Journal for Geometry and Graphics
Volume 10 (2006), No. 1, 109–114.

Evaluation of Students' Score Distribution in the Subject Mechanical Design

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Abstract. Students' achievement must be correctly evaluated. One of the best methods for evaluation is to study the students' score distribution. This is a mirror of their education. The following article deals with a change of students' score distribution resulting from a change of pedagogical circumstances in the subject Mechanical Design. Mechanical Design professors must teach students the synthesis of mechanical design. Unfortunately, the school hours for graphics or figures in Japanese universities have recently been decreasing and decreasing. This results in a lower level of the Mechanical Design education.

The article concludes with a discussion of consequences to be taken from the evaluation of students' real score distribution in the subject Mechanical Design.

Key Words: Education, Mechanical Design, students' score distribution, examination question

MSC 2000: 51N05

1. Introduction

Students' score distribution is a mirror of their education. The author of this article already reported in [1] about the students' real score distributions from 1990 to 1999 with respect to the subject Mechanical Design. They were arranged in a roughly normal distribution. This means that the pedagogical circumstances of the author's mechanical engineering department remained unchanged.

The author retired in 1998 but continued the education in Mechanical Design after retirement. However, from 1999 on the decision about success in the examination has been transferred from the author to another professor who disliked to failure. After the year 2000 the students' real score distribution drastically changed.

Mechanical Design in the field of practical engineering comprises strength calculations of parts employed as well as drawings. The drawings consist of figures and manufacturing information. We, mechanical design professors, must teach students the synthesis of mechanical design. Different to most of the important subjects of mechanical engineering department, the

ISSN 1433-8157/$ 2.50

school hours for graphics or figures have recently been decreasing and decreasing in Japanese universities. This results in a lower level of the Mechanical Design education.

The students' achievement must be correctly evaluated. A suitable counter plan derives from precise evaluation of students' achievement. One of the best methods is to study the students' score distribution.

This article deals with the process of changing examination questions referring to students' score distributions in the subject of Mechanical design. One reason for the drastic change of students' score distribution will be discussed. As a result, the important information will be derived from this evaluation, that a key subject like Mechanical Design must not become an optional course in the mechanical engineering department.

2. Score Distribution

The students' score distributions in the subject Mechanical Design for the years 1999 through 2003 are depicted in Figs. 1 to 5. In Figs. 1 to 5, N denotes the number of students, S the score and the arrow entered the mean value. For fifteen years before 1999, the mean ratio of the failed students to the total lectured students was 15.5%. As seen from Figs. 2 and 3, the students' score distributions remarkably changed.

Table 1 shows the change of the mean value S_m of examinations, the total number N_0 of lectured students and the number N_f of students who failed.

Table 1: Change of pedagogical circumstances

Year	*Subject*	S_m	N_0	N_f	*Note*
1998	Compulsory	55.7	195	16	Author was retired
1999	do.	42.9	125	11	Another professor decided
2000	do.	30.3	152	9	do.
2001	do.	20.1	156	6	do.
2002	do.	23.6	121	2	do., Check of drawings
2003	Optional	43.9	60	10	do. (Author decided)

3. Explanation

The author was retired in the school year 1998 and he became a part-time professor as entered in the note column in Table 1. The lectures on Mechanical Design continued. However, the decision about the success in the examinations was transferred to another professor who disliked to failure. The students did not know the fact of this transfer in the next year, 1999. Then the students' score distribution depicted in Fig. 1 was considered to be arranged roughly in a normal distribution.

In the year 2000 the students began to know about the decreasing number of failed students in the preceding year, 1999, as shown in Table 1. From now on they did not work hard. As a consequence, the students' score distribution inclined to the right direction as depicted in Fig. 2.

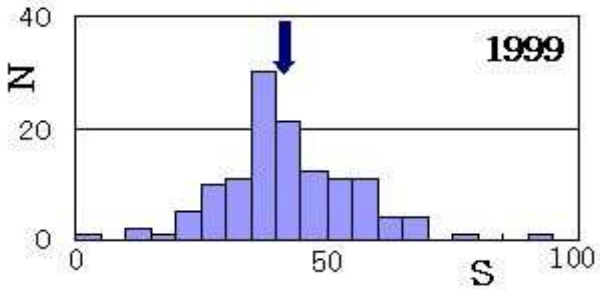

Figure 1: Score distribution 1999

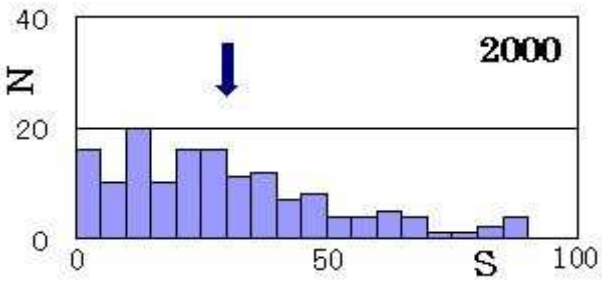

Figure 2: Score distribution 2000

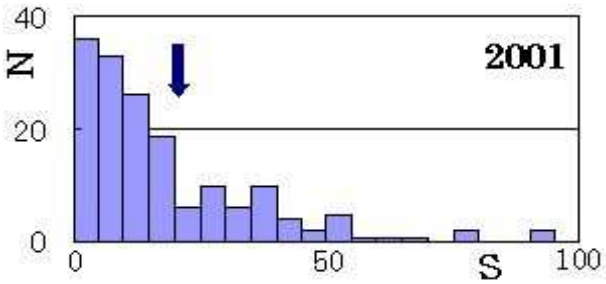

Figure 3: Score distribution 2001

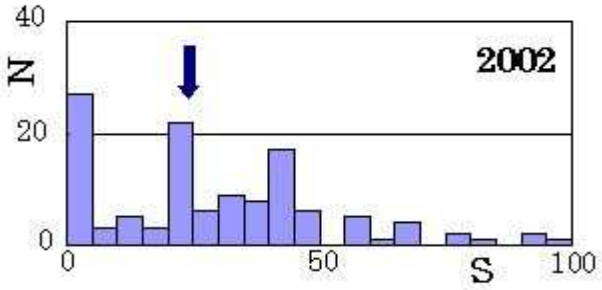

Figure 4: Score distribution 2002

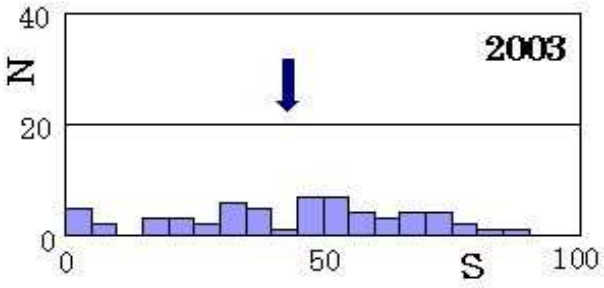

Figure 5: Score distribution 2003

In the next year, 2001, the students entirely knew the number of failed students in the preceding year 2000. They more and more stopped working hard. The students' score distribution became more steep as depicted in Fig. 3. The mean values of the examinations decreased for about ten points every year in the period of 1999–2001, as shown in Table 1.

The author's examination questions had usually been to draw an indicated part from a given assembly drawing taken from his pedagogical life. The students' score distribution as depicted in Fig. 3 could not evaluate correctly the students' achievement. In the next year, 2002, the author changed reluctantly an examination question to a lower level; the goal was to check drawings [2]. However, the students' score distribution did not vary as depicted in Fig. 4. This revealed the fact that the students no more worked hard.

In the next year 2003, the subject Mechanical Design was changed from a compulsory to an optional course. The attendance dropped down to about 40% of the total number of students. The decision about the examination was returned again to the author. The examination question was to check given drawings. The students' score distribution, thereupon, became rather flat as depicted in Fig. 5.

4. Discussions

4.1. Number of failure and mean value

Students are always in dread to fail. More than about half of the students do not work hard if students cannot fail. Fig. 6 depicts the relation between the school year and the numbers S_m and N_f. The author had educated consistently construction of drawings in the classroom which had been far from widely employed tracing education in Japanese universities and given an examination question as mentioned in Chapter 3 until 2001.

The correlation coefficient between S_m and N_f was calculated as 0.986 for four years from 1998 to 2001. This value of the correlation coefficient is considered to be extremely high. However, this result is contrary to the practical sense. Further discussions were omitted because another professor was not interested in the contents of the author's lecture and was concerned only with the number of failed students. This was a peculiarity of the department.

However, the author concludes that a decrease of the number of failed students correctly results in an increase of students who do not work hard.

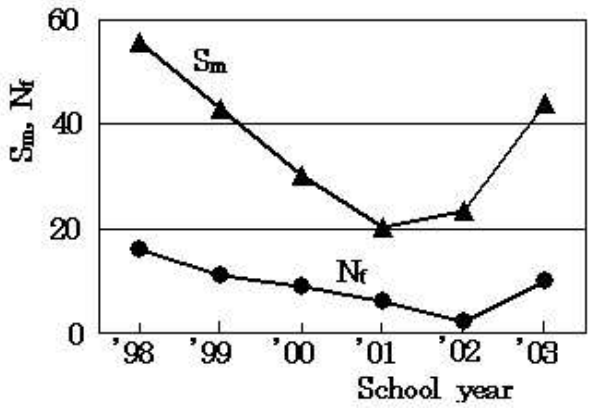

Figure 6: Change of S_m and N_f

4.2. Transition from compulsory to optional

Studying in an university is not a pastime but has the aim to get finally an income. The main courses in a mechanical engineering department must remain compulsory. The Ministry of Education in Japan has forced universities to reduce the compulsory courses in a curriculum.

The Tokyo University of Science followed the Ministry of Education. Table 2 shows the history of decreasing credit for the Mechanical Design course in the department. In spite of decreasing credit, the author has been firm in his mind to keep the level of education in the subject Mechanical Design. The efforts had ended in smoke when the decision about the examination was shifted to another professor as depicted in Fig. 6.

The subject Mechanical Design was changed again back to the author's charge by an optional course in 2003. The number of students in the author's charge decreased to 60 as shown in Table 1. The author considered that these students worked hard except 10 students who failed. The students' score distribution, however, became roughly flat as depicted in Fig. 5. The standard deviation on Fig. 5 was calculated as 20.9. On the other hand, all values of the standard deviation during 27 years before 1999 were less than 10. The author now has no data to explain the difference between them.

A more precise discussion on students' score distributions will be possible when referring to results after 2004.

Table 2: History of reduction of credit

Year	*Course*	*Credit*	*Ratio*
$1966 \sim 1995$	Compulsory	4	1
$1996 \sim 2002$	do.	2	1/2
$2003 \sim$	do.	1	1/4

4.3. Homework

The students' score distribution, however, does not arrange like a normal distribution curve at one single trial, i.e., only one examination question. The author set the students homework every week.

We can find many mechanical products everywhere around us. The author believes that one of the best ways of education is to utilize them for education. A typical example of homework is *"Investigate the procedure of manufacturing any mechanical product which the students can see around them".*

A large number of mechanical products, goods and parts were selected by the students. One can imagine that plenty of time and knowledge is necessary to check their reports. The author returned many of those reports when he judged the contents of their reports to be insufficient or not enough and after the insufficient parts were clearly underlined by a red ball-point pen. Students were asked for resubmission of their reports next week. There is a limit to the author's knowledge so that he cannot check everything. The author took over some mechanical products selected by students and taught the corresponding procedure of manufacturing in the classroom during the following week. This was very important for the author.

4.4. Evaluation of score distribution

If professors set an easy examination question, almost all students will get full marks. On the contrary, a difficult examination question raises no marks. The best examination question is considered to be such that students' scores are arranged in a normal distribution.

An important matter to evaluate students' score distribution is considered to be a result of professors' sincere efforts on education. Design of mechanical products means to create and to apply knowledge obtained by practical experience. If Mechanical Design professors have no practical experience, they should not teach students. There are many such professors in Japan. One of the best methods to evaluate professors' educational abilities in the subject Mechanical Design is to evaluate the students' score distribution.

A normal distribution curve is ideal, but an obtained distribution curve may deviate from it. If this deviation is remarkable, the Mechanical Design professor must change his educational method into one which is appropriate for the students' level. In this sense the whole information can be deduced from the students' score distribution.

5. Conclusion

Some of the professor's educational abilities can be evaluated by his students' real score distribution. This is a work of vital importance for university professors.

The conclusions obtained are the following:

1. The whole information about the instruction can be derived from the students' score distribution.
2. The smaller the number of failed students, the more students do not work hard.
3. Key subjects in a curriculum must not be changed to optional courses.

References

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Received October 4, 2004; final form May 12, 2006