

Keystone Method: A Synergistic Model for Teaching and Learning

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Have you noticed how people with a talent for calculation are naturally quick at learning almost any other subject; and how training in it makes a slow mind quicker? (Plato, *The Republic*).

The Keystone method is a synergistic approach to teaching and learning of mathematics at the college. Drawing upon the research literature on learning educational psychology and causes of student failure in mathematics, this method focuses on the links between students' difficulties in mathematics and specific behaviors, attitudes, and habits that inhibit learning. These include short attention spans, limited time horizons, poor attendance patterns, passivity, failure to learn from errors, inattention to homework assignments, inattention to teacher's statements, and—underlying all—a lack of confidence and self-esteem.

How does the Keystone method address these difficulties? The key element is the continuous monitoring of the students' progress, paralleled with a set of teaching/learning strategies targeted to identified weaknesses. Carefully designed daily quizzes become an invaluable tool of communication between students and teacher. The instructor's preparation for each class session is informed by quiz results. That quizzes are administered at each class meeting improves class attendance and punctuality. That the quizzes are based on homework encourages the students to do their homework assignments for each class. This regimen eliminates the disconnected study spurts and cramming for the tests, encouraging regular study from the very beginning of the term—which soon becomes a "study habit."

Timed pressured quizzes focus students' attention and improves their concentration skills. Finally, the fact that quizzes are cumulative consolidates students' learning and enables them to integrate their knowledge of the topics covered in the course at all times. Computer scoring of quizzes provides statistical data such as the mean and standard deviation for the entire quiz as well as the item analysis of each question. The teacher not only receives a global view of the class performance overall, but also obtains the valuable information on students' performance on each question. The teacher provides immediate feedback, reviews the troublesome questions, and repeats them on the next quiz to encourage attainment of the mastery and learning from mistakes. By achieving a higher level of success each time, the student gets motivated to do better and becomes more self-reliant. Success of students improves their self-esteem.

Students in the Keystone classes are graded on an absolute rather than relative scale. There is no grading on curves and there is no quota for the number of A's and B's given. Each student is expected to attain a level of mastery, irrespective of other students' standing in the course. This is academically sound, as well as providing an additional incentive. In the absence of the curve, achievement of one student is not to the detriment of others. Thus, cooperation and collegiality are encouraged, reinforcing the fact that the mathematics class is a

shared learning community. This community aspect is critical when, as often happens, students in a class span a wide range of math aptitudes.

The Keystone method is a student-centered and versatile teaching approach. When the standard deviation of the quiz scores is high (more than 25%)—indicating a serious split in skill levels—the teacher moves from lecture to cooperative learning and peer tutoring. In such circumstances, weaker students are tutored by stronger students. The stronger students benefit in turn by reinforcing their own knowledge. Such peer learning experiences are especially effective at addressing student passivity.

The Keystone approach encourages attentiveness to the instructor's messages. For example, to encourage the study of particular topics often ignored by the students (word problems, for example), the instructor administers dedicated quizzes, e.g., consisting entirely of word problems. Students learn quickly, via a concrete and strong message, that even the topics cannot be placed in the forgetting bin. In short the Keystone approach creates a synergy among various pedagogical techniques parlaying these into a highly effective teaching program for improving student learning.

Highlights of the Past Results

The research we have compiled over the past ten years on the Keystone method has shown significantly improved outcomes in elementary, intermediate, and college algebra courses. The results were achieved with no losses to the retention rates. A surprising concomitant result of the Keystone method has been an improvement in students' reading comprehension scores as demonstrated in standardized norm-referenced tests. Beyond this, in studies comparing hundreds of students in Keystone classes vs. control classes, students in the Keystone classes have shown better persistence in mathematics classes, as well as at the college. We attribute these improvements not only to the above techniques, but to mathematics itself.

Learning mathematics necessarily hones students' thinking and concentration skills. As such, our experience confirms Plato's observation that training in mathematics sharpens the mind, broadly strengthening student performance, even in an unrelated subject such as reading.

Applicability to Other Disciplines

Even so, the principles of the Keystone program are not exclusive to the mathematics discipline. They can be applied to any other discipline whose students exhibit the behavior characteristics as described above. On our campus, for example, we have had positive results in regard to knowledge gain and pass rates of students in geography classes. The Keystone method may, therefore, also be regarded as a best practice model to improve teaching effectiveness and student learning across the entire curriculum.