DO MATH SKILLS IMPROVE WITH THE USE OF THE TI-89? A SCHOOL PROJECT REPORT

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In 1999 a project was launched in 8 of the 107 grammar schools in the German state of Thuringia to investigate the effects of using CAS technology in math education. Grammar schools allow students to go to university after successfully finishing grade 12.

For 3 consecutive years grade 10 students in these schools were given Texas Instruments TI-89 calculators for use in math courses (and examinations) over a period of 3 years (cf. Table 1).

	grade 10	grade 11	grade 12
1999	TI-89		
2000	TI-89	TI-89	
2001	TI-89	TI-89	TI-89
2002		TI-89	TI-89
2003			TI-89

Table 1: Calendar of School Project (test groups shaded)

In November 2000 and November 2001 assessments were carried out of all grade 11 students of the project schools and all grade 11 students of 6 (5) control schools (here, the use of calculators, etc. was not permitted).
In the study were students of the basic course (BC) as well as of the advanced course (AC). All students have to attend at least one type of math course in every school year; only students with a particular interest in math opt for the more intensive advanced course instead of the basic one. Hence, students in AC are expected to perform better in a test because they are more interested in math than those in BC and are also taught more hours per week.

Two of the 8 project schools offer special classes in mathematics for the most talented math pupils in Thuringia who have to apply for acceptance in these classes. They are taught even more math hours per week than AC students in a normal grammar school. Unsurprisingly, there are no special classes at BC level.

It was decided to provide both special classes with TI-89 calculators. However, had one of them been in the project group and the other in the control group, it would have allowed a better comparison of the pupils' performances.

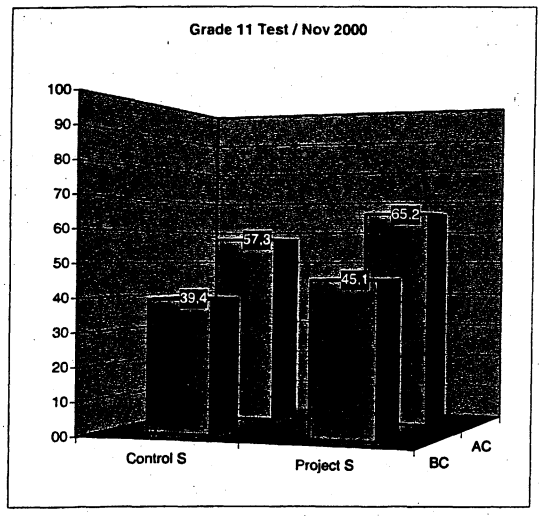

Fig. 1: Nov 2000 Assessment

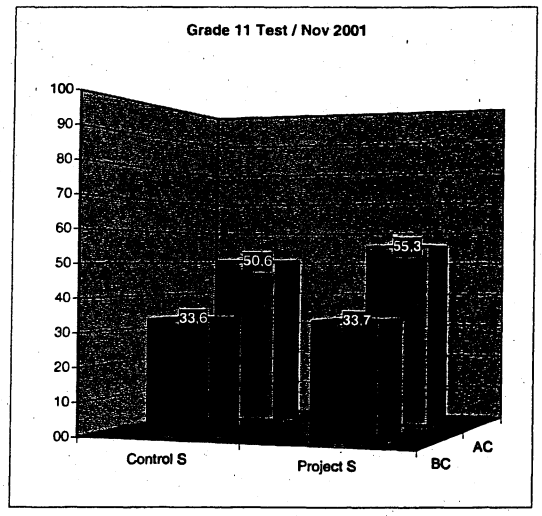

Fig. 2: Nov 2001 Assessment

Fig. 1 and 2 compare the percentage of points the students achieved in the assessments. Apart from the BC students in the November 2001 assessment, where no difference was found, project school students performed 5 to 8 percentage points better than pupils from a control school.

If we analyze the 2 special classes separately we get a somewhat different picture.

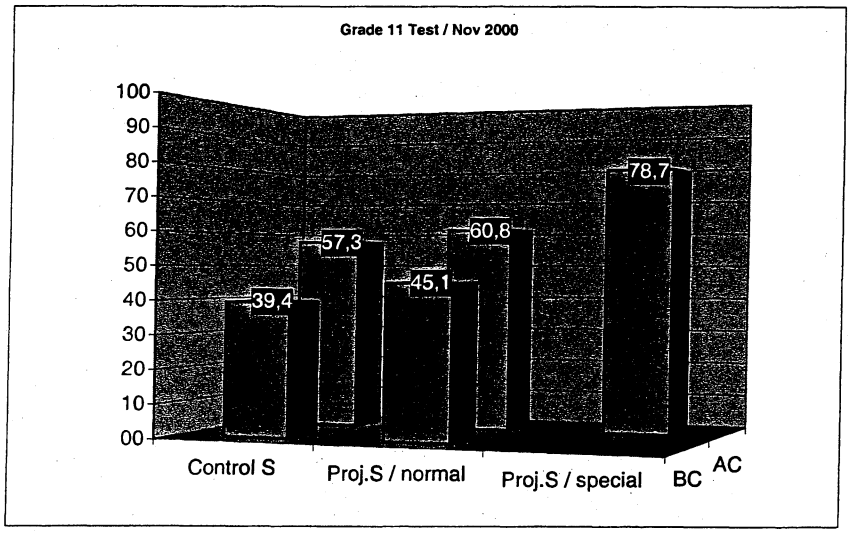

Fig. 3: Nov 2000 Assessment (special classes separated)

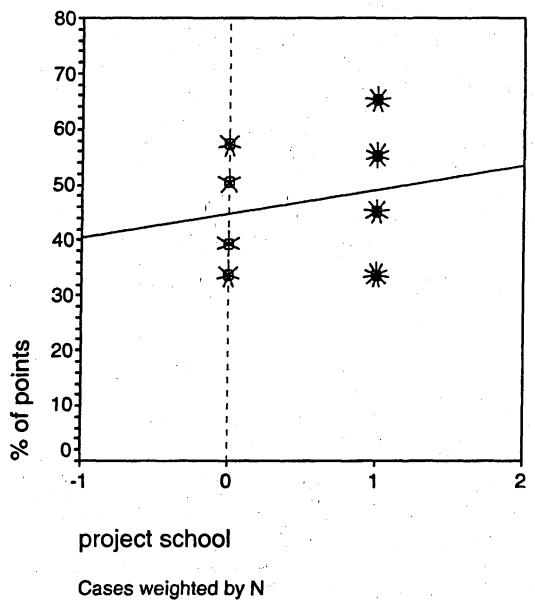

Fig. 5: POP vs. PS-dummy (both assessments pooled)

If we add another dummy variable reflecting whether a student is in AC or BC, we get

$$POP = 35.5 + \underset{(16.6)}{3.94}PS + \underset{(85.9)}{20.0}AC \qquad \left(R^2 = .83\right)$$

Here, a control school student in BC is expected to achieve 36% of the total points in the test. A student in AC is expected to get 20 percentage points more and a project school student (regardless of whether in BC or AC) 4 percentage points.

Also taking into account if a student is in a special class (SC) we find

$$POP = 36.9 + \underset{(6.59)}{1.62}PS + \underset{(69.4)}{17.0}AC + \underset{(41.6)}{20.2}SC \qquad \left(R^2 = .86\right)$$

While a BC student from a control school is expected to achieve 37% of the total points, students in AC are expected to get 17 percentage points more, students from a project school (regardless of which class they attend) another 2 percentage points and those in a special class a further 20 percentage points, i.e. a project school student in a special class is expected to get 76% of the total points.

Finally, some results from a survey of all students in grades 11 and 12 of the project schools are presented. This survey was carried out in August 2001 to find out their opinions about the use of the TI-89 in math education. 846 pupils participated in this survey. In the questionnaire the students had to give their opinion on 8 statements concerning the use of the TI-89 by making marks on a scale from "1 = definitely true" to "6 = definitely not true".

Again, only aggregated data was available.

From Fig. 6 it is evident that students particularly liked being able to work faster, and to have more possibilities to check results, when using the TI-89. On the other hand, the TI-89 was not so strong in terms of avoiding mistakes, and not so much used in other lessons, according to the students' opinions. No mean value was greater than 2.81 (and this for the statement "I like math lessons", the only non-TI-89-related statement) and hence rather positive, keeping in mind that the scale runs from 1 to 6.

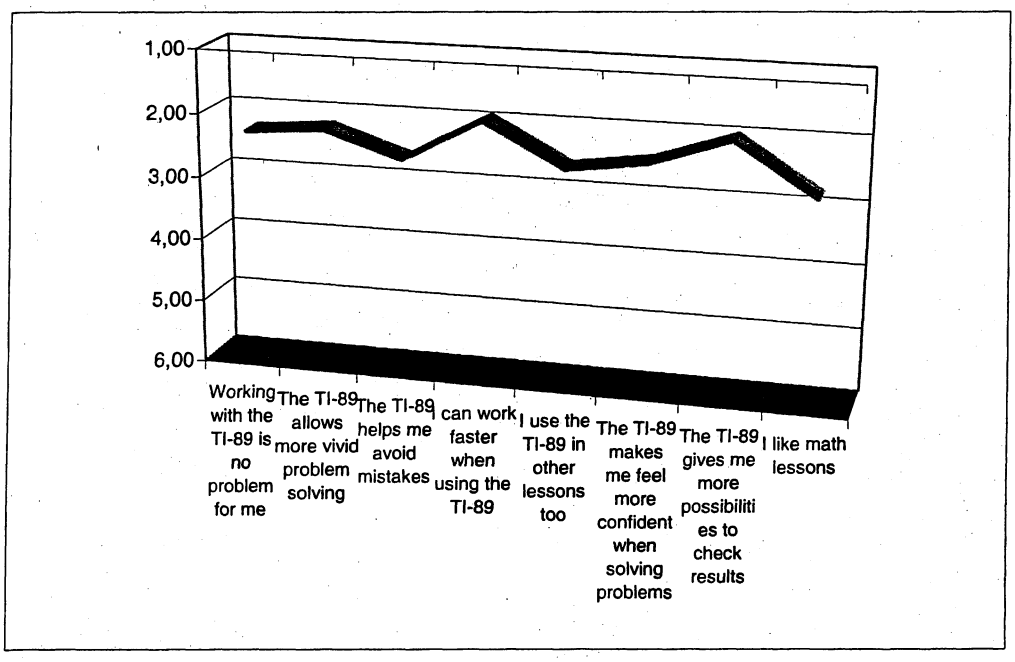

Fig. 6: Mean Values of Student Marks ($N = 846$)
(on a scale from "1 = definitely true" to "6 = definitely not true")

At the end of the questionnaire the students were asked to agree or disagree with the statement "If given the choice I would decide in favor of lessons with the TI-89". 86% answered "Yes" – a pretty strong decision in favor of the use of technology in math education by students who have used it for up to two years.

It was decided to carry out the survey again in November 2002, this time making the original data available for investigation in order to analyze how the sex of the student or his/her mark in math influences his/her attitude towards the use of technology in math education.

This paper is based on data made available by ThILLM (Thuringian Institute for Teacher Training, Curriculum Development and Media). I would like to thank Dr. Wolfgang Moldenhauer of ThILLM, who also provided additional information, for his support.

Fig. 3 shows that in the case of AC students the difference between normal project schools and control schools was no more than 3.5 percentage points while the special project schools were way ahead. (Remember that there are no special classes at BC level.)

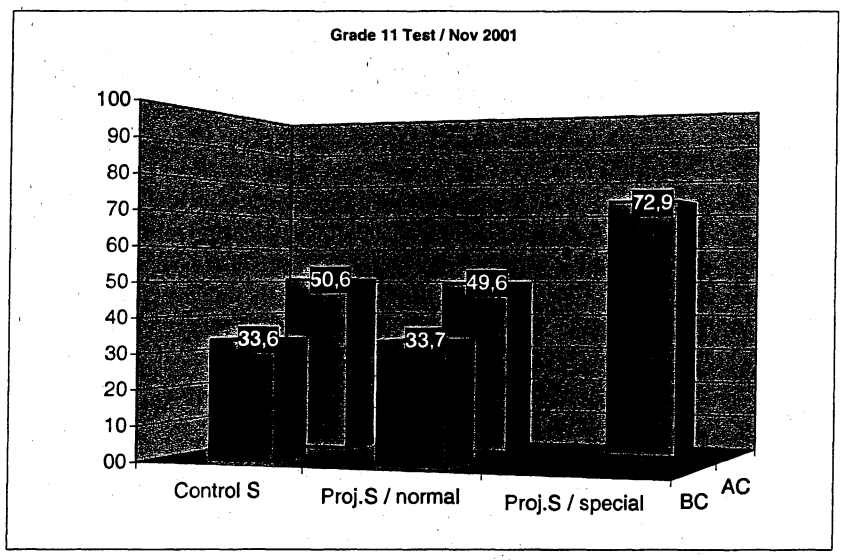

Fig. 4: Nov 2001 Assessment (special classes separated)

In the November 2001 test there was virtually no difference between control schools and normal project schools, with the special classes way ahead again (cf. Fig. 4).

We now want to try to predict the performance of students from different schools by applying Linear Regression Analysis to the data. We start with a scatterplot (Fig. 5) of the percentage of points (POP) a student got, depending on whether he or she is in a project school (PS) or not (coded as a dummy variable: 1 = student attends project school, 0 = student attends control school).
Since only aggregated data was available the plot contains only a few different points. However, each point represents quite a few observations in the original data; each "petal" around a point stands for approximately 25 observations. The total number of observations is 1599: 787 from the Nov 2000 assessment, and 812 from the following year, i.e. for this analysis both assessments are pooled.

Fig. 5 also includes the straight line fitted by the following Linear Regression (t-values are given in parentheses below the respective estimated coefficients):

$$POP = 44.8 + \underset{(7.74)}{4.36}PS \qquad \left(R^2 = .04\right)$$

According to this result, a control school student is expected to achieve 45% of the total points in the test and a project school student 49%.