Diversity equality – Classifying groups of freshmen in engineering sciences

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Abstract

The results of a long-term study of the elementary mathematical skills of freshmen in engineering sciences are: The mathematical abilities of the freshmen depend on the type of the previous school education. Those groups of freshmen who have been identified in the previous studies as the weakest have become still weaker. The positive effect of the bridging course was shown more clearly than in the earlier studies. Suggestions for improvement of equal opportunities are: The university has to bear in mind that the students differ in their learning attitude and learning ability according to their educational / personal background. These groups are identified with this long-term study to give consideration to the diversity of the students. The support of the students should individually be adapted to the identified special groups. The observed results reflect the situation in Germany and especially in Berlin.

Introduction

At the beginning of the Winter Term in 2010/2011 elementary mathematical skills of freshmen in engineering sciences have been tested. The long-term study started in 1995 and has been repeated every five years with the same questionnaire. The results are evaluated with respect to four aspects: type of previous school, gender, participation at the offered previous bridging course and, in the actual study, also migration background. The university has to bear in mind that the students differ in their learning attitude and learning ability according to their educational / personal background. These groups are to be identified to give consideration to the diversity of the students and to gain enough information to install student tandems across the special groups.

Test Setup

The questionnaire consists of seven groups of over all 27 exercises. All tasks had to be carried out without the use of a pocket calculator. If required, appropriate approximate values were given. The students have 90 minutes to work with the test. Each single exercise is marked discretely by 0 point or 1 point, so the maximum of points which can be achieved is 27. The students remain anonymous. The test requires only mathematical knowledge that has been taught up until the 10th year of school. The test was performed in the first week of study for all freshmen of the Beuth University. The number of participants in the test was 1138 on the last occasion.

General overview

Figure 1 shows the results of the last three tests in 2000, 2005, and 2010. It shows the percentage of the participants over the points achieved. In 2010 nearly 70% of the participants failed at a level of 40% of the maximum points, in 2000 only 60% failed. The 40% level of points (11 points) is marked by the vertical line. There is a dramatic

change in the proportion of all participants who failed totally (zero or one points out of 27 points); this has increased from 4% (year 2000) over 7% (2005) to 11% in 2010.

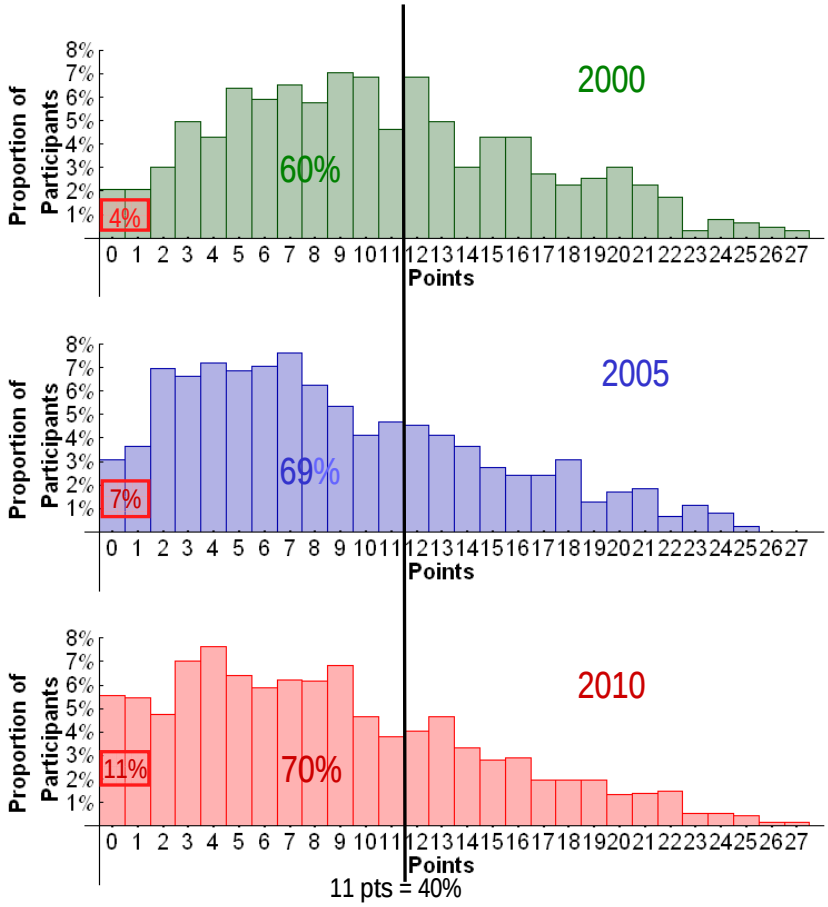

Figure 1 Percentage of the participants over the points achieved

Influence of the previous school education

In Germany there are different ways to meet the entrance requirements of the Universities of Applied Sciences: Students after 12 years of school (the so-called "Fachoberschule", below marked by "F") and after 13 years of school (the so-called "Gymnasium", below marked by "G"). The students who have 12 years of school are again separated in to two subgroups: the first subgroup consists of students who have done an apprenticeship of two or three years (below marked by "F1"), the second subgroup has been continuously in school for 12 years without an apprenticeship in between (below marked by "F2"). In Germany there is also an alternative entry pathway into university without a higher school education. That is an aim of politicians and society. What is required is a basic school education followed by an apprenticeship and several years with work experience in an appropriate job (below marked by "job"). The study proves that the mathematical abilities of the freshmen depend on the type of the previous school education.

First we take a closer look at the groups “G” and “F” who have a higher school education (Figure 2).

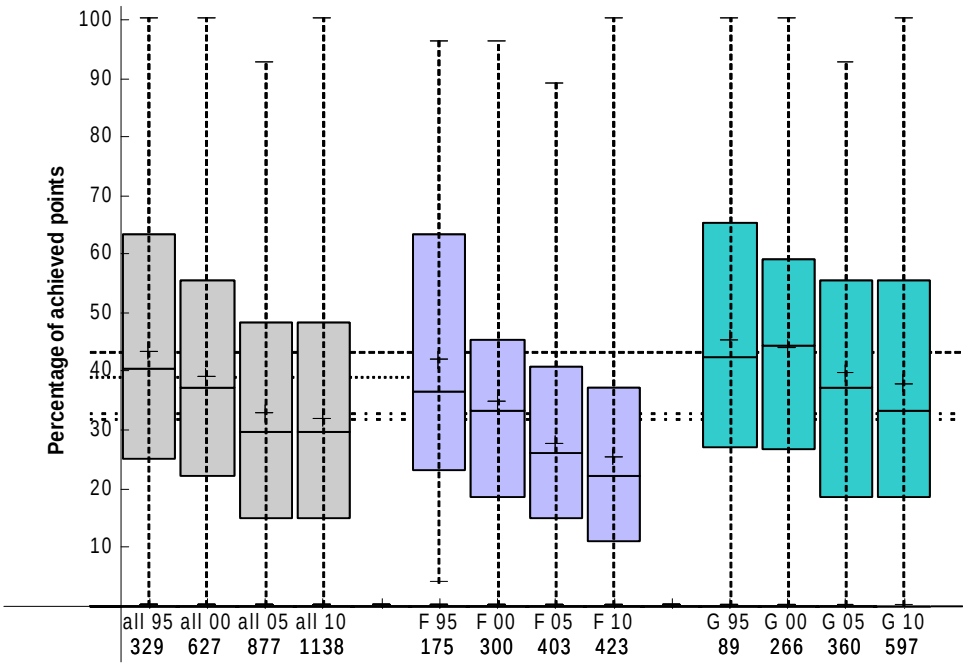

Figure 2 University entrants of the years 1995, 2000, 2005 and 2010, comparison of ‘Fachoberschule’ (F) and ‘Gymnasium’ (G)

In Figure 2 the results of the university entrants of the years 1995, 2000, 2005 and 2010 are compared by box plots. It shows the proportion of the achieved points in percentages for different years and different groups. The size of each population is given in the last line. The four boxes at the left show the results of all participants: the results of 2010 are worse than 15 years earlier. The mean value, indicated by a cross, dropped from 43% to 32%, and there is also a significant decline in the 75% mark by 15 percentage points. However, the dramatic decline seems to have stopped, considering the values in the years 2005 and 2010. The group ‘Gymnasium’ (G, the four boxes at the right) has a similar performance but on a slightly higher level. However the group ‘Fachoberschule’ (F, four boxes in the middle) is still decreasing over the whole period. Furthermore the level of the group ‘Fachoberschule’ is significantly lower than the level of the group ‘Gymnasium’.

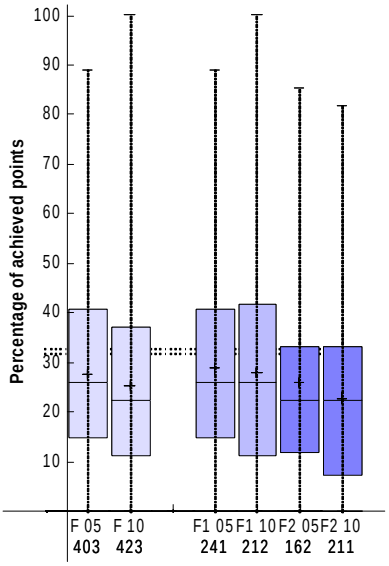

Figure 3 Comparison of the subgroups F1 and F2

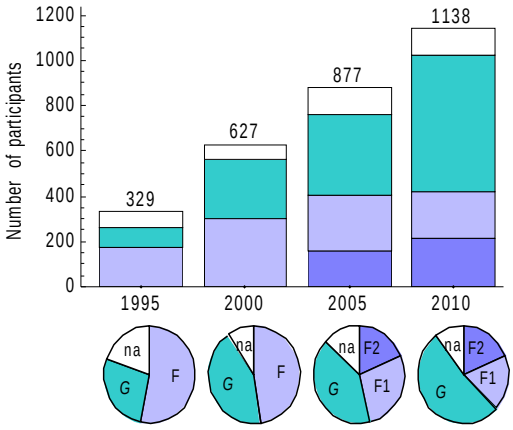

Figure 4 Population of the groups and subgroups (na = no answer)

Figure 3 takes a closer look at the group ‘Fachoberschule’ by considering also the subgroups F1 (with apprenticeship) and F2 (without apprenticeship) in the years 2005 and 2010. The results of the subgroup F2 (two boxes at most right) are significantly worse then those of subgroup F1 (two boxes in the middle). One realises that the subgroup F2 is responsible for the decline of the whole group F (two boxes on the left).

Also, the sizes of the populations of the groups and subgroups show a noticeable change over the time (see Figure 4). The number of participants in the test has clearly increased. The Beuth Hochschule specialises in engineering study programmes. In 1995 the number of engineering students in Germany was at a minimum level and is increasing since that time. Figure 4 mirrors this global development. The pie diagrams below show the most noticeable fact that the proportion of the group ‘Gymnasium’ has increased at the expense of the subgroup F1 (‘Fachoberschule’ with apprenticeship).

Those university entrants without higher school education have worked several years on the job before entering the university. Therefore two special problems are combined: the low mathematical background and the lack of practice in studying theoretical subjects. However this group is known for its high self-motivation. At the moment this group still is very small. This group unsurprisingly showed the lowest scores (see Figure 5 below). The bridging course has nearly no effect for the group because their mathematics level is so low. Student tandems can be useful which means that a student without higher school education individually gets his personal student assistant, a buddy, who is from a gymnasium.

Influence of personal distinguishing marks

The data of the test have been evaluated with respect to migration background, gender, and participation at the bridging course.

Due to political and social discussions the feature of migration background came into the focus. So only in the study 2010 data with respect to this feature have been collected by the question “Do you have a (perhaps second) not German mother tongue?”. In Berlin there is high proportion of people, especially young people, with migration background. The majority of those have (grand) parents who came from Turkey and the Middle East, so they have Turkish and Arabic backgrounds. Other groups from Russia and the Far East do not dominate.

The median of the achieved points is 22% for this migration group compared to 33% for those without migration background (i.e. only German mother tongue) (see Figure 5 below, MiY = Migration Yes, MiN = Migration No). This significant difference is a challenge for the universities in the near future.

In the study 2010 male students have slightly better scores than females (see Figure 5 below). This difference between male and female has also been observed in the previous studies. The mean differs by 5 % points - a score of 34% for the men and 29% for the women.

The Beuth University offers a mathematical bridging course in a compact form eight days before the beginning of the lectures. The participation in the bridging course reflects the individual attitude to exert oneself for learning. Low scores in the test correspond with a low participation proportion in the bridging course of that (sub)group. The lowest participation of 19% in the bridging course is shown by male migrants from F2 (Fachoberschule without apprenticeship). However for this group the effect of the bridging course has been the best. Within this group the mean score in the test differs by 19 % points, i.e. there is a score of 20% without bridging course and a score of 39% with bridging course. The highest participation of 54% in the bridging course is shown by female Germans from a gymnasium (G).

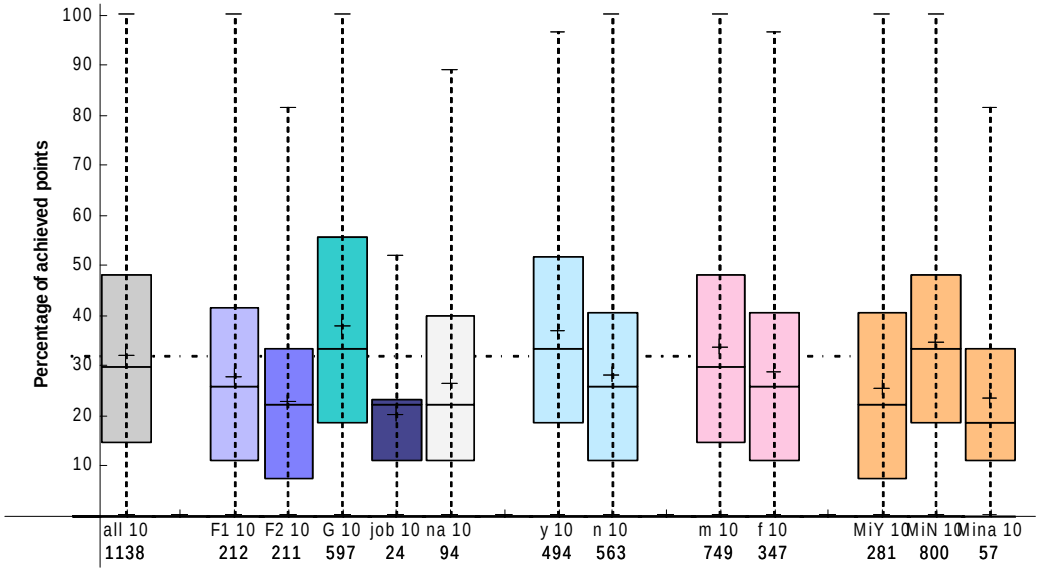

Figure 5 Overview of the scores of different groups (na = no answer)

In general the effect of bridging course has become clearer than in the previous studies. The mean score in the test differs by 8% points, i.e. there is a score of 29% without bridging course and 37% with bridging course (see Figure 5). Over the years the bridging course has been accepted more by the students; in 1995 only 36% of all participants in the test have shown up in the bridging course while in 2010 this percentage has increased to 43%.

Conclusion

The observed findings reflect the situation in Germany and especially in Berlin. In general freshmen from gymnasium (G) perform better than those from Fachoberschule (F), men perform better than women, and freshmen with German as their only mother tongue perform better than migrants. The average of the points achieved stopped decreasing at a low level. This stopping is due to the fact that the group F has become smaller in size and extremely weaker and that the best group G has become bigger in size. A closer look shows that the group identified in the previous studies as the weakest has become still weaker.

Suggestions for improvements of equal opportunities are: universities have to bear in mind that the students can be distinguished in different types according to their educational / personal background. These types have to be identified to give consideration to the diversity of the students. The support of the students has to be individually adapted to the identified special groups.

The best effect of support programmes is expected within the small group without higher school education because they have the lowest mathematical knowledge but the highest motivation. The biggest challenge is the group of migrants because some of them seem to be less motivated and seem not to realise their problems.

Support programmes like bridging course are useful. In addition student tandems across the special groups should be installed.