AN EXPERIMENT IN PRE-COLLEGE CALCULUS REFORM IN FRANCE

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The French have a long history of teaching Calculus at the Pre-College level dating back to the early 1900's. It's first calculus curriculum was introduced in France in 1903 by Poincare, Borel, Hadamard, and some other prominent associates. It was implemented within the year. (It helped that Poincare had a relative who was the current Prime Minister.) They proposed the presentation of a rigorous Calculus starting in the 8^{th} grade and continuing through the 10^{th} grade (in France the 8^{th} to 10^{th} grades are referred to as the Lycee). All students took the first Calculus course. Other mathematically necessary topics where either covered previous to 8^{th} grade or were integrated into the Calculus courses. The authors of the curriculum suggested that the "very small number arguments" (delta-epsilon arguments) be left out due to the maturity of the students at that age. The difficulty level remained relatively constant (moderate) until the 1970's when the Burbaki plan (rigorous) was implemented. (The French curriculum is State controlled and thus the country always has a specific Calculus curriculum.)

The Burbaki plan began to be formulated in the late 1930's due to a cry from the mathematics community to increase the level of competency of the graduates entering the University (starting in 11^{th} grade) to study the sciences. However, due to a lack of relatives obtaining the role of Prime Minister and other reasons related to the inertia of the status-quo, the Burbaki plan was not implemented until the early 1970's.

This more rigorous style, what we would see in a science-curriculum collegiate Calculus course, created an environment of hostility toward mathematics at the Lycee level. The problem was that while the elite students were benefiting from this curriculum (and very likely the scientific community) the student population in the Lycee in general was struggling. In response, and due to recommendations from educational psychology based researchers and others in the mathematics preparation institutions in France (IREM), a technology-based, lower-rigor Calculus was introduced in the early 1980's.

This new Calculus involved such specifics as students recognizing the notion of a tangent by using a graphing calculator to plot several secant lines to a point on a curve and gradually increasing the nearness (decreasing the distance) to the point of interest. They would then complete a table of values and look for a pattern. The resulting value which the pattern approached was identified as the tangent of the curve at that point so long as they had became "close enough", which was discussed. The idea of limits is clearly suggested but not necessarily addressed in detail until later.

Due to the less rigorous nature of the curriculum a much higher number of French students were taking at least 2 years of Calculus before the end of Lycee (70%) than in the 1970's (percentage unknown). However, only 40% of all those entering University understood the basic analysis fact that $A-B < (1/n)$ for all n implies that $A = B$ They could see that there is a type of extreme closeness, but not the equality. Due to such problems, and the fac that even the advanced students were likely to fall prey to such errors, this program was recently dismissed.

Due to a variety of factors, there has been a movement in the United States to reform the calculus courses taught

to collegiate students. One of these factors is a high drop-out rate during and immediately after the first calculus course.

Several programs have been implemented in the U.S. at various institutions to try to remedy these problems. One major classroom factor which has been considered is the use of technology to enhance the learning experience.

While no-one is suggesting that we implement the type of program used by France at the Lycee level in the 1980's and 1990's, learning from successes and failures of others is a beneficial way to avoid similar detours on the path to improve the preparation of students in Calculus.

In fact, we see today at many institutions of learning in the U.S. that the Business Calculus course offered is very similar to the French lower-rigor version. On the other hand, we also see many rigorous Calculus courses taught with substantial use of technology in the course without any loss of rigor.

As we contemplate the destiny of the Calculus course sequence curriculum for our individual Institutions, it is valuable to have some knowledge of the success and failures of our counterparts, not only at other Institutions, but also in other countries and at other levels.

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