

* Technical High School ** Regular High School

From 1995 through 1999, 73% of the technical high school graduates went on to obtain bachelor's degrees, whereas the figure for graduates of regular high schools was 79%; both groups of students attaining the status within the usual 4-year period in Niigata University (Table 2.). The rate for students extending their university education beyond that, was a much higher than expected, 34%, in the case of tech-school graduates, and 57% for those coming to us from regular high schools.

Table 2 Rates for 4-year period graduation and going on to graduate school, Niigata University

Academic year of entrance	Graduates from THS*			Graduates from RHS*		
	Number of students	4-year period graduation	Going on to graduate school	Number of students	4-year period graduation	Going on to graduate school
1995	19	16(84.2%)	9(47.4%)	501	378(75.4%)	260(51.9%)
1996	33	24(72.7%)	7(21.2%)	498	378(75.9%)	292(58.6%)
1997	40	27(67.5%)	11(27.5%)	481	385(80.0%)	265(55.1%)
1998	38	25(65.8%)	14(36.8%)	500	410(82.0%)	274(54.8%)
1999	46	36(78.3%)	19(41.3%)	474	398(84.0%)	299(63.1%)
Total	176	128(72.7%)	60(34.1%)	2,454	1,949(79.4%)	1,390(56.6%)

* Technical High School

**Regular High School

3.2 Study of two-track entrance-examination system

In 1996, the Faculty of Engineering at Niigata University became the first in the country, to adopt a two-track system of entry; one, in which admission is based upon the recommendation of the principal of the technical high school from which the student graduated, and the other one is the "Entrance examination for technical high school graduates". The latter system requires that the students from technical high schools undergo both the examination conducted by the "National Center for University Entrance Examinations", and Niigata University's in-house entrance examination, in which the subject is loosely labeled "Engineering". While preparatory-school administrators give comments over most universities' entrance examinations, they have never commented on nor criticized our subject "Engineering". This is because the number of students taking our examination was limited (usually less than twenty), we decided to ask teachers working in technical high schools to review and comment on some of the questions included in our past examinations. Their criticisms were most helpful, and the various changes we made, a clear reflection of their input. In evaluating the students, we direct our focus away from pure "scholastic ability", and more toward "capacity" or "ability". We make every effort, how to evaluate students' capacity, in discussions with teachers in technical high schools. Judging from past, -and even current census figures, the number of candidate students in our special two-track examination-system is sufficient to maintain it (Table 3), into the foreseeable future.

4. Conclusion

While there was some concern at the outset of this project in 1994, that graduates of technical high schools would not be able to pass university-level examinations and much less accumulate sufficient credits to graduate, these fears have proven groundless. The students in our study showed themselves to be highly motivated, and, -possibly due to the supplementary lessons and remedial classes we provided for them-, achieved final grade-point averages that closely approximated those of students who had graduated from regular high schools. As regards overall distribution of students' grades, we were surprised to find that schools emphasizing technical skills tended to produce greater numbers of students whose grades came in at either one extreme or the other. And, while it is true, that fewer technical high school students graduated within four years, or went on to graduate schools, compared with regular high school students, the numbers were in no way a source of disappointment.

Table 3 Entrance Examination of Faculty of Engineeri

Capacity/ AY*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recommendation from THS	24	24	24	27	27	26	23	23	23	21
Examination for THS	12	12	14	14	14	14	14	14	14	14
Others	461	461	479	449	439	440	443	443	443	445
Sum	497	497	517	490	480	480	480	480	480	480
Applicants/ AY*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recommendation from THS	42	63	45	75	62	72	90	83	78	65
Examination for THS	19	50	30	40	46	51	53	45	53	40
Others	1,990	1,562	1,508	1,635	1,367	1,606	1,406	1,371	1,293	1,117
Sum	2,051	1,675	1,583	1,750	1,475	1,729	1,549	1,499	1,424	1,222
Competition rate/ AY*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recommendation from THS	1.8	2.6	1.9	2.8	2.3	2.8	3.9	3.6	3.4	3.1
Examination for THS	1.6	4.2	2.1	2.9	3.3	3.6	3.8	3.2	3.8	2.9
Others	4.3	3.4	3.1	3.6	3.1	3.7	3.2	3.1	2.9	2.5
Sum	4.1	3.4	3.1	3.6	3.1	3.6	3.2	3.1	3.0	2.5
Successful candidates/ AY*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recommendation from THS	18	25	24	28	26	31	35	31	28	30
Examination for THS	12	16	13	18	14	17	17	15	15	14
Others	539	524	554	509	503	507	500	506	506	492
Sum	569	565	591	555	543	555	552	552	549	536
Enrolled students/AY*	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Recommendation from THS	18	24	24	28	26	31	35	31	28	30
Examination for THS	12	16	13	18	13	17	17	14	15	14
Others	495	480	497	472	472	475	474	478	476	460
Sum	525	520	534	518	511	523	526	523	519	504

* Academic Year

The most important lesson we, as teachers, took away from this project is, that should we be forced to choose which supplementary lesson we are going to provide for the students, we should select mathematics, because a keen understanding of the principles of "differential and integral calculus" is essential, regardless of which fields of science they pursue.

We created the unique program, which allows technical high school graduates skilled in design and manufacturing, to work side-by-side with graduates of regular high schools in Niigata University. We are firm in our belief that this arrangement provides a well-rounded educational background for both groups, preparing them to move confidently into the future. We also believe that Japan's technical high schools were useful for Japan's development until 60's and would be useful for developing countries even in the 21st century, if the developing countries could construct the entrance examination system adapted for their graduates.

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