

## **The Effectiveness of a Mathematics Review for Student Placement into College-Level Mathematics**

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### **Abstract**

At the University of Texas at El Paso (UTEP), a public university with an open admission policy, the majority of entering engineering and science students *initially* place into one of two developmental mathematics courses. Mathematics “refresher” sessions held during freshman orientation significantly increase mathematics placement exam scores and, as a result, place more students into college-level mathematics courses. Of the students who participated in the mathematics reviews in the summers of 2000, 2001, and 2002, 28 percent who initially placed into developmental mathematics improved upon their placement score enough to enroll in college-level mathematics (Pre-Calculus or Calculus I). This increase shifted the majority of the students into college-level mathematics. The performance of students who advanced into college-level courses was comparable to the performance of students who did not improve their scores after the review. Overall, 29 percent of all students who attended the mathematics review were able to advance at least one semester in the mathematics curricular sequence. The majority was successful in these courses, enabling them to enroll sooner in freshman science and engineering courses.

### **I. Introduction**

UTEP is the largest Mexican-American majority university in the nation. Given its mission to serve one of the poorest cities in country,<sup>1</sup> UTEP has adopted an inclusive, open admission policy, which has led to an acceptance rate of over 90 percent. As would be expected, the mean Scholastic Aptitude Test (SAT) score at UTEP is slightly lower than the national average. In 2001, the mean combined SAT score of the newly admitted student population at UTEP was 928 (464 verbal, 464 math) compared to the national average SAT score of 1020. Students enrolled in the Colleges of Engineering and Science achieved slightly higher scores than overall UTEP averages. Engineering students had a mean combined SAT score of 965 (458 verbal, 507 math),

and science students had a mean combined score of 960 (482 verbal, 478 math).<sup>2</sup>

Typically, the majority of UTEP entering science and engineering students do not initially place into college mathematics courses that count toward the university core requirements. This phenomenon is shared by many institutions nationwide, especially public institutions that have generous access policies. In 2001, the National Commission on the High School Senior Year reported that, on average, one-third of high school graduates are unprepared for college-level courses and must enroll in developmental courses.<sup>3</sup> The Commission attributes much of this problem to a combination of attitudes and behaviors of students, parents, teachers, and school administrators that may not view this critical year as a time to strengthen and enhance academic skills of students in preparation for college.<sup>3,4</sup>

At UTEP, other factors contribute to low placement scores. Many students at UTEP are first-generation college students and do not have a good understanding of what is necessary to be successful in college. Anecdotal evidence suggests that many students may not take the initial math placement test seriously because they simply do not understand the importance of placing high in the mathematics sequence. Unless they receive adequate guidance in high school, many students fail to see the relevance of mathematics to their degree completion and, consequently, may spend six to eight years pursuing a college degree.

However, the fact remains that acquiring mathematics skills is crucial for success in science and engineering. At UTEP, students cannot even begin to take for-credit engineering courses until they are eligible to enroll in Calculus I. Entering engineering students who place into developmental mathematics courses can, in a best-case scenario, expect to take Introduction to Engineering in their third semester, adding at least a year to their degree completion. Typically, students take university core courses in liberal arts, social science, and humanities while they are completing their mathematics prerequisites. The result is that many students who have enough credit hours to be considered sophomores have not even begun taking their freshman engineering courses. This situation was compounded in 2001 when the Texas legislature passed a new policy that penalizes students who have earned more than 170 college credit hours but have yet to complete a degree by having them pay out-of-state tuition.

In order to remedy some of the problems discussed above, a mathematics review program was implemented in 1998 and made a part of the Summer Orientation for all pre-science and pre-engineering students. The goal of this intervention was, and continues to be, to increase mathematics placement scores and increase the number of students who take college-level mathematics during their first semester.

## **II. Mathematics Placement Test**

Entering students are required to take a series of placement exams for preliminary mathematics placement. UTEP offers four math placement tests: Elementary Algebra, Intermediate Algebra, Functions and Graphs, and Tier 4 (T4). The Elementary Algebra, Intermediate Algebra and the Functions and Graphs tests are part of the Multiple Assessment Programs and Services (MAPS) battery developed by The College Board, the national non-profit association that developed the

SAT and Advanced Placement Exams. These tests were implemented at UTEP in 1998 for placement into mathematics courses.

The Elementary Algebra and Intermediate Algebra battery of tests assesses 11 basic competencies. The Functions and Graphs test was designed to assess students' preparedness for college-level mathematics. In addition to the MAPS tests, the Student Assessment & Testing office at UTEP administers the T4 test. The T4 test was designed by faculty in the UTEP Mathematics Department to assess students' preparedness for Calculus.

Each mathematics test has a time limit of 30 minutes. Calculators are not allowed. Entering students complete both the Elementary Algebra and Intermediate Algebra tests during a MAPS test session. Students who qualify to take the Functions and Graphs test and/or the T4 test attend an additional placement test session. Because there are only two forms per test, the retake policy for mathematics tests requires that students wait 120 days between retesting using the same form.

A scoring program calculates scaled scores based on the total number of correct answers. The Mathematics Department determines the course placement based on MAPS scores. The following table lists the cut-scores currently used to place students into mathematics courses.

**Table 1. Mathematics Course Placement**

**Elementary Algebra Test**

Scaled Score	Number Correct	Placement Score	Course Placement
601 – 612	0-23	1	Introductory Algebra
613 – 625	24-35	2	Intermediate Algebra

**Intermediate Algebra Test**

Scaled Score	Number Correct	Placement Score	Course Placement
701 – 713	0-19	2	Intermediate Algebra
714 – 725	20-30	3	Pre-Calculus or Qualifies for Functions & Graphs

**Functions & Graphs Test**

Scaled Score	Number Correct	Placement Score	Course Placement
401 – 411	0-14	3	Pre-Calculus
412 – 425	15 -30	4	Qualifies for T4

**T4 Test**

Scaled Score	Number Correct	Placement Score	Course Placement
	1-9	4	Pre-Calculus
	10-15	5	Calculus I

Entering students place into one of the following courses in the mathematics curricular sequence:

Mathematics 0310 (Introductory Algebra), Mathematics 0311 (Intermediate Algebra), Mathematics 1508 (Pre-Calculus), and Mathematics 1411 (Calculus). The course descriptions from the *2002-2004 Undergraduate Catalog* are as follows:

- MATH 0310 Introductory Algebra  
This course begins with a review of signed numbers, rational numbers, and exponents. Major topics include variables, linear equations and inequalities, word problems, and operations with polynomials. This course is designed as an introduction to MATH 0311. Credit hours received for MATH 0310 may count toward removal of provisional status, but may not be used to satisfy any institutional degree requirements.
- MATH 0311 Intermediate Algebra  
This course begins with a review of polynomials. Major topics include rational expressions and equations, radical expressions, rational exponents, complex numbers quadratic equations, graphing lines, and geometry. This course is designed as an introduction to MATH 1508. Credit hours received for MATH 0311 may count toward removal of provisional status, but may not be used to satisfy any institutional degree requirements.
- MATH 1508 Pre-Calculus  
Topics include the algebra of real functions, graphs of functions, analytic geometry of first and second degree curves, rational functions, exponential and logarithmic functions, and polynomial equations, sequences, series, and mathematical induction.
- MATH 1411 Calculus I  
Topics include limits, continuity, differentiation, and integration of functions of a single variable.

### **III. The Mathematics Review**

UTEP, with funding provided by the National Science Foundation's Model Institutions for Excellence (MIE) initiative, implemented an entering student program for pre-engineering and pre-science students in 1998. The Circles of Learning for Entering Students, or CircLES, program incorporates three intervention activities: a weeklong summer orientation, course clustering, and proactive advising and scheduling.

All first-time entering students attend a mandatory one-week orientation in the summer. In addition to participating in the general university orientation with all entering students, CircLES students also participate in engineering and science oriented sessions. Students have lunch with professors and staff and participate in a weeklong laboratory activity. On the final day, students register for classes with the assistance of coordinators who specialize in advising engineering and science students. At this time, students are put into course clusters based on their mathematics and English placement scores. The course clusters include a mathematics course, an English course, University Seminar, and a science or engineering course where applicable.<sup>5,6</sup>

The mathematics review is an integral part of orientation and is designed to refresh students' mathematics skills and to stress the importance of mathematics placement. The mathematics review consists of three two-hour sessions. The students are broken up into three groups of 20 to 25 students each, according to their initial placement on the mathematics placement test.

(Students are expected to take their placement tests prior to attending orientation). Two peer facilitators, upper division science or engineering students, supervise each group. Peer facilitators receive basic training in cooperative learning techniques and are involved in planning and teaching orientation activities.<sup>5</sup> Each entering student receives a 100-page booklet broken up into 13 sections (see Table 2) covering material on the placement tests. Each section includes a short explanation of the subjects covered and practice exercises. During the review session, the students work on solving exercises in groups of 4 to 5 students. The peer facilitators check the correctness of the students' solutions, give explanations if necessary, and keep track of timely progress within the groups. On the final day of orientation, students retake the placement test. The individual tests are scored before the students register, so that the students can register for the appropriate mathematics course.

Chapter 1.	Fractions
Chapter 2.	Percents, Ratios, and Proportions
Chapter 3.	Exponents and Scientific Notation
Chapter 4.	Linear Equations
Chapter 5.	Systems of Linear Equations
Chapter 6.	Inequalities and Absolute Value
Chapter 7.	Geometry
Chapter 8.	Rational Functions
Chapter 9.	Polynomials
Chapter 10.	Exponential and Logarithmic Functions
Chapter 11.	Trigonometry
Chapter 12.	Inverse Trigonometric Functions
Chapter 13.	Sample Test Questions

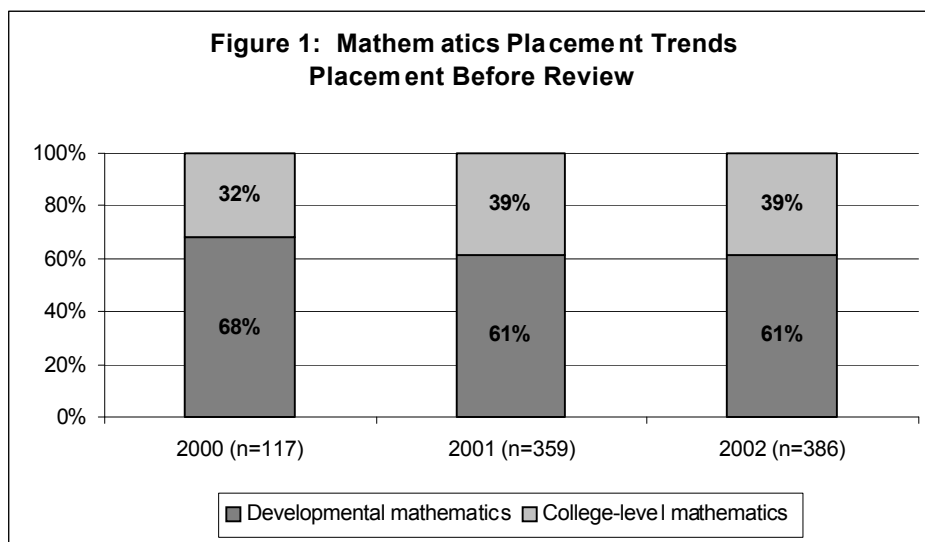
#### **IV. Impact**

The mathematics review at UTEP has been effective in increasing mathematics placement scores and increasing the number of students who enroll in college-level mathematics. A three-year data study of students, beginning in the summer of 2000, provides evidence that the summer mathematics review delivers the necessary mathematics refresher materials to enable the majority of science and engineering students to successfully enroll in college-level mathematics courses. In order to be included in this study, students had to take the placement exam only once before attending orientation or on the first day of orientation. Those not included either 1) chose not to take the exam a second time, 2) had already taken the exam twice before attending orientation, or 3) took the exam again later in the summer permitting other interventions to have occurred. Table 3 provides the number of students attending orientation as well as those included in the study. During the summer of 2000, a large number of test scores were reloaded into a new student information system (BANNER). Unfortunately, the actual test dates were lost in this transition. Only those students with valid test dates in the system were included, as to prevent other interventions from interfering with study results. This accounts for the large loss of students attending orientation but not included in the study.

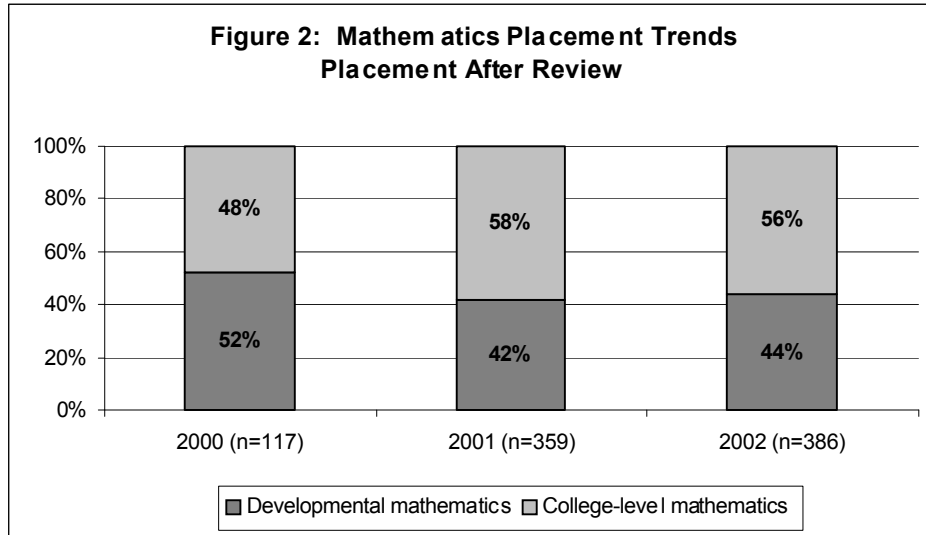
**Table 3. Students included in Mathematics Review Study**

	<b>2000</b>	<b>2001</b>	<b>2002</b>
<b>Attended Orientation</b>	495	495	482
<b>Included in study</b>	117	359	386

Figure 1 shows that the majority of entering students (between 61% and 68%) initially placed into developmental mathematics in the summers of 2000, 2001, and 2002.

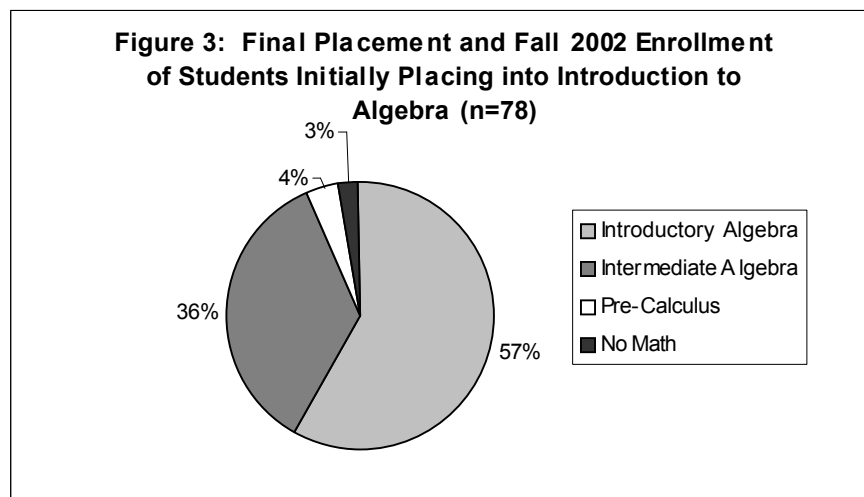


After students attended the mathematics review during summer orientation, there was a shift in the number of students placing into college-level mathematics. Almost a third (between 28% and 31%) of those who initially placed into developmental mathematics placed into college-level mathematics on the retake. By the summer of 2001, no longer were the majority of engineering and science students placing into developmental mathematics. (See Figure 2).



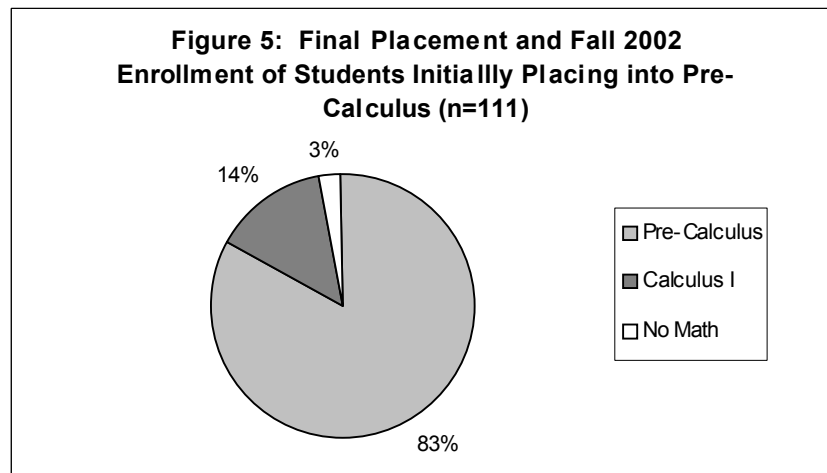
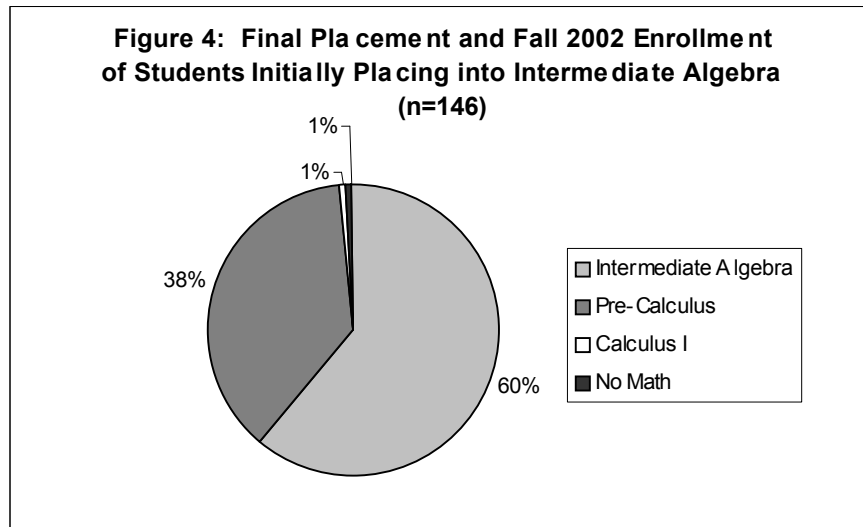
The following figures depict the final placement and enrollment of the students who participated in the mathematics review during the 2002 summer orientation. It should be mentioned that 51 of the students included in the 2002 data above enrolled in a higher-level mathematics course than they placed into and are, therefore, not included in the study.

A significant number of students who initially placed into Introductory Algebra performed better on the placement exam after the review and was able to move up at least one mathematics course. As seen in Figure 3, 36 percent moved up to Intermediate Algebra and 4 percent moved up to Pre-Calculus. While it is the policy of the CircLES program that students must enroll in mathematics courses during their first semester, a couple of students (3%) did not enroll in a mathematics course in the fall semester.



Figures 4 and 5 show the final placement and enrollment of students initially placing into Intermediate Algebra and Pre-Calculus. Of the 146 students who initially placed into Intermediate Algebra, 36 percent moved up to Pre-Calculus and 1 percent moved up to Calculus. Finally, 14

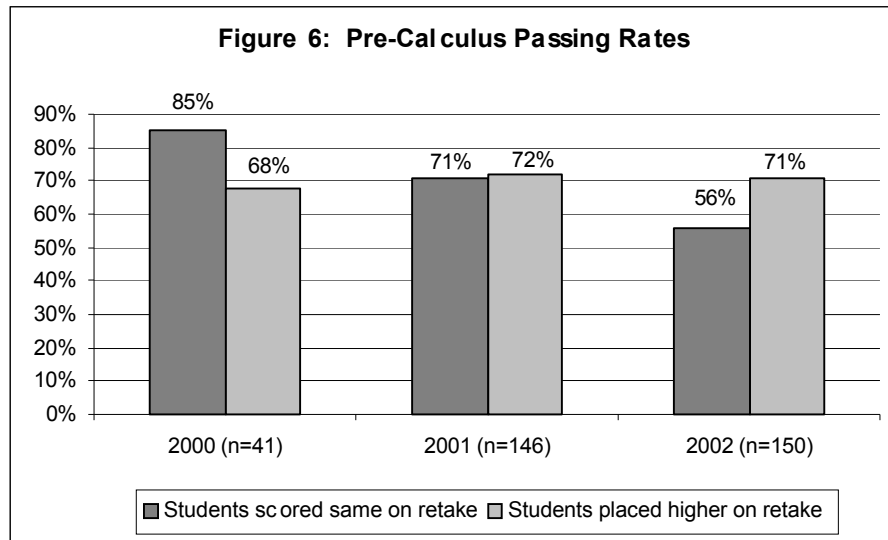
percent of those who initially placed into Pre-Calculus moved up to Calculus I. These results are consistent with results from previous years.



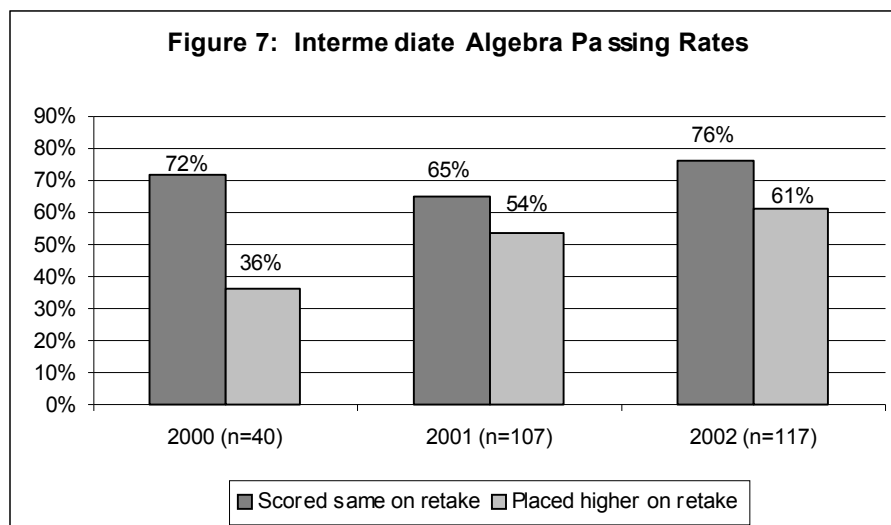
Of course, placing students in college-level courses does not guarantee that they will succeed in them. Are students better off after the review? The data show that between 88 and 100 percent of the students who placed into Calculus on the retake did pass the course with a C or better on their first attempt. The majority of students who placed into Pre-Calculus on the retake did pass the course. Figure 6 compares the passing rates of students who placed into Pre-Calculus on both attempts and those who placed into the course on the retake. In 2000, the students who placed into the course on the retake did not perform as well as their counterparts; however, by the fall of 2002, students placing into Pre-Calculus on the retake were actually passing the course at a higher rate than those who did not score higher on the retake. The Mathematics Department has focused much effort on the Pre-Calculus course in recent years. The course is a four-part modular course that utilizes cooperative learning strategies. Students have three opportunities to pass each of the four modules in order to pass the course; however, students who have not passed all modules by the end of the semester have a chance to finish during the winter break or the following semester.



This reform has improved overall passing rates in Pre-Calculus over the past few years.



In general, students placing higher on the retake, but still in developmental mathematics, do not perform as well as students who do not improve their scores on the retake. Over a third of the students who initially placed into Introduction to Algebra placed into Intermediate Algebra on the retake. Figure 7 shows that the passing rates for these students were lower; however, the passing rates seem to be improving with each year. (The sample size in the 2000 was small, which accounts for the significant deviation in the rates for that year.)



## V. Discussion

At UTEP, a review of only 6 hours was effective in placing almost a third of the students who attended the review into a higher-level course than they originally placed. In addition, 28 percent of those who initially placed into developmental mathematics scored high enough to enroll in college-level mathematics after the review. The students who placed into college-level mathematics after the mathematics review performed as well or better than the students who did not improve their scores. However, the students who moved from Introduction to Algebra to Intermediate Algebra did not perform as well as the students who initially placed into the Intermediate Algebra and were not able to place into the next level. This is an area of concern that is being addressed by the Mathematics Department.

The mathematics review developed at UTEP as a just-in-time intervention serves those students who are ready for college-level mathematics, but for a variety of reasons, do not perform well on the placement exam on their first attempt. In the end, more students are enrolling and succeeding in college-level mathematics. Therefore, they are spending less time in developmental courses and are able to enroll in for-credit engineering and science courses earlier.

### **Acknowledgment**

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