

**MATHEMATICS LITERACY  
(MARSHALL PLAN)**

**Ninth Year Summary**

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## I. BACKGROUND

The Marshall Plan dictates that all freshmen entering Marshall University must successfully complete a mathematics literacy requirement. The majority of the students satisfy this requirement with MTH 121, MTH 123, or MTH 127/130. In actuality, any mathematics course above intermediate algebra except MTH 400, MTH 401, and all 1-hour courses may be used. The course descriptions for all the courses from which students may select their mathematics literacy requirement are listed in Appendix A.

Since the inauguration of the Marshall Plan in Fall 1995, the Mathematics Department has made substantive changes in order to support the mathematics literacy requirement. In 1995 and 1996, courses were added or altered in order to better reflect the literacy learning outcomes. During 1997-98, the syllabi for all mathematics courses were reviewed and updated. The new syllabi reflect the increase in the use of technology for both class activities and outside projects. Graphing calculators are required and used extensively in the College Algebra and Calculus courses. Most faculty members require their students to complete *Mathematica* (a computer algebra program) computer projects in the Calculus courses. Additionally, four one-hour technology courses were introduced on the following topics: graphing calculators, Excel spreadsheets, *Mathematica* and LaTeX (a mathematical typesetting program). Students in the Integrated Science and Technology Program take a four course Analytical Methods sequence. In the first course, Analytical Methods I, students are trained to use Excel to organize and analyze data. In the second course, Analytical Methods II, the students are trained to use *Mathematica* to analyze applied calculus problems.

In 2000, the assessment instruments used to evaluate the effectiveness of the Marshall Plan mathematics courses were reexamined and the ineffectual ones were removed. In 2001 we added a Mid Level assessment tool designed to determine if the mathematics literacy requirement provides adequate preparation for the integrated science courses. This tool is essentially a comparison of students' grades in their required mathematics course to their grades in their subsequent ISC courses.

Because grades are influenced by so many factors that have nothing to do with student understanding, in 2004 another Mid Level assessment tool was developed and piloted. The tool is a written objective examination developed by the Mathematics Literacy Committee embedded in final exams for MTH 121. The results from the pilot of this test are part of this report. We continue to explore strategies that will more effectively ensure that students are enrolled in mathematics courses that will meet both their program and instructional needs. At present, the entry-level assessment instrument is limited to a student's ACT mathematics score. Unfortunately, with this instrument it is

possible for students to enroll in courses that are unsuitable for their major. In the last year we have been successful in restricting MTH 123 to the business majors for which it was designed. We hope that the considerable jump in useable grades that occurred in this course is representative of the improved learning environment that the change created.

## II. ENTRY LEVEL ASSESSMENT INSTRUMENTS

Course placement based on ACT Scores is the only entry-level assessment tool that the Mathematics Department currently has in place. Students are permitted to enroll in university or community college mathematics courses based on the following requirements:

- ◆ Enhanced ACT Mathematics Score: 00-15 must first take MAT 096 (CTC)  
 16-18 must first take MAT 097 (CTC)  
 19-36 must take MTH 121 or higher

As reported on the table below, 59.38% of incoming students in the last academic year are prepared to take college level mathematics courses. This continues the trend of a gradual increase in the number of 19+ scores since 1995.

### Distribution of ACT Math Scores and Course Placement

ACT Math Score Ranges	Course Placement	1998	1999	2000	2001	2002	2003
1-11	ASC 096	0.0 %	0.1%	0.2%	0.0%	0.0%	.06%
12-15	MAT 096	14.1%	12.5%	11.1%	8.8%	8.3%	8.75%
16-18	MAT 097	36.0%	37.0%	36.4%	35.4%	33.8%	31.8%
19+	MTH 121 or higher	49.7%	50.4%	52.3%	55.9%	57.9%	59.38%
Total Number		1645	1515	1543	1439	1600	1657

### III. MID LEVEL ASSESSMENT INSTRUMENTS

#### 1. *Usable Grade Chart*

A chart containing the percentages of usable grades (A, B, C, or Cr) for the courses most frequently used to satisfy the mathematics literacy requirement has been generated each year since 1997. This chart is shown below. The university goal is to meet or exceed a usable grade percentage equal to a **target value of 70%**. The percentage is based on enrollment at the conclusion of the withdrawal period after midterm.

In order to provide space for the current data the first two years of information are no longer included in the chart. During the two years that have been dropped from the chart all courses met or exceeded the target value except MTH 123, 127, 130, and 140. Each of these courses dropped below the target for a semester and then rebounded above 70%.

The primary course used to satisfy the mathematics literacy requirement for non math and science majors is MTH 121. This course has met and usually exceeded the target each semester except Spring 2003.

Many factors influence the grades that students earn. As a consequence these courses are examined for institutional reasons for a drop in useable grades when the courses stay below the target for more than a year. MTH 123 has recently benefited from such an examination. Currently college algebra (MTH 127, MTH 130) and trigonometry (MTH 122) are under scrutiny.

## Usable Grade Chart

(Percentage of students with usable grade after withdrawals during the following semesters )

Course	Fall 1999	Spring 2000	Fall 2000	Spring 2001	Fall 2001	Spring 2002	Fall 2002	Spring 2003	Fall 2003	Spring 2004
MTH121	80%	79%	79%	72%	71%	70%	76%	65%	75%	75%
MTH 122	84%	81%	76%	77%	54%	77%	66%	57%	59%	60%
MTH 123	68%	70%	72%	74%	67%	62%	60%	56%	58%	86%
MTH 127	59%	55%	72%	74%	67%	65%	53%	57%	60%	69%
MTH 130	79%	81%	85%	81%	81%	64%	68%	62%	68%	61%
MTH 132	86%	69%	55%	92%	72%	79%	68%	56%	70%	65%
MTH 140	82%	69%	76%	94%	56%	78%	77%	78%	78%	80%
MTH 225	89%	87%	83%	85%	80%	66%	64%	65%	71%	74%
MTH 229	84%	81%	81%	77%	87%	64%	74%	56%	69%	71%

### 2. *Embedded Final Exam Questions*

In 2004-2005 a new mid-level assessment was developed and piloted by the Mathematics Literacy Committee (authors of this report). Two batteries of eight questions were developed, each question in a set designed to measure whether a corresponding Learning Objectives was met (see p. 7). The committee members asked volunteers from the group of professors teaching MTH 121 to incorporate one set of eight questions into their final exam. The questions were written in an objective format and the volunteers were asked to return copies of the appropriate pages of their exams to the Chairman of the Math Literacy Committee. Eight sections of MTH 121 were tested in the fall semester and ten sections of MTH 121 were tested in the spring semester. The results are presented in the table that follows.

## Embedded Question Percentages

(Percentages of correct responses in selected sections of MTH 121.)

Learning Outcome	Criteria	% Correct
1) A	Ability to apply mathematics to a diverse set of real world problems.	38.10
C	Ability to apply and interpret statistical measures.	27.66
2) A	Ability to represent a mathematical situation in written, symbolic, graphic, and numeric form.	56.46
C	Ability to solve multi-step problems	76.42
3) A	Ability to write appropriate mathematical models.	72.11
E	Ability to acquire quantitative skills needed for subsequent college acquired.	39.91
4) B	Ability to discern significant patterns.	41.27
5) B	Ability to determine if an argument is sound and valid.	37.41

The new measure offers a uniform method for assessing whether each of the selected criteria were met across all sections of MTH 121 offered by the department. In 2003/2004 all students in the selected sections were tested and percentages for the combined data were calculated. Plans for application of this measure for the next academic year include the use of a random sample of test scores from all sections of MTH 121 taught in each of the fall and spring semesters.

The targeted percentage of correct responses for each of the designated learning objectives is **60**. For the pilot study, objectives 2C and 3A met or exceeded this targeted value and 2A was reasonably close to target. These questions measured the student's ability to solve multi-step problems, to create mathematical models, and to represent mathematical situations in a variety of different forms, respectively. The selected group of students struggled most with the questions testing knowledge of statistical measures and logic. This may indicate that these areas are not discussed in sufficient detail in MTH 121. Note that each of the targeted objectives has only one question to assess whether it has been met. The rationale for such a small battery of questions was the desire to make the assessment process as straight forward and as non-intrusive as possible for the classroom instructor.

## 2. Comparison of MTH 121 and 123 grades to ISC grades

The office of Institutional Research has provided us with grade data which cross tabulates usable grades (A, B or C) in MTH 121 and MTH 123 with all final grades including incompletes, (A, B, C, D, F, I, W), in sections of ISC from Spring, 1998, through Spring, 2004.

To simplify the data set we combined all the ISC sections into a single entity, which we labeled "All ISC." The combined numerical data is shown in the following table.

	MTH 121 A	MTH 121 B	MTH 121 C	MTH 123 A	MTH 123 B	MTH 123 C
ISC A	210	178	85	148	112	82
ISC B	106	209	152	87	132	148
ISC C	29	82	89	18	55	73
ISC D	9	18	25	3	10	25
ISC F	0	7	12	2	6	7
ISC I	1	2	3	0	0	1
ISC W	14	36	31	7	16	14
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Totals	369	532	397	265	331	350

### Grades in MTH 121 or 123 Compared to Grades in ISC Courses

This data represents 2244 students whose ISC grades are paired with their MTH grades. Of these, 1298 took MTH 121 and 946 took MTH 123. Among these 2244 students, 1995 (almost 89%) earned A, B or C in their ISC course.

Some features are notable in the table. In the two "A" MTH columns we can see that the most common ISC grade is an A. In fact, almost 56.5% of these students made an A in ISC. Furthermore, as we look downward in these two "A" columns, the ISC grades drop from A to F and the frequencies drop also. Of the 634 MTH "A" students, 598 (over 95.6%) earned usable grades in ISC, which excludes D, F, I and W. By any reasonable measure the "A" students in MTH seem to be extremely well prepared for ISC courses.

In the other four columns of the table -- among those students who earned a B or a C in their mathematics courses -- the ISC grades show a clear peak at the B level. These students seem most likely to earn a B in their subsequent ISC course. Among the 863 "B" students from MTH courses, 768 (about 89%) earned A, B or C in ISC. Among the 747 "C" students from MTH courses, 629 (over 84%) earned A, B or C in ISC.

Again this year we have taken the extra step of finding the correlation coefficient between the students' MTH grades (A, B and C, counted as 4, 3 or 2, respectively) and



the students' ISC grade (A – F, counted on the same 4-point scale). The correlation coefficient is about 0.286, a positive value that is considered to be *moderate*<sup>1</sup> since it is near 0.3. “A moderate correlation is large enough for laypersons to recognize.”<sup>2</sup>

According to David A. Kenny, whose textbook we cite in the footnotes, the correlation coefficient,  $r$ , can be related to a probability. In our case think of two students – one is a standard deviation above the mean in the mathematics course and the other is a standard deviation below the mean in that course. These students are separated by two standard deviations. Specifically, the correlation coefficient,  $r$ , is related to the probability that the better math student will score higher in ISC than does the other student.<sup>3</sup> Using interpolation on Kenny's table on page 115, with  $r = 0.286$ , we arrive at a probability of 0.667 that the better math student will prevail over the weaker one in a [later] ISC course. That is two chances out of three for the better math student to be the better ISC student.

Our correlation coefficient is showing some positive linear association between the MTH grades and the ISC grades, but no correlation coefficient is sufficient to show causality between the sets of grades. Nevertheless, we have over 2000 pairs of grades, earned over a six-year span, from diverse collections of faculty from mathematics and from the “bench” sciences. We feel that this is strong evidence supporting consistency of the “math literacy” and “integrated science” programs.

This data is summarized graphically in three colored charts. The first has three frequency polygons showing the numbers of students with an A (blue) in either MTH course, a B (yellow) in either MTH course or a C (green) in either MTH course. The second keeps the same color scheme for the three MTH letter grades, but it separates the MTH 121 students (bold line) from those in MTH 123 (thin line). The second chart expresses the data as percentages of the total enrollment in MTH 121 or in MTH 123, as appropriate.

Grades are influenced by other concerns besides a student's understanding of course material. As a result, we believe that a reasonable target value for “success” is to achieve all of the following:

- 85% of those with an A in MTH 121 or MTH 123 should earn at least a C in their ISC. In fact, over 94% of these students earned at least a C.
- 80% of those with a B in MTH 121 or MTH 123 should earn at least a C in their ISC. In fact, almost 90% of these students earned at least a C.

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<sup>1</sup> Kenny, David A., *Statistics for the Social and Behavioral Sciences*, Little, Brown and Co., Boston, 1987, p 112 ff.

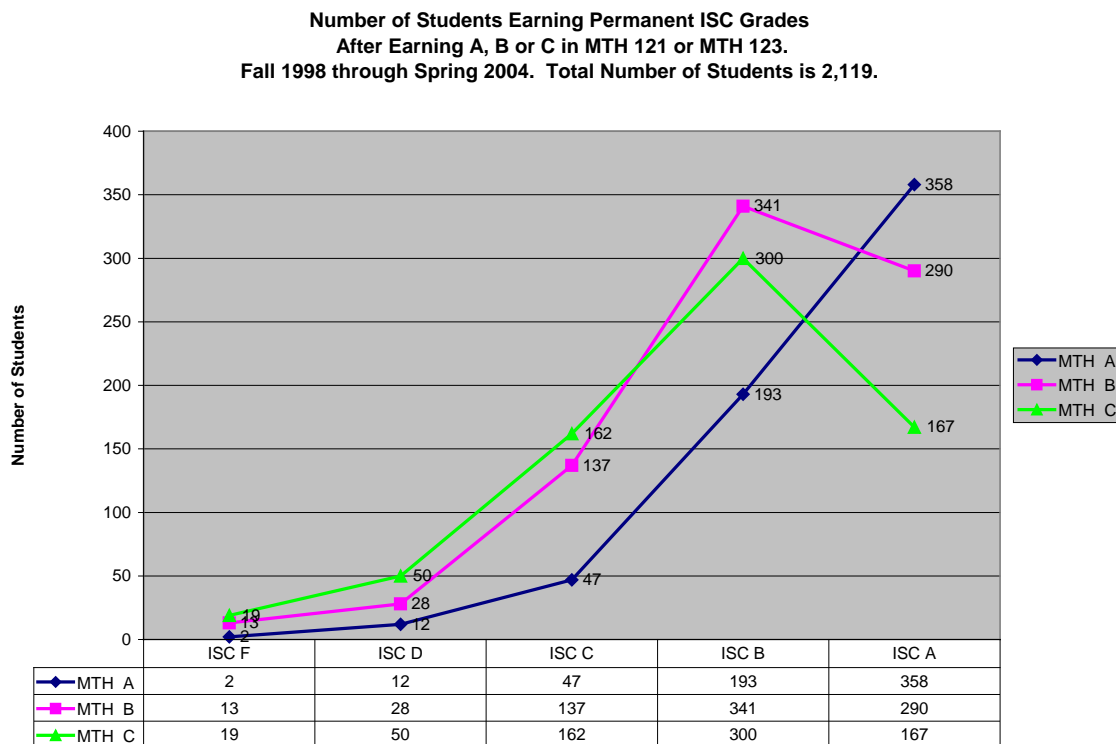
<sup>2</sup> Ibid. p 112

<sup>3</sup> Ibid. pp 114 and 115.

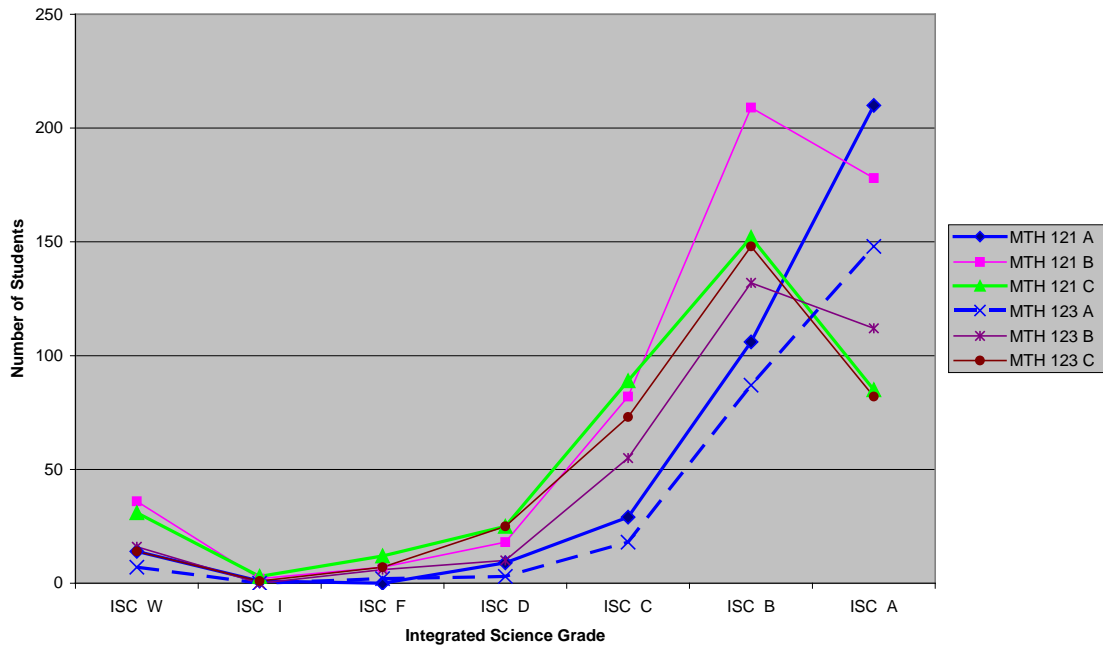
- 75% of those with a C in MTH 121 or MTH 123 should earn at least a C in their ISC. In fact, over 84% of these students earned at least a C.
- Note that over 72% of all of these students earned an ISC grade that equaled or exceeded their MTH grade.

The second chart separates MTH 121 and MTH 123. It shows that each of the two courses produces excellent preparation for ISC, and that the preparation results are remarkably similar to one another.

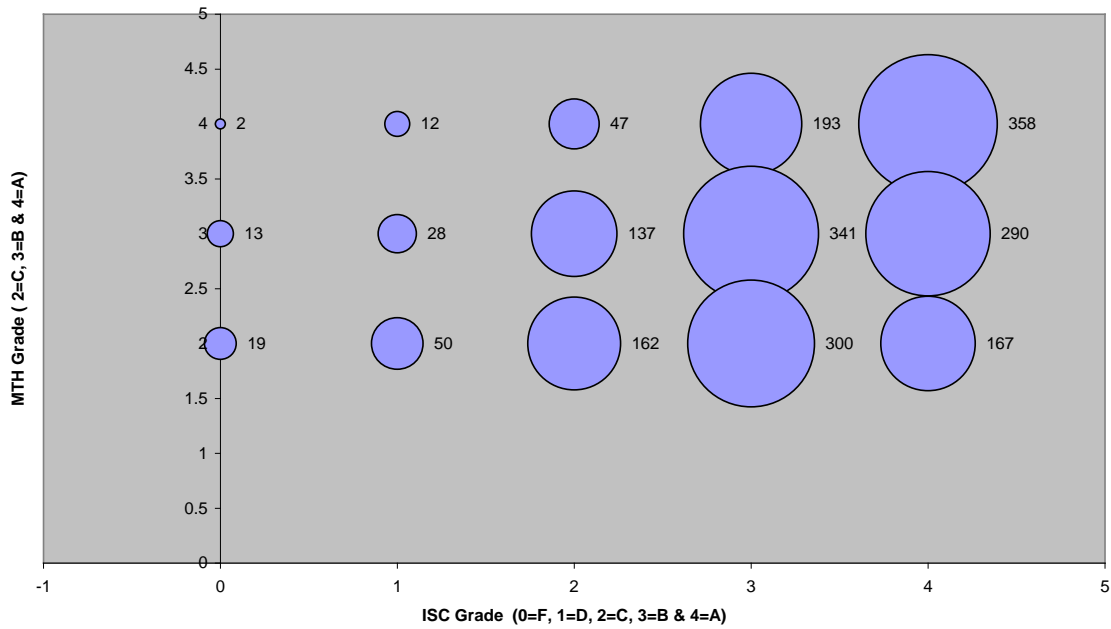
The third chart is a bubble-plot for the pairs of MTH 121 and ISC grades. There are only 15 paired data values onto which are placed 1141 students who have taken MTH 121 and an ISC course. Each of the 15 data points has a frequency greater than 1. The area of each bubble indicates that frequency.



**Student Performance in ISC Courses Graphed by Performance in MTH 121 or MTH 123. Fall, 1998 – Spring, 2004. 2244 Students Shown.**



**Grade Distribution for Selected ISC Courses for Students Who Earned A, B, or C in MTH 121 and/or MTH 123. Fall, 1998 – Spring, 2004. 2,119 students represented. Correlation coefficient is 0.286. Bubble area counts repeated grade pairs.**



#### IV. EXIT LEVEL ASSESSMENT INSTRUMENTS

##### 1. *The Academic Profile*

In compliance with the Board of Trustees Initiative 2, the Mathematics Literacy Committee selected a nationally normed competency exam to test the general education mathematics skills of students at Marshall University. The test we selected was the short form of the *Academic Profile* by ETS.

The *Academic Profile* test was first administered to ISC students at Marshall in the academic year 1998-99. These results were summarized in previous reports from this committee. During the last 4 years, the test was administered to a random sample of Marshall students from ISC courses and mathematics courses. Mathematics courses were chosen to ensure COS students were represented in the sample.

These students had already completed their mathematics literacy requirement. The Marshall University target was to achieve 95% of the national average. For AY 2000 and 2001, the MU student average on the mathematics portion was 115, which is right on the national average. For the next two years, the MU student average score have dropped slightly below 115 but above 95% of this value. The collected data from the previous four years appears on the table below.

**Skills Dimension Sub-Scores\***

<b>Mathematics</b>	<b>Scores, Fall 2000 394 Student Responses</b>		<b>Scores, AY 2001 417 Student Responses</b>		<b>Scores, AY 2002 583 Student Responses</b>		<b>Scores, AY 2003 637 Student Responses</b>	
<b>Marshall University Group</b>	Min. Score	108	Min. Score	108	Min. Score	108	Min. Score	108
	Max. Score	122	Max. Score	122	Max. Score	122	Max. Score	122
	Avg. Score	115.2	Avg. Score	115.1	Avg. Score	113.6	Avg. Score	112.91
<b>Total Group</b>	Min. Score	100	Min. Score	100	Min. Score	100	Min. Score	100
	Max. Score	130	Max. Score	130	Max. Score	130	Max. Score	130
	Avg. Score	115	Avg. Score	115	Avg. Score	115	Avg. Score	115

**\*Norm-referenced Scores:** Norm-referenced scores derive their meaning only from comparison with other scores: scores of other students, scores of the same students at different time periods, or scores from other colleges and universities. The scale scores reported above are norm-referenced. Score comparisons may be made over time. MU has 2 years for comparison

In order to track performance of Marshall students internally, we have included the chart below. The following chart provides actual percentages of Marshall University student performances based on designated levels of competence.

Levels*	1999--2000 Academic Profile Actual Percentage at Each Level	2000--2001 Academic Profile Actual Percentage at Each Level	2001--2002 Academic Profile Actual Percentage at Each Level	2002--2003 Academic Profile Actual Percentage at Each Level	2003--2004 Academic Profile Actual Percentage at Each Level
Level 1 Not Reached	19%	20%	13%	26%	39%
At Least at Level 1	81%	80%	87%	64%	61%
At Least at Level 2	46%	44%	31%	26%	20%
At Least at Level 3	20%	19%	5%	5%	2%

\* **LEVEL 1:** A student at Level 1 demonstrates basic number sense and skills in arithmetic operations and relationships and in elementary geometry and measurement. A student at this level can read and interpret information from simple graphs or charts, can solve simple equations or evaluate expressions, and can solve simple and routine word problems.

**LEVEL 2:** In addition to performing successfully at Level 1, a student who is proficient at Level 2 also understands number systems, including order, magnitude, and relationship of integers, fractions, and decimals. A student at this level can solve moderately difficult equations and inequalities, can evaluate complex charts and graphs, and can apply reasoning, geometry, and measurement skills in solving moderately complex problems including word problems.

**LEVEL 3:** In addition to performing Level 1 and Level 2 skills successfully, students at Level 3 also can generalize and apply mathematical knowledge and skills in non-routine situations, and can demonstrate real comprehension of exponents, variables, geometry, and measurement. A student at this level can solve multi-step and non-routine problems involving a range of reasoning skills.

## 2. *Exit Questionnaire*

Questions 1, 4, and 15 on the Graduate Survey address basic knowledge in general education, effective use of mathematics, and critical thinking skills. The compiled results of the surveys for these questions starting with the Class of 1996 follow. Our target is to have the mean response to the questions regarding mathematics literacy within the Agree or Strongly Agree category. The total percentage of graduates that either agreed or strongly agreed with these selected statements, reported as the final entry at the bottom of each column, shows that the target was met in each case. The graduates that answered the survey expressed satisfaction with their general education (Question 1), 83.8% responding SA or A, and with their critical thinking skills (Question 15), 79.9% responding SA or A. Their perception of their ability to use mathematics effectively (Question 4) has a lower total SA and A percentage at 58.9. The committee will report these results to the mathematics faculty (particularly those teaching MTH 121) and discuss the types of applications discussed in the course as well as ways to increase the number of practical examples used to reinforce concepts. As in previous years, in this year more than 50% of the responses do fall in the Strongly Agree or Agree category for all three statements.

- ◆ **Question 4:** *While pursuing my degree at Marshall University I developed the ability to use mathematics effectively.*
  
- ◆ **Question 15:** *While pursuing my degree at Marshall University I developed critical thinking skills.*
  
- ◆ **Question 1:** *While pursuing my degree at Marshall University I acquired a basic knowledge in general education.*

Years/Categories	Scales	Class of 1996 N=430	Class of 1997** N=350	Class of 1998 N=350	Class of 1999 N=362	Class of 2000* N=291	Class of 2001 N=273	Class of 2002 N=330	Class of 2003 N=305
<b>I. Evaluation of Educational Experiences</b>		1100 Surveys	1100 Surveys	1200 Surveys	1200 Surveys	1200 Surveys	1200 Surveys	1200 Surveys	1500 Surveys
1. Acquired a basic knowledge in gen. Ed	SA Agree Neutral Disagree SD	137 32% 229 53% 52 12% 10 2% 2 1%	116 33% 170 49% 51 15% 7 2% 4 1%	135 38.9% 172 49.6% 35 10.1% 5 1.4%	139 38.6% 174 48.3% 35 9.7% 9 2.5% 3 0.8%	97 33.7% 157 54.5% 25 8.7% 7 2.4% 2 0.7%	85 31.4% 130 48.0% 34 12.6% 17 6.3% 5 1.9%	123 37.4% 167 50.8% 31 9.4% 5 1.5% 3 0.9%	112 37.1% 141 46.7% 31 10.3% 12 4.0% 5 1.7%
4. Developed ability to use mathematics effectively	SA Agree Neutral Disagree SD	65 15% 158 37% 72 17% 24 6% 6 1%	68 19% 135 39% 96 34% 33 9% 14 4%	68 19.5% 131 37.5% 106 30.4% 32 9.2% 12 3.4%	54 14.9% 157 43.4% 109 30.1% 33 9.1% 9 2.5%	45 15.6% 113 39.1% 86 29.8% 34 11.8% 11 3.8%	135 49.6% 92 33.8% 27 9.9% 12 4.4% 6 2.2%	66 20.1% 129 39.3% 101 30.8% 25 7.62% 7 2.1%	70 23.3% 107 35.6% 87 28.9% 28 9.3% 9 3.0%
15. Developed critical thinking skills	SA Agree Neutral Disagree SD	105 37% 132 47% 33 12% 9 3% 3 1%	117 33% 171 49% 41 12% 10 3% 10 3%	126 36.2% 173 49.7% 39 11.2% 8 2.3% 2 0.6%	116 32.2% 177 49.2% 48 13.3% 13 3.6% 6 1.7%	84 29.0% 151 52.1% 40 13.8% 11 3.8% 4 1.4%	50 18.5% 96 35.6% 82 30.4% 29 10.7% 13 4.8%	115 35.0% 164 49.9% 43 13.1% 4 1.2% 3 0.9%	112 37.0% 130 42.9% 44 14.5% 10 3.3% 7 2.3%

\* The number of surveys compiled is smaller for 2000 because the surveys for the Academic Year 2000 are for the Fall, 1999 and Spring, 2000 graduates only. Summer 2000 Graduates will be picked up with the Academic Year 2001. This change is being made to conform to the report data sent to Central Office.

\*\* The survey was revised for the Academic Year 1997 graduates to reflect the addition of the Marshall Plan component.

### 3. Professional Skills Tests (PPST and Praxis II)

The Pre-Professional Skills Test (PPST) is a national examination prepared by ETS that is taken by education majors prior to their formal admission to the teacher preparation program. Because of when the test is taken, for most students, the mathematics component of this test reflects students' mathematics experiences before entering Marshall University and their one Marshall Plan course. Prior to 2001 the data in the chart immediately below represents the percentage of Marshall students who passed the mathematics component of the PPST on the first attempt. After 2001 the data includes students who have taken the examination multiple times. When a state fails to have a certain minimum number of students taking the PPST, ETS does not furnish any state data. While state percentages are not available after 1999, national percentages have been included for 2002-2003. With the exception of 1998-1999, the Marshall passing rate for the PPST generally exceeds or is within reach of our goal of meeting or exceeding available state or national passing levels.

Year	MU Examinees	Percentage Passing	WV Examinees	Percentage Passing	National Examinees	Percentage Passing
2003-2004						
2002-2003	331	79%			117, 995	77%
2001-2002	179	67%				
2000-2001	176	83%				
1999-2000	192	81%				
1998-1999	136	53%	1224	86%		
1997-1998	196	78%	1620	77%		
1996-1997	160	72%	1371	74%		
1995-1996	No Data		1163	80%		
1994-1995	127	72%	1288	77%		

At the end of their program, mathematics education majors take another national examination called the Praxis II. Both the PPST and the Praxis II are prepared and graded by the Educational Testing Service (ETS). The students who are attempting to be certified at the 5-9 level take a different mathematics examination from those that seek certification at the 5-adult level. In 1999-2000, 100% of the 5-9 and 5-adult mathematics education majors passed the mathematics content specialization examination (Praxis II). From 2000-2003, thirty-one students have taken the 5-adult test and ten students have taken the 5-9 test. Of those students taking the 5-adult test, 7 failed. At the 5-9 level only one student failed the exam. The drop in the passing rate of 5-adult mathematics majors may reflect a change in the structure of the examination that occurred in 2001-2002.

## V. LEARNING OUTCOMES

A listing of Mathematics Literacy Goals (Learning Goals) can be found below. The Component/Outcome Chart for these is in Appendix C, page 17.

### 1. *Mathematics Literacy Goals or Learning Outcomes*

When students have completed their Mathematics Literacy GER experience they should be able to

- ◆ Think critically about quantitative issues.
- ◆ Write and read abstractions and their symbols, and represent a problem in alternate ways.
- ◆ Learn mathematical methods in order to recognize mathematical structure embedded in diverse contexts and write the appropriate mathematical model.
- ◆ Explain and present their quantitative reasoning so that they will be able to meet the challenges of a technological society.
- ◆ Understand the concepts of inductive and deductive reasoning sufficiently well to construct an effective argument using quantitative information.

## VI. CONCLUSIONS AND RECOMMENDATIONS

At Marshall University approximately **60%** of the incoming students are prepared to take a college-level course. The entry-level assessment, however, shows that this percentage has increased from **45.1%** to **59.38%** since 1995.

Because of variables like the mathematics background of our students when they start at the university, there will always be fluctuations in the percentage of usable grades (A, B, C, or Cr) from one semester to the next. This year all of the usable grade percentages are above **58%**. Most are higher than the percentage for the same course at the same time last year. The trigonometry and college algebra courses are not currently at or above the target value of **70%**. There has been some question that **70%** is unreasonably high for this set of courses and does not represent the percentage that would be found at any other university of comparable size. The Literacy Committee intends to investigate this claim.



Many variables are involved when it comes to comparing grades, in particular, individual grading procedures, and specific course content. For this reason the Mathematics Literacy Committee created the Mid-Level Assessment Tool described on page 5. Eight questions developed by the committee were embedded in the final exams of seven professors teaching MTH 121 who volunteered to help the committee with the pilot run. (The results are presented on page 7.) The results of the embedded questions paint a much different picture than the Usable Grade percentages. It is fairly clear that the students are weak in the areas of the use of statistical measures and logic. The committee will continue to fine tune this measure by searching for standardized tests with questions that will serve the purpose for this assessment tool. In addition, the committee will meet with the professors teaching MTH 121 and discuss the results of the assessment and possible ways of improving conceptual understanding, thus completing the assessment cycle with a feedback loop.

Because MTH 121 and MTH 123 are the courses most frequently used for the Marshall Plan mathematics requirement, they are the only two courses that we examined to see if the mathematics requirement provides adequate preparation for students' integrated science requirement. Students who complete MTH 121 or MTH 123 with a usable grade are likely to complete their ISC requirement with a usable grade. In fact, last year **85%** of the students with an A in either mathematics course, **80%** with a B, and **75%** with a C earned a usable grade in ISC. These percentages well exceed the target values. This assessment uses usable grades. The committee is discussing alternative approaches to this assessment that do not use course grades for the measure.

The Academic Profile by ETS is a nationally normed competency test. During the last four years the random sample of Marshall Students taken from ISC and mathematics courses has scored at or slightly below the national average.

The latest data from the exit questionnaire shows that **79.9%** of the students who answered the survey either "agreed" or "strongly agreed" that they developed critical thinking skills. This is an important point because the value of critical thinking skills extends across academic disciplines and careers paths. Last year almost **60%** of those responding to the survey felt they developed the ability to use mathematics effectively. The committee will bring this data to the attention of the mathematics faculty and discuss how this can be improved.

In 1998-1999 the format of the Professional Skills Test (PPST) was changed, and Marshall's passing rate dropped from **78%** to **53%**. The adjustment to the changes was certainly made because in the next year (1999-2000) **81%** of Marshall Students who took the exam passed. Since then the pass rate has stayed above or near **70%**. An additional complication of the new test is that the Mathematics Department no longer receives information about the type of questions that students answered incorrectly. Consequently, we have no way to determine if the drop is the result of students not

receiving instruction in new topics that are now included on the test. We will be in a better position to interpret this drop once we have both statewide data and local data from a subsequent year. From 2000-2003, thirty-one students took the 5-adult test with a **77.42%** passing rate. During this same period, ten students took the 5-9 test with a passing rate of 90%. The drop in the passing rate of students in 5-adult certification in mathematics may reflect a change in the structure of the examination that occurred in 2001-2002.

We use such a diverse set of assessment tools because we are attempting to determine if the mathematics requirement of the Marshall Plan meets the needs of students from a wide range of majors. For the majority of the courses considered, the usable grade percentages were not significantly below the targeted values. The relationships among the assessment tools and the corresponding student learning outcomes are summarized in Appendix C. The new assessment for MTH 121 will offer insight about whether the Learning Outcomes are being met independent of course grades.

The restriction of the entry-level assessment to the mathematics score on the ACT is still a source of concern. The committee continues to look for effective ways to augment the entry-level assessment tool. We are examining both the possibility of augmenting the ACT score with an additional placement test and the option of providing more detail about specific courses to the student advisors.

## APPENDIX A

### Course Descriptions for Entry Level Courses

**MTH 121 -- Concepts and Applications of Mathematics.** 3 hrs. A course for non-science majors that develops quantitative reasoning skills. Topics include logical thinking, problem solving, linear modeling, beginning statistics and probability, exponential and logarithmic modeling, financial and geometry concepts. (PR: MAT 097 or Mathematics ACT 19 or above)

**MTH 122 -- Trigonometry.** 3 hrs. A study of the trigonometric functions, graphs of the trigonometric functions, identities, equations, inverse trigonometric functions, vectors, complex numbers, and applications. (Pr or CR: MTH 127 or 123 or at least 21 on Mathematics ACT.)

**MTH 123 -- Selected Topics in College Algebra.** 3 hrs. Solve equations and inequalities, solve systems of linear equations, study of functions (including exponential and logarithmic functions), matrices, basic probability and statistics. Applications mostly in business and economics. (PR: MAT 097 or equivalent or Mathematics ACT at least 19)

**MTH 127 (formerly MTH 130E) -- College Algebra - Expanded Version.** 5 hrs. A brief but careful review of the main techniques of algebra. Polynomial, rational, exponential, and logarithmic functions. Graphs, systems of equations and inequalities, sequences. (PR: MAT 097 or Mathematics ACT 19 or 20)

**MTH 130 -- College Algebra.** 3 hrs. Polynomial, rational, exponential, and logarithmic functions. Graphs, systems of equations and inequalities, sequences. (PR: MTH 123 or at least 21 on Mathematics ACT)

**MTH 132 -- Precalculus with Science Applications.** 5 hrs. Polynomial, rational, exponential, logarithmic, and trigonometric functions. Graphs, vectors, systems of equations and inequalities, sequences. (PR: MTH 123 or at least 21 on Mathematics ACT)

**MTH 140 -- Applied Calculus.** 3 hrs. A brief survey of calculus including both differentiation and integration with applications. Not to be substituted for MTH 229 or MTH 203. (PR: 2 yrs. of high school algebra and at least 23 on Mathematics ACT, MTH 123)

**MTH 225 -- Introductory Statistics.** 3 hrs. Basic probability, descriptive statistics, fundamental statistical inference procedures involving estimation and hypothesis testing for a variety of situations with wide applications. (PR: Mathematics ACT 21 or MTH 123 or higher)

**MTH 229 -- Calculus with Analytic Geometry I.** 5 hrs. An introduction to analytic geometry. Limits, derivatives, and integrals of the elementary functions of one variable, including the transcendental functions. (PR: Mathematics ACT of 27 or above, or MTH 130 and MTH 122, or MTH 127 and MTH 122, or MTH 132)

## **APPENDIX B**

### **COURSE SECTIONS OFFERED**

Course	AY 94-95	AY 95-96	AY 96-97	AY 98-99	AY 98-99	AY 99-00	AY 00-01	AY 01-02	AY 02-03	AY 03-04
MAT 096	6	10	20	20	26	21	20	36	34	34
MAT 097*	27	42	46	51	58	52	53	50	66	63
MTH 110	23	5	3	0	0	0	0	0	0	0
MTH 120	47	21	14	3	0	0	0	0	0	0
MTH 121	0	24	30	33	48	43	47	45	47	47
MTH 123	0	8	13	20	34	35	36	39	38	31
MTH 127/130E	0	0	5	9	9	10	10	8	13	14
MTH 130	20	22	21	17	17	14	14	14	15	13
MTH 229	11	10	9	9	9	12	8	6	7	8
Total	134	142	161	162	201	187	188	188	220	0

- **The prerequisite ACT score for MTH 097 was changed from 12 to 14 in Fall 1995, and from 14 to 16 for Fall 1996**
- **Beginning in Fall 1997, one section of MAT 096V and one section of MAT 097V were offered as Internet courses.**
- **The data for AY 99-00 and AY 00-01 in Appendix B reflect the fall and spring course offerings only.**

## **APPENDIX C**

### **Criteria for Evaluating Student Outcomes**

Learning Outcomes	Criteria	Criteria Measures	Target	Evaluation	Conclusion
1) Think critically about quantitative issues.	A. Students are able to apply mathematics to a diverse set of real world problems.	A. Usable course grade in MTH 121, 123, 140 and 225 A. Embedded Questions.	A. 70%  A. 60%	A. Only MTH 123 sig. Below target for Fall A. Sig. below target	A. See p. 5
	B. Students believe that they have acquired sufficient information to make decisions on quantitative issues that confront them in their personal life.	B. Exit questionnaire	B. Mean within agree or strongly agree category	B. Target met	B. See p. 13
	C. Students are able to apply and interpret statistical measures.	C. Usable course grade in MTH 121, 123, and 225 C. Embedded Questions	C. 70%  C. 60%	C. . Only MTH 123 sig. below target for Fall C. Sig. below target	C. See p. 5
	D. Students are able to use a calculator and/ or a computer to explore quantitative processes and ideas.	D. Usable course grade in MTH 122, 123, 130, 127, 132, 229	D. 70%	D. MTH 122 is sig. Below target for both semesters. MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 are sig. below target for spring,	D. See p. 5
	E. Students are aware of historical and contemporary uses of mathematics for societal concerns.	E. Usable course grade in MTH 121	E. 70%	E. Target met	E. See p. 5
2) Write and read abstractions and their symbols, and represent a problem in alternate ways.	A. Students are able to represent a mathematical situation in written, symbolic, graphic, or numeric form.	A. Usable course grade MTH 121, 122, 123, 130, 127, 132, 140, 225, 229 A. Embedded Questions	A. 70%  A. 60%	A. MTH 122 is sig. Below target for both semesters. MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 are sig. below target for spring, A. Not sig. below target	A. See p. 5
	B. Students believe that they have acquired sufficient information to read and understand technically based materials.	B. Exit questionnaire	B. Mean within agree or strongly agree category	B. Target met	B. See p. 13
	C. Students are able to solve multi-step problems.	C. Usable course grade MTH 121, 122, 123, 130, 127, 132, 140, 225, 229	C. 70%	C. MTH 122 is sig. Below target for both semesters.	C. See p. 5

Learning Outcomes	Criteria	Criteria Measures	Target	Evaluation	Conclusion
		C. Embedded Questions	C. 60%	MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 are sig. below target for spring, C. Target Met	
3) Learn mathematical methods in order to recognize mathematical structure embedded in diverse contexts and write the appropriate mathematical model.	A. Students are able to write appropriate mathematical models	A. Usable course grade MTH 121, 122, 123, 130, 127, 132, 140, 225, 229  A. Embedded Questions	A. 70%  A. 60%	A. MTH 122 is sig. below target for both semesters. MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 sig. below target for spring, A. Target Met	A. See p. 5
	B. Students are able to recognize mathematical structure.	B. Usable course grade MTH 121, 123, 140, 229	B. 70%	B. Only MTH 123 sig. below target for Fall	B. See p.5
	C. Students achieve an adequate level of mastery of algebraic techniques.	C. Usable course grade MTH 121, 122, 123, 130, 127, 132, 140, 225, 229	C. 70%	C. MTH 122 sig. below target for both semesters. MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 sig. below target for spring,	C. See p.5
	D. Students achieve an adequate level of mastery of statistical techniques.	D. Usable course grade MTH 121, 123, or 225	D. 70%	D. Only MTH 123 sig. below target for Fall	D. See p.5
	E. Students acquire quantitative skills needed for subsequent college courses.	E. Comparison of MTH 121 and 123 to ISC grades  E. Embedded questions	E. 75% of the students making a C, 80% of the students making a B, and 85% of the students making an A in MTH 121 or MTH 123 make a usable grade in ISC  E. 60%	E. Target met  E. Sig. below target	E. See p. 6
4) Explain and present their quantitative reasoning so that they will be able to meet the challenges of a	A. Students can communicate quantitative ideas clearly	A. Exit questionnaire	A. Mean within agree or strongly agree category	A. Target met	A. See p. 13

Learning Outcomes	Criteria	Criteria Measures	Target	Evaluation	Conclusion
technological society.					
	B. Students can discern significant patterns	B. Usable course grade MTH 121, 122, 123, 130, 127, 132, 140, 225, 229  B. Embedded questions	B. 70%  B. 60%	B. MTH 122 sig. below target for both semesters. MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 sig. below target for spring, B. Sig. below target	B. See p.5
	C. Students can use problem-solving techniques in a wide variety of circumstances.	C. Usable course grade MTH 121, 122, 123, 130, 127, 132, 140, 225, 229	C. 70%	C. MTH 122 sig. below target for both semesters. MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 sig. below target for spring,	C. See p. 5
	D. Students believe that they have acquired the necessary quantitative skills to meet their individual career goals	D. Exit questionnaire	D. Mean within agree or strongly agree category	D. Target met	D. See p.13
5) Understand the concepts of inductive and deductive reasoning sufficiently well to construct an effective argument using quantitative information.	A. Students know the basic principles of logic.	A. Usable course grade MTH 121	A. 70%	A. Target met	A. See p.5
	B. Students can determine if an argument is sound and valid.	B. Usable course grade MTH 121 B. Embedded questions	B. 70% B. 60%	B. Target met. B. Sig. below target	B. See p.5
	C. Students can construct effective arguments using quantitative information	C. Usable course grade MTH 121, 122, 123, 130, 127, 132, 140, 225, 229	C. 70%	C. MTH 122 sig. below target for both semesters. MTH 123 and MTH 127 sig. Below for Fall. MTH 130 AND 132 sig. below target for spring,	C. See p.5