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A Study of the Level of Math Preparedness of Manufacturing Sciences Students in the Fall Semester of 2005

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Abstract

The main objective of this study was to gauge preparedness in math with achievement in first semester math for the fall 2005 intake of Manufacturing Sciences Division Post-Secondary program students. he data used to measure this level of preparedness was gleaned from students' high school grade 12 (new and old curriculum) or OAC math marks and the results of a diagnostic test given to students during the first week of the fall semester. In addition, success in first semester math was analyzed in relation to the specific high school math course taken. The results of this study demonstrate that high school math marks alone are a poor predictor of performance in first semester math. In addition, students emerging from the new curriculum grade 12 Math for College and Apprenticeship (MAP4C) failed first semester math at nearly three times the rate of all other course groupings combined. Conversely, students emerging from any of the University stream high school Grade 12 math courses or the College stream Math for Technology (MCT4C) were best prepared for college math in Manufacturing Sciences Division Post-Secondary programs. The diagnostic test marks were not a reliable predictor of individual student success (or "at risk" behaviour) in first semester. However, students falling into the fortieth percentile or lower groupings on the test showed a marked increase in tendency towards "at risk" behaviour or failure. Technician stream students as a group exhibited a failure rate that was double that of the technology stream group. It is recommended that the administration of the diagnostic test be continued by the college and that tracking of these indicators be carried out annually in order to monitor these trends. In addition it is recommended that students at the high school level are made aware of the need to take Grade 12 Math for Technology (MCT4C) as a minimum preparation for success in Manufacturing Sciences Division math courses. The questions raised in this study concerning differences in performance according to gender and stream warrant further study.

Acknowledgements

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May not music be described as the mathematics of the sense, mathematics as music of the reason? The musician feels mathematics, the mathematician thinks music: music the dream, mathematics the working life.

-- J.J. Sylvester --

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1.0 Introduction

1.1 Objectives and Scope

The subject of mathematics has long been considered an important indicator of potential student success in all levels of education. During the first week of the Fall 2005 term at Fanshawe College, a mathematics diagnostic test was administered to all math classes of technician and technology streams in the Manufacturing Sciences Division. The goal of this study was to find meaningful correlations between College first semester math grades and the marks students achieved on both the diagnostic test and in senior high school math courses. The results of this diagnostic test were correlated with students' fourth or fifth year high school math marks and first semester Fanshawe College math grades in an attempt to identify trends relating to student success in first semester math courses as well as other program courses (by GPA).

In addition, there have been significant changes to the Ontario high school mathematics curriculum. Data collection was carried out with a view to providing useful information towards the current curriculum revision which is being undertaken for all technician and technology programs within the Manufacturing Sciences Division.

No testing outside of the Manufacturing Sciences Division was carried out. The diagnostic test used was developed at Fanshawe College. Accordingly, no comparison with similar work carried out at other colleges was attempted.

1.2 Background

Performance in Mathematics and English has been viewed as an indicator of potential for student success in College. A smooth transition between high school Mathematics courses and first semester Fanshawe College Math courses had existed under the old curriculum. Previous to 2003, it was recommended that students entering technology programs at Fanshawe College have Grade 12 Advanced level Math (MAT4A) or better, and those technicians apply with Grade 12 General level Math (MTT4G) or better. Many students had also completed an additional (OAC) year.

The Ontario high school mathematics program revision process was initiated during the late 1990s with the implementation of new courses beginning in the fall term of 1999. The first group of students having taken new curriculum courses graduated from high school in 2003.

To date (2006), there have been two minor revisions of new curriculum math courses and pathways since 1999. The need to study the impact of these changes in the math curriculum and their effect on student success at College became apparent. As a result, academic tracking of first semester Manufacturing Sciences Division students was undertaken in the Fall of 2005.

Since 2003, students graduating from high school have been entering College with the new curriculum mathematics courses (see Table 1.1). The College is still in a transition period with respect to mathematics prerequisites due to the intake of mature students who have a variety of old curriculum mathematics courses (see Table 1.2).

Currently, far fewer students graduate from high school with Math for College Technology (MCT4C) than students with Math for College and Apprenticeship (MAP4C). As a result, most colleges, including Fanshawe College, have been accepting students with MAP4C as well as MCT4C (and higher level math courses).

At the moment, Fanshawe College and most other colleges specify MAP4C or MCT4C mathematics courses as the minimum requirement for acceptance into postsecondary technician and technology programs. The Fall 2005 intake for Manufacturing Sciences Division postsecondary programs was 386 students. Of this number, 278 students (72 % of the total intake group) entered with one or more of the new curriculum Grade 12 mathematics courses (includes both College and University stream courses). Of this subgroup, 196 students (51% of the total intake group) had one of either of the acceptable College stream courses.

First-year candidates entering Manufacturing Sciences Division postsecondary programs generally had one or more of the following: an old curriculum Grade 12 math course, a new curriculum Grade 12 math courses or an OAC math course. In studies involving correlations of a student’s high school math mark with other parameters, the best mark in any one of these courses was used.

The course in which the student achieved this mark was used in studies that involved a comparison of high school math courses. These courses are referred to throughout this report as "year 4/5" math courses.

Table 1.1 Course Code, Stream and Description of Grade 12 Math Courses from the Ontario High School Curriculum Post-2002

Course Code	Stream	Description
MCB4U	U	Calculus
MGA4U	U	Geometry and Discrete Mathematics
MDM4U	U	Data Management
MCT4C	C	Mathematics for Technology
MAP4C	C	Mathematics for College & Apprenticeship

Table 1.2 Course Code, Level and Description of Grade 12/OAC Math Courses from the Ontario High School Curriculum Pre-2002

Course Code	Level	Description
MAT4A	Grade 12	Advanced Math
MTT4G	Grade 12	General level Math
MAGOA	OAC	Algebra and Geometry
MCAOA	OAC	Calculus
MFNOA	OAC	Finite Mathematics

1.3 Testing and Data Gathering Procedures

1.3.1 Diagnostic Testing

Diagnostic tests were administered to students of all first semester math classes within technician and technology streams of the Manufacturing Sciences Division during the first week of classes in the Fall of 2005. Of the 386 students registered in Manufacturing Sciences Division postsecondary programs, 329 took the diagnostic test. The tests were given during a two-hour period and invigilated by math professors in the division during regular class time. The programs involved in the diagnostic testing along with the number of students from each program who wrote the test are given in Table 1.3 below.

Table 1.3 Programs Involved in Mathematics Diagnostic Testing, Fall 2005

Program Code	Program Name	Enrolment Fall 2005	First Semester Math Course
ECN41	Electronics Technician	28	Math 1133
ELN21	Electrical Technician	71	Math 1133
ENT11	Environmental Technology	40	Math 1054
ERN11	Controls Technician	19	Math 1133
ERY21	Electrical Eng. Technology	26	Math 1043
MED21	Mechanical Design Technician	37	Math 1049
MEN11	Manufacturing Technician	52	Math 1049
MME11	Mobile Equipment Technology	27	Math 1049
SLT11	Science Laboratory Technology	29	Math 1054

Each student was given two tests. The first of these tests (Part 1) dealt with basic arithmetic skills such as operations with integers, numeric fractions, decimals and percentages and associated simple word problems. Part 1 was completed without the aid of an electronic calculator. Students handed in Part 1 of the test upon completion and requested the second part. There was no time limit imposed for Part 1 of the diagnostic test.

The second test (Part 2) covered a wide range of algebra skills, word problems, geometry and trigonometry. An electronic calculator was allowed and recommended for Part 2 of the test. The two tests were colour coded to facilitate invigilation.

Students were given no prior notice of the administration of this test. Students were made aware at the beginning of the test that the results would be analyzed as part of a research project and that no credit towards a final first semester math grade would be derived from this test.

Test marks were compiled on Parts 1 and 2 separately, as well as a combined mark on both parts. Further, for the purpose of marking and analysis, the tests were subdivided by skill type. Part 1 of the test was subdivided into three sections or skill groupings while Part 2 was subdivided into 17 sections. Student marks on each of these sections were recorded and analyzed.

1.3.2 Additional Data

A substantial body of academic and demographic information was made available for analysis, upon request, from Fanshawe College's Institutional Research and Planning Department. The data from this source used in this study consisted of the following:

- all mathematics courses (identified by course code) ;
- taken by each student during high school and numeric marks (percentages);
- first semester Fanshawe College mathematics course and letter grade;
- first semester Program Grade Point Average (GPA);
- age and gender.

The acquisition of this data was approved by the Fanshawe College Research and Development Review Committee. All data was stored, processed and analyzed in accordance with Fanshawe College Policy 1-J-03.

2.0 Results

2.1 Diagnostic Test Results

Diagnostic tests were marked according to the following rubric. A single mark was awarded for problems which required a single skill for correct completion. In cases where a single mark was assigned, the answer had to be correct in every sense. Those questions requiring more work to answer were assigned a possible two mark score. No half marks were awarded.

2.1.1 Descriptive Statistics for Student Scores on Part 1 and 2 of the Diagnostic Test and the Combined Scores

Computations of descriptive statistics for the results of Parts 1 and 2 as well as the combined score were based on statistical methods for discrete data. However, the results are presented graphically in grouped form. Ranges of 10 marks were arbitrarily selected to best exhibit trends in the data on all three histograms of the frequency-score distributions.

Fig. 2.1a shows the sample group (n = 329) results on Part 1 of the diagnostic test. The frequency of students achieving scores within the stated mark ranges, out of a possible 66 marks, is plotted as a histogram against the mark ranges. The distribution is fairly normal, as expected (skewness = -0.040). The average mark on this test was 34.7 marks out of 66 or 52.6 %. The range and standard deviation for the group were 61 and 14.0 respectively.

Fig. 2.1b shows the group results on Part 2 of the diagnostic test. This distribution is clearly positively skewed (skewness = +1.308). The average mark, out of a possible 68 marks, was 16.4 or 24.2 %. The range and standard deviation for this distribution were 60 and 12.8 respectively. The combined results (of Parts 1 and 2) for the group are given in Fig. 2.1c. The average mark for the group on both tests was 51.2 marks out of a possible 134, or 38.1 %. The range and standard deviation of this distribution are 119 and 23.9 respectively. The results in Part 2 combined with those of Part 1 yields a skewed normal distribution for the group (skewness = +0.557).

Fig.2.1a

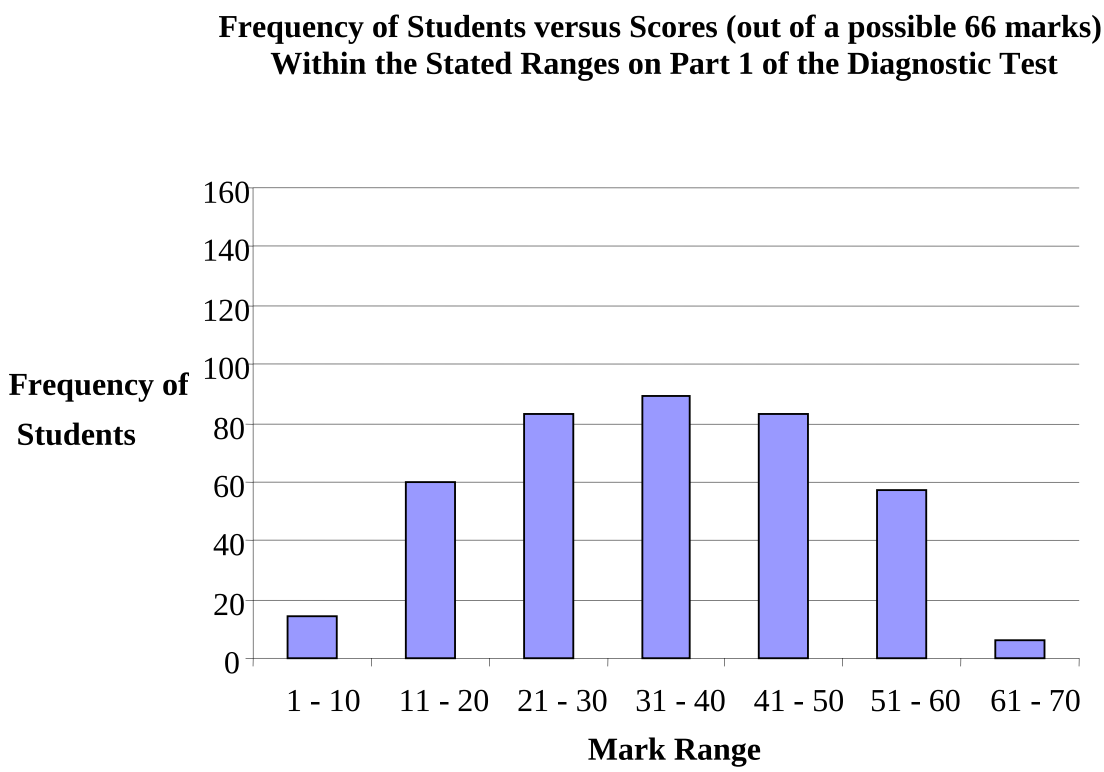


Fig.2.1b

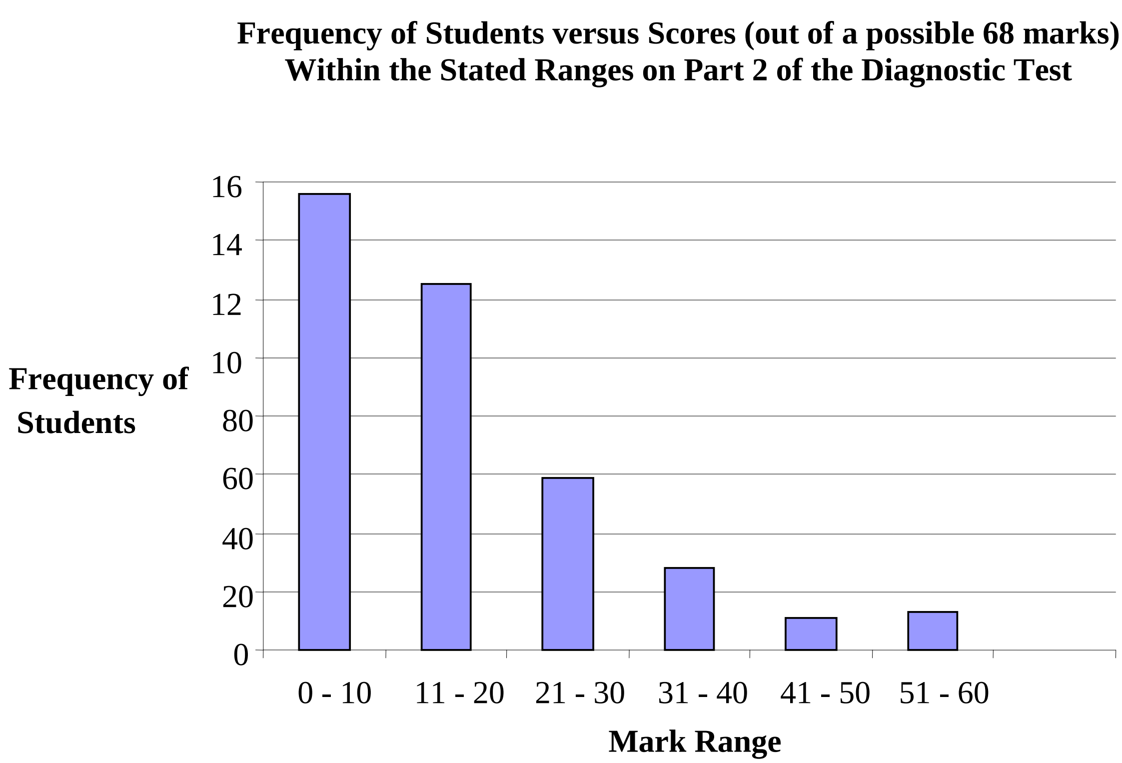
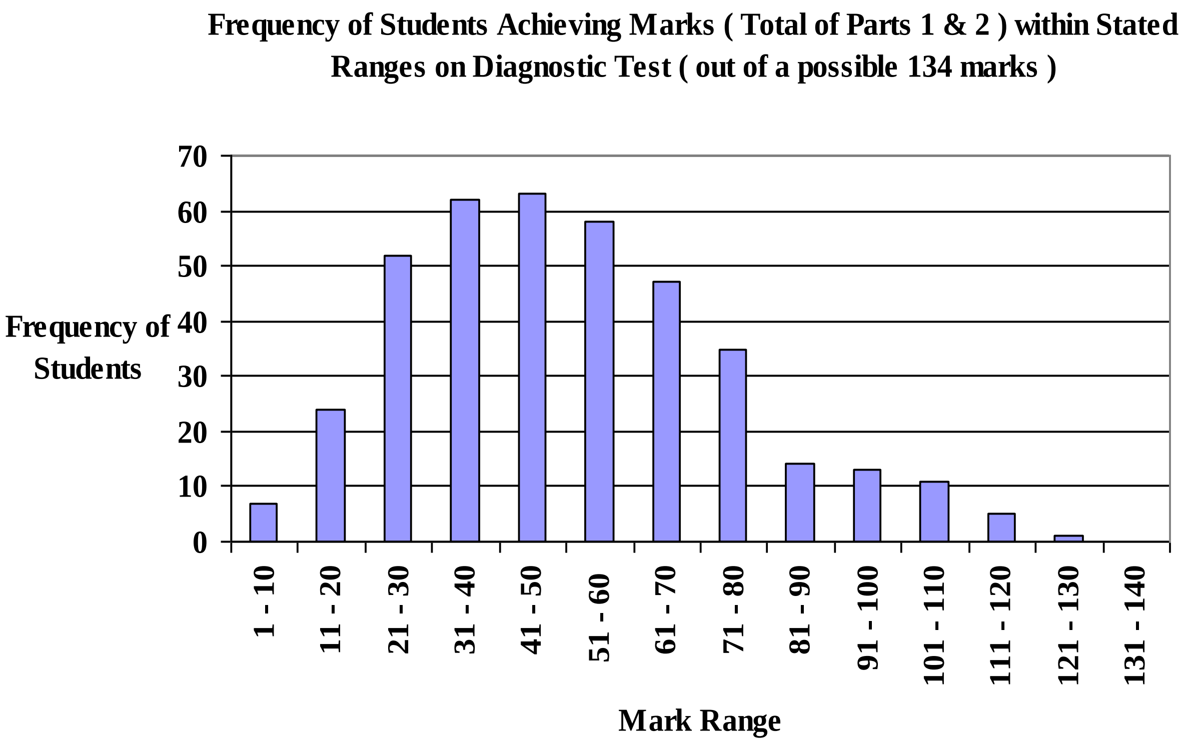


Fig. 2.1c



2.1.2 Skills Analysis on the Diagnostic Test

The student results on the diagnostic test were subdivided by skill set. The results for each skill grouping were tabulated and analyzed individually. The skill subsets and results are given in Table 2.1. The first part of the diagnostic test was subdivided into only three skill subsections due to the commonality of topics. The second part of the test was subdivided into 17 skill subsections due to the wide range of topics including basic algebra, trigonometry and geometry.

Table 2.1 provides the scores for the sample group (n = 329) on each skill subsection of the two tests. The maximum possible score per section is given along with the average mark and that mark expressed as a percentage. While the number of possible marks per section in Part 2 of the test was small, a sufficiently large number of participants in the sample ensured reliability of the results. Generally the results on Part 2 of the test in basic algebra topics show a steady decline after the subsection with heading “Solving Simple Linear Equations”. A slight reversal of this trend occurs at the end of the test in topic subsections dealing with trigonometry and geometry.

Table 2.1 Summary of Average Marks on Each Subsection of Diagnostic Tests Parts 1 and 2

Section description	Max. Possible	Average	%
Operations with Integers and Fractions	30	15.4	51.3
Operations with Decimals and Percentages	30	17.3	57.6
Simple Word Problems Involving Percentages	6	2.1	34.2
Overall Mark on Test 1	**66**	**34.7**	**52.6**
Operations with Integers	5	3.0	59.6
Simplifying Exponential Expressions	6	1.9	31.0
Evaluating Exponentials (Numerical)	3	1.1	35.8
Removing Brackets and Collecting Like Terms	2	0.5	26.9
Solving Simple Linear Equations	2	0.8	41.1
Simple Word Problems	2	0.7	17.5
Multiplication & Division of Algebraic Expressions	3	0.6	20.0
Factoring Algebraic Expressions	2	0.4	20.5
Multiplication & Division of Algebraic Fractions	4	0.6	15.9
Addition & Subtraction of Algebraic Fractions	2	0.2	8.7
Solution of Fractional Equations	2	0.4	20.4
Word Problems Involving Ratio and Proportion	4	0.8	21.2
Formula Rearrangement	3	0.5	17.6
Graphical Analysis of Straight Lines	12	1.8	15.4
Solving 2 x 2 Systems of Linear Equations	4	0.4	10.3
Triangles and Simple Trigonometry	8	1.7	21.3
Geometry and Mensuration	4	0.9	22.5
Overall Mark on Test 2	**68**	**16.4**	**24.2**

2.2 Correlation Analysis for Diagnostic Test Marks

The task of correlating diagnostic test marks with high school math marks and Fanshawe College first semester math grades is central to this study. While 329 students out of the 386 students registered wrote the diagnostic test, 313 students had all four of the following: a diagnostic test mark, one or more of the 10 acceptable prerequisite High School Year 4/5 math courses, a grade record in a first semester post-secondary program math course and a GPA score. Of this number, 199 students were enrolled in technician programs and 114 students in technology programs. The groomed data was used in most of the following correlation studies.

2.2.1 Correlation of Diagnostic Marks with Fanshawe College First Semester Math Grades

The set of histograms on the following pages (Fig. 2.2 a–j) correlate student rankings on the diagnostic test with Fanshawe College first semester final math grades. Rather than correlate letter grades with overall diagnostic test marks, it was decided for the sake of clarity to represent the results of the diagnostic test as decile rankings. In this way, the actual mark achieved on the diagnostic test is replaced by relative ranking of participants within the group.

The top four decile groups exhibit the expected skewing of frequencies towards the upper end of the grade scale. While the next three decile groups indicate a shift of frequencies towards the middle of the grade range, there are still significant numbers of students achieving excellent grades in first semester math from these decile groups.

The lowest four sub-groups exhibit an increase in the number of lower passing grades and failing grades. While there are high achievers in college math among these groups, the percentage of "at risk" students in these deciles is clearly higher.

Fig. 2.2a

First Semester College Math Grades for Students Scoring in the 91-100 Percentile

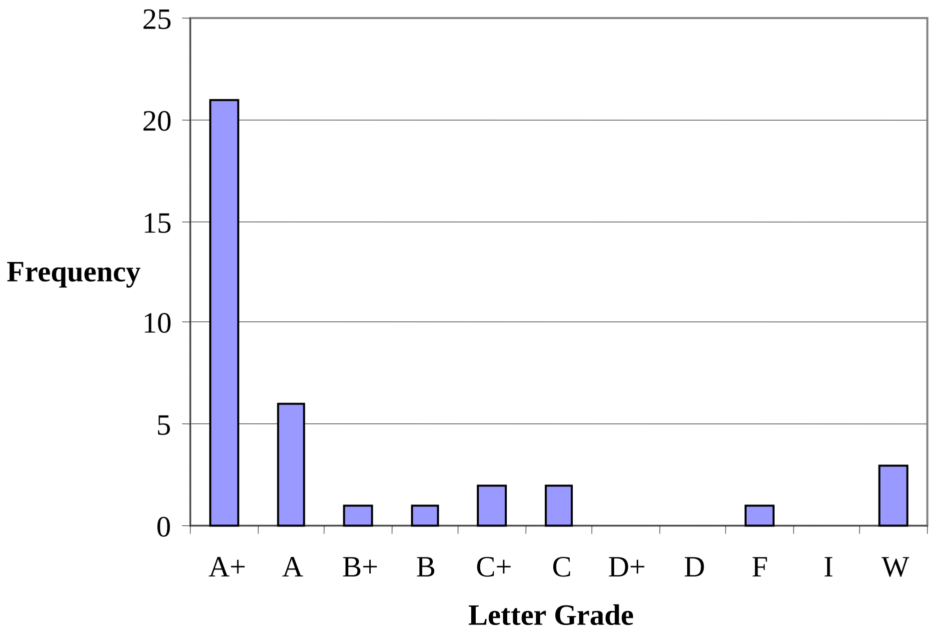


Fig. 2.2b

First Semester College Math Grades for Students Scoring in the 81-90 Percentile

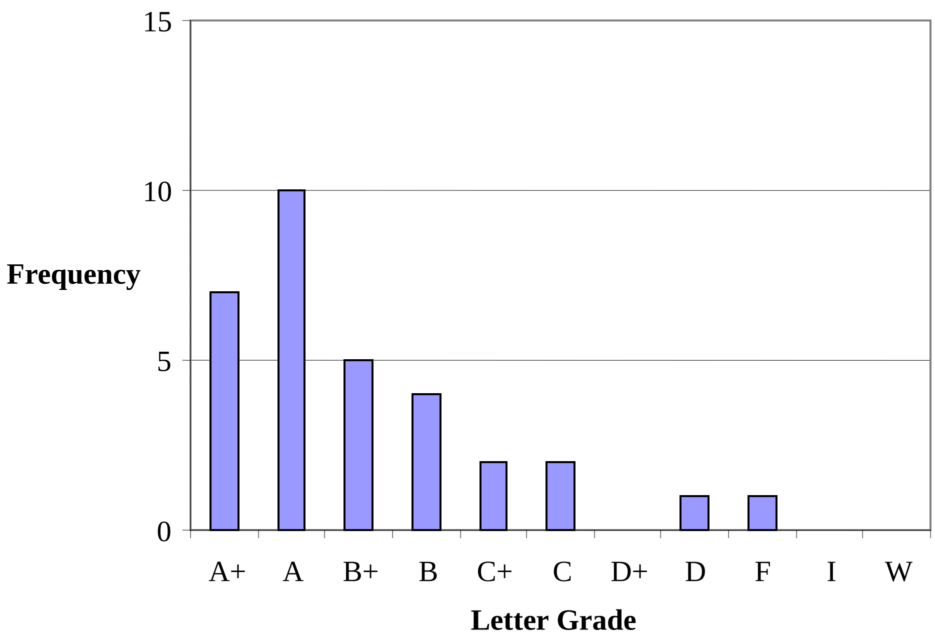


Fig. 2.2c

First Semester College Math Grades for Students Scoring in the 71-80 Percentile

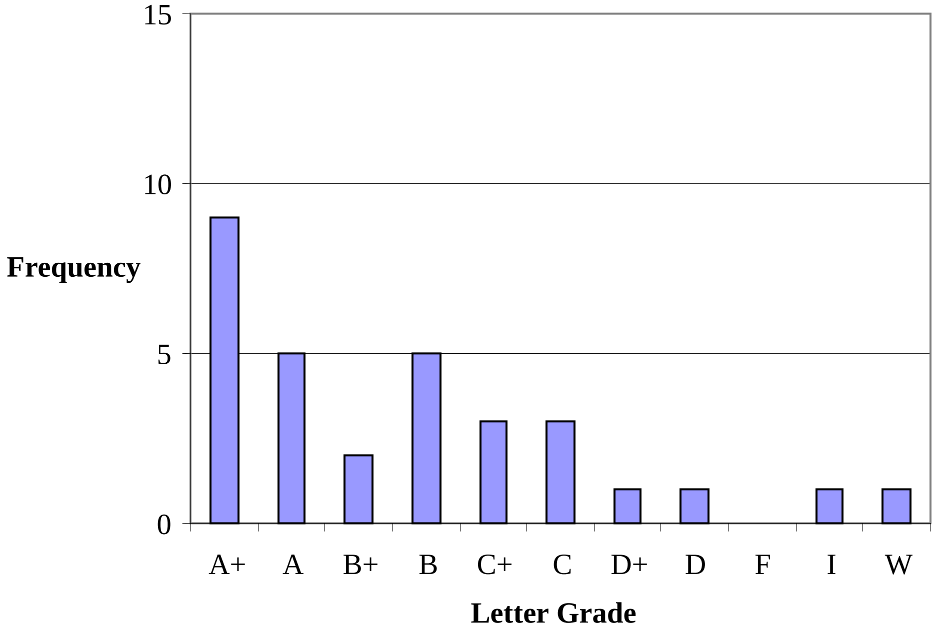


Fig. 2.2d

First Semester College Math Grades for Students Scoring in the 61-70 Percentile

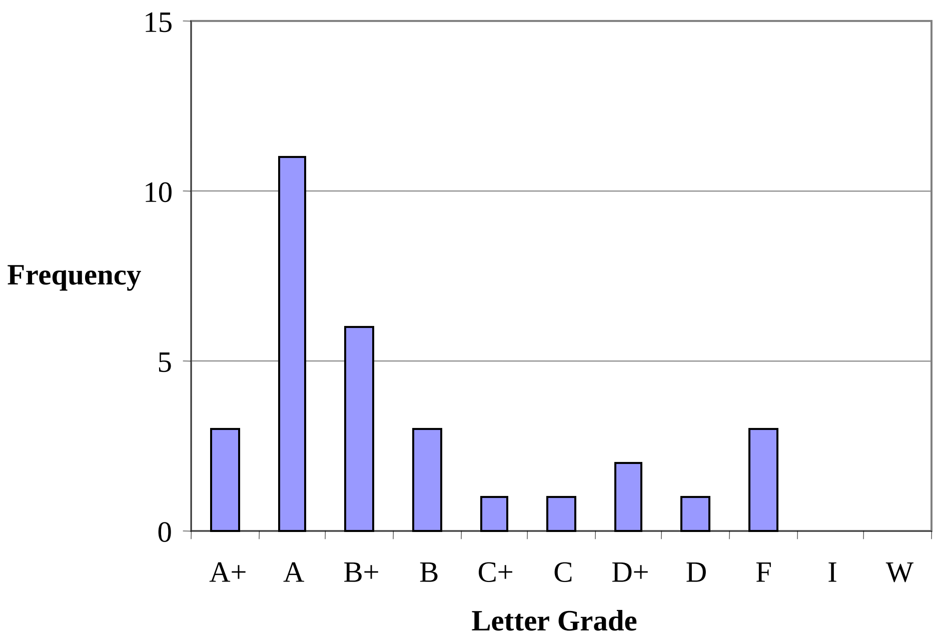


Fig. 2.2e

First Semester College Math Grades for Students Scoring in the 51-60 Percentile

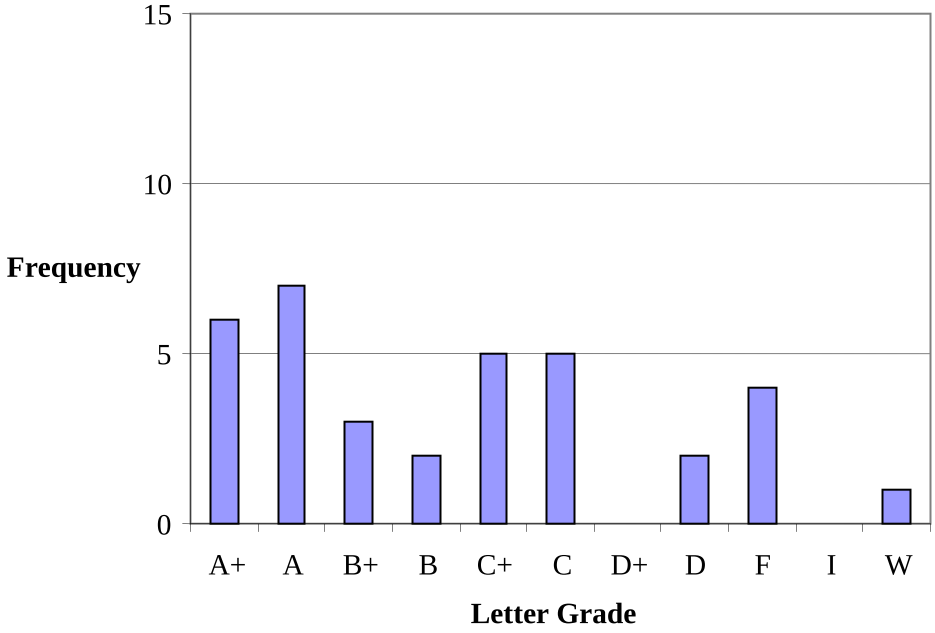


Fig. 2.2f

First Semester College Math Grades for Students scoring in the 41-50 Percentile

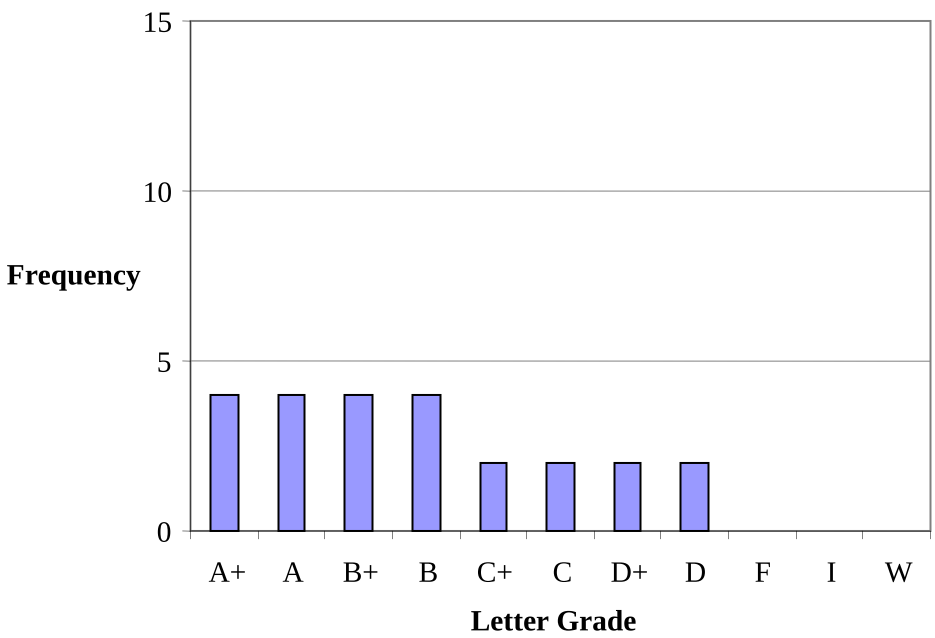


Fig. 2.2g

First Semester College Math Grades for Students Scoring in the 31-40 Percentile

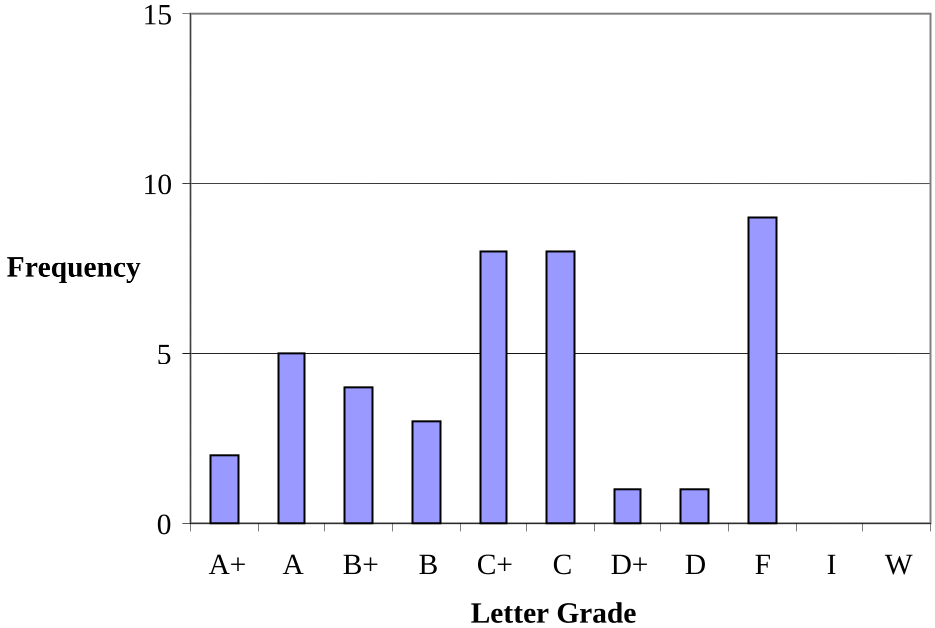


Fig. 2.2h

First Semester College Math Grades for Students Scoring in the 21-30 Percentile

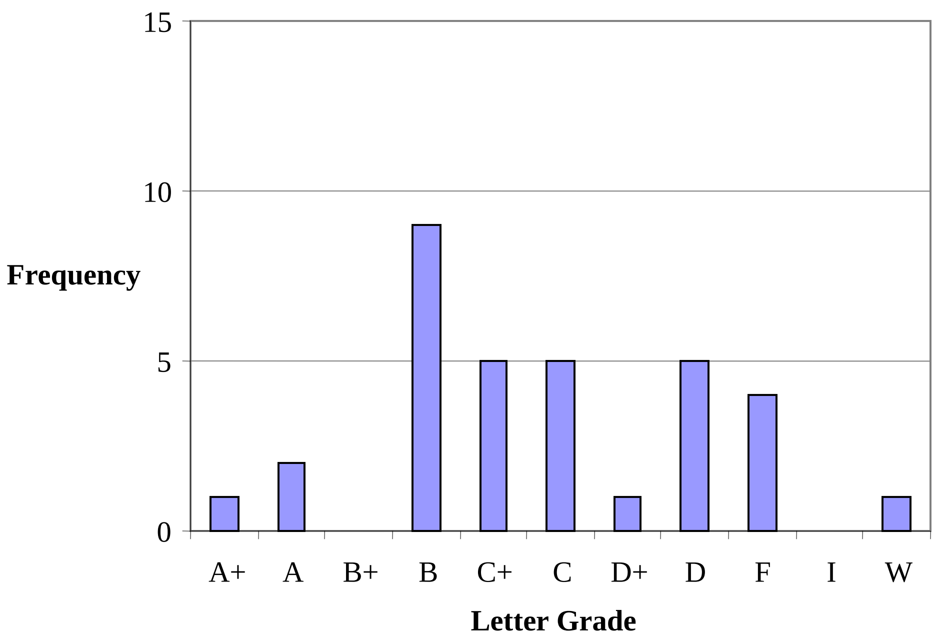


Fig. 2.2i

First Semester College Math Grades for Students Scoring in the 11-20 Percentile

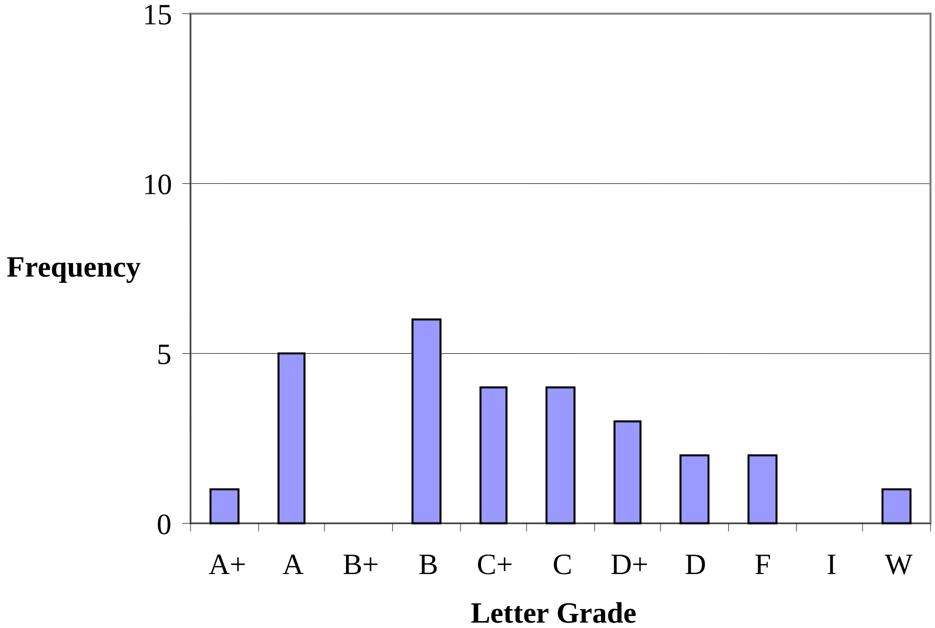
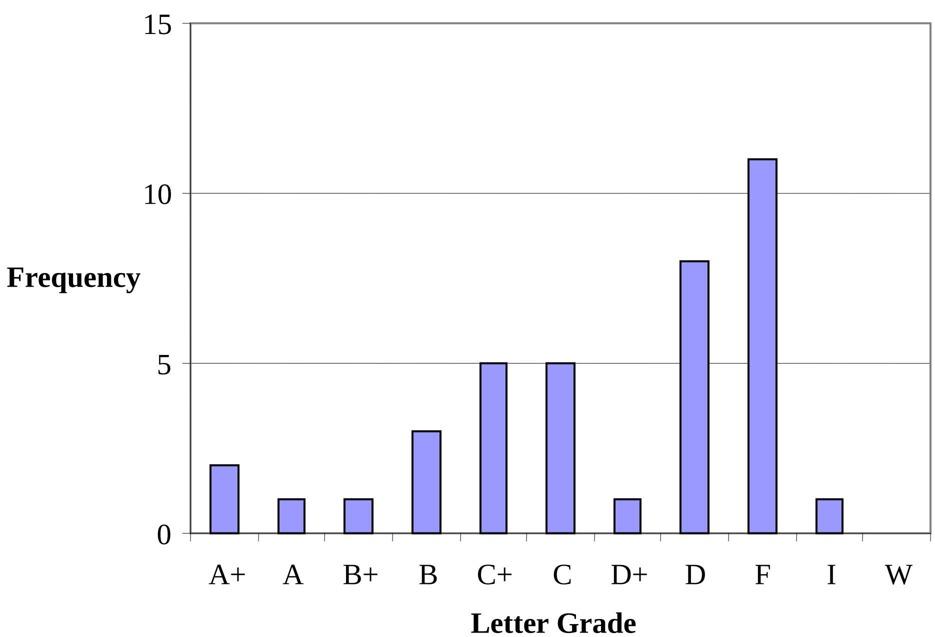


Fig. 2.2j

First Semester College Math Grades for Students Scoring in the 1-10 Percentile



2.2.2 Analysis of Diagnostic Test Marks & First Semester Math Grades by Stream

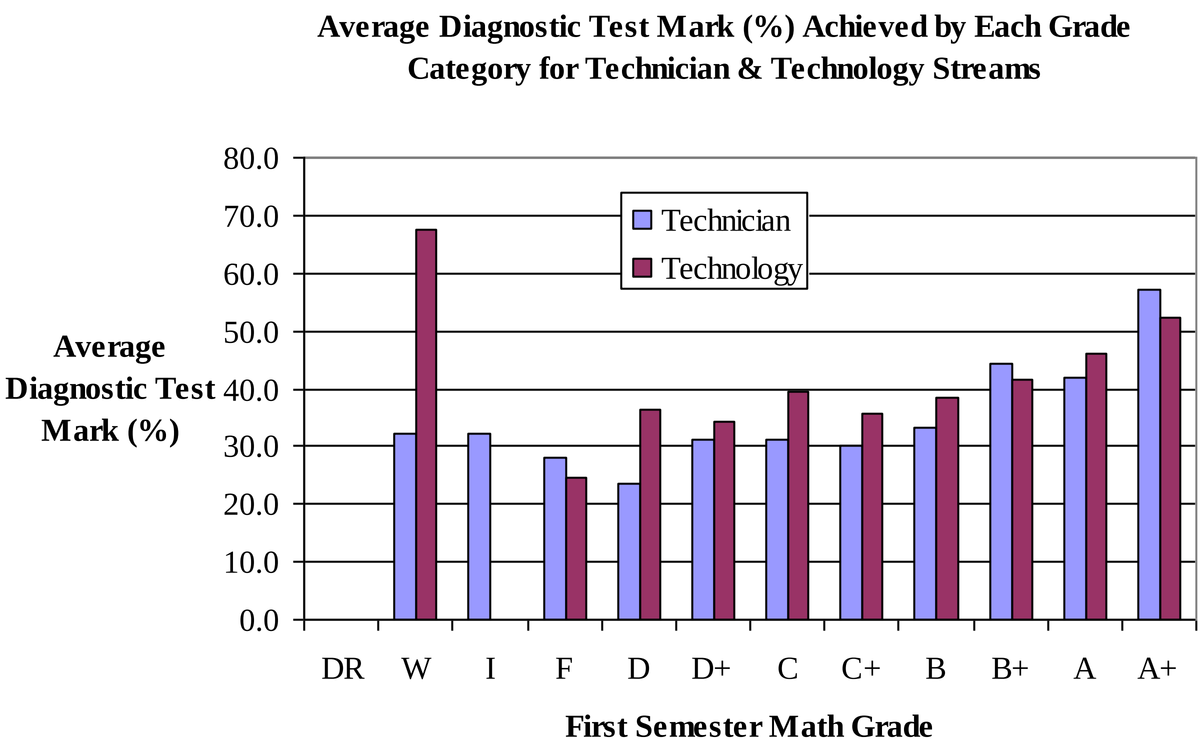
The Manufacturing Sciences Division offers postsecondary programs at both technician and technology levels. These streams have different application criteria for acceptance into the Division's programs as well as different learning outcomes for graduates of each stream. However, four programs had a common first semester math course taught to both technician and technology streams.

It is of some interest to separate the streams for analysis of achievement on the diagnostic test as well as first semester math courses. Figure 2.3 presents the average diagnostic mark, as a percentage, for each first semester math grade category. The histogram exhibits the expected trend of increasing average marks on the diagnostic test with higher first semester math grades. An accompanying analysis of dispersion shows the variation of diagnostic test results within each grade category. Table 2.2 provides the dispersion statistics of range and standard deviation, as well as the mean value for each grade category by stream. Neglecting the categories W and I, the range and standard deviation of the A+ grade category are the largest of all other grade categories in both streams.

Students who performed poorly on the diagnostic test did not necessarily perform poorly in first semester math courses. Conversely, some students who performed well on the diagnostic test achieved low math grades in first semester. The category showing the highest mean test score (67.5 %) corresponded to technology students (n = 4) who withdrew (W) from Manufacturing Science programs during the semester.

Although the sample size is quite small, the reasons why students who scored well on the diagnostic test ultimately withdrew from their College first semester math course/program warrant further study.

Fig. 2.3



DR = Dropped

W = Withdrawn

I = Incomplete

Table 2.2 Statistics for Results of Diagnostic Test by Stream and First Semester Math Grade

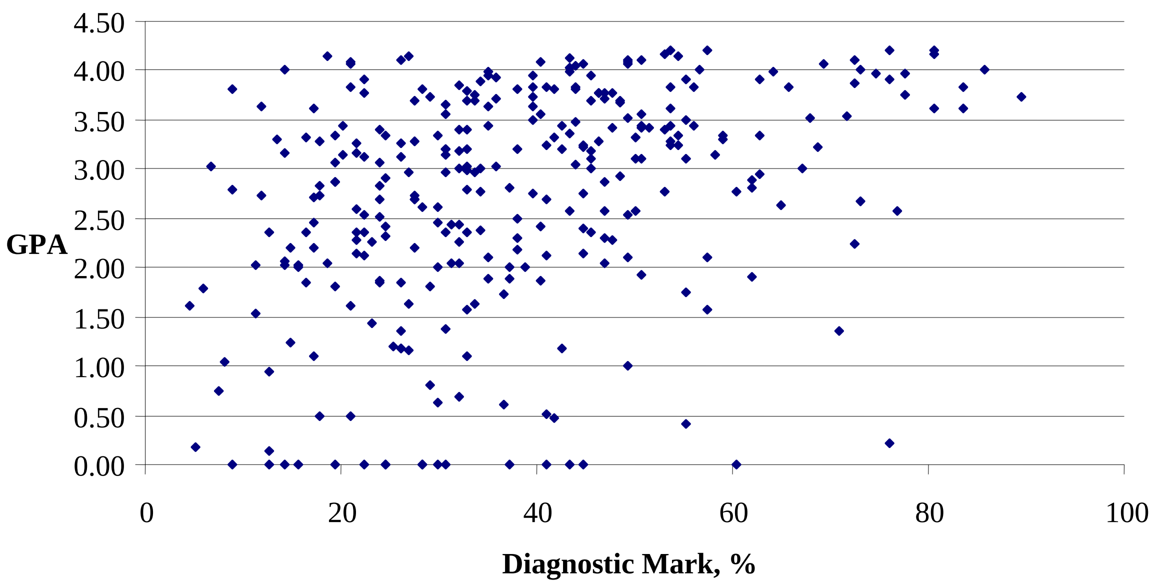
	Technician Stream				**Technology Stream**			
First Semester Math Grade	**Count**	**Diagnostic Test Mean Mark, %**	**Range, %**	**Standard Deviation %**	**Count**	**Diagnostic Test Mean Mark, %**	**Range %**	**Standard Deviation %**
A+	26	57.1	70.1	19.1	30	52.3	80.6	20.1
A	29	42.0	66.4	16.2	27	46.2	50.0	12.8
B+	13	44.4	33.6	10.2	13	41.4	55.2	14.3
B	29	33.1	44.0	12.6	11	38.5	55.2	18.2
C+	22	30.2	53.0	14.7	14	35.7	38.8	10.9
C	25	31.0	58.2	14.2	12	39.6	52.2	15.0
D+	10	31.0	33.6	11.8	1	34.3	0	0
D	20	23.4	43.3	12.2	3	36.3	32.1	16.1
F	28	28.0	70.9	16.8	7	24.5	22.4	8.4
W	3	32.1	26.9	14.9	4	67.5	47.0	21.3
I	2	32.1	29.9	21.1	0	n/a	n/a	n/a
Totals	207	35.8	86.6	17.7	122	43.8	81.3	17.5

2.2.3 Diagnostic Test Mark and First Semester GPA

Figure 2.4 provides a plot of student's first semester program GPA scores versus Diagnostic Test marks. Figure 2.4 shows a moderate positive correlation ($r = 0.355$) between Program GPA and Diagnostic Test mark.

Fig. 2.4

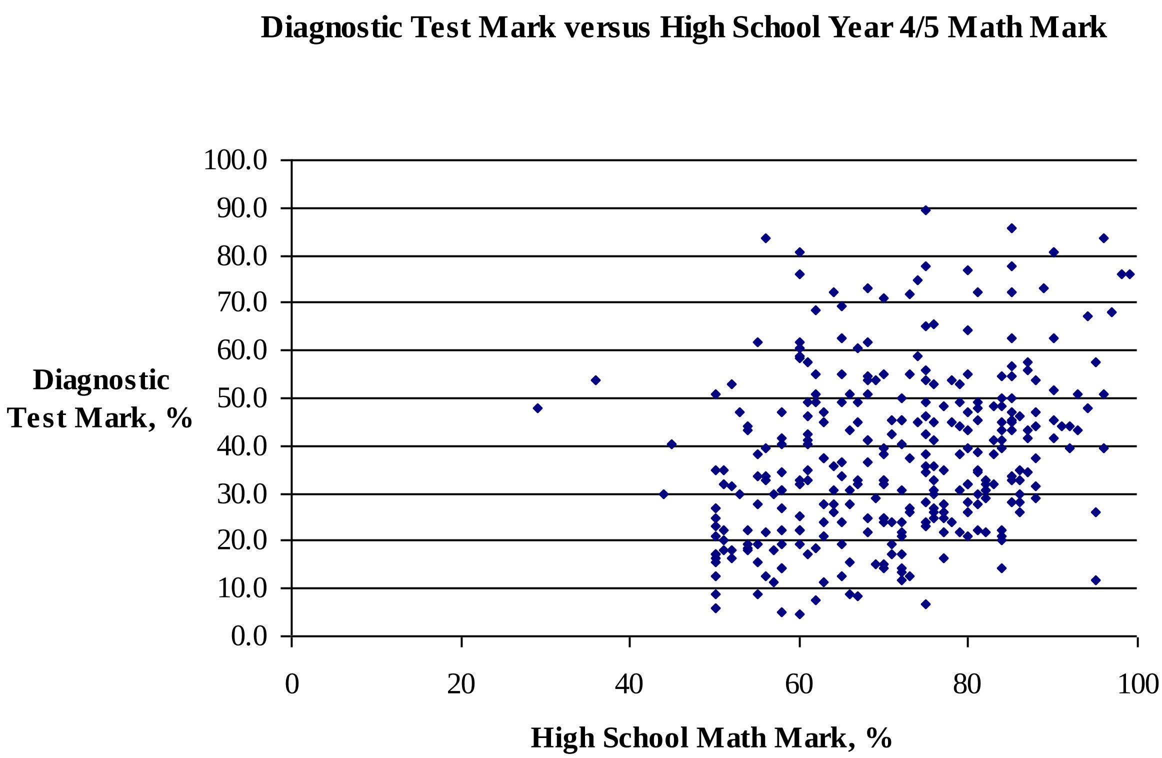
Fanshawe College First Semester Program GPA versus Diagnostic Test Mark for both Technician and Technology Streams



2.2.4 Diagnostic Test Mark and High School Year 4/5 Mark

Figure 2.5 illustrates the diagnostic marks achieved plotted against student high school year 4/5 math marks. This scatter does not take into consideration the range of math levels and duration between when the high school math course was taken and the administration of the diagnostic test. Also, it does not take into account how many math courses were taken at this level. The math mark reflecting the student's best performance was chosen for this plot. This data exhibits a moderate positive correlation between these scores with an r value of 0.307.

Fig. 2.5



2.3 High School and College First Semester Success in Math

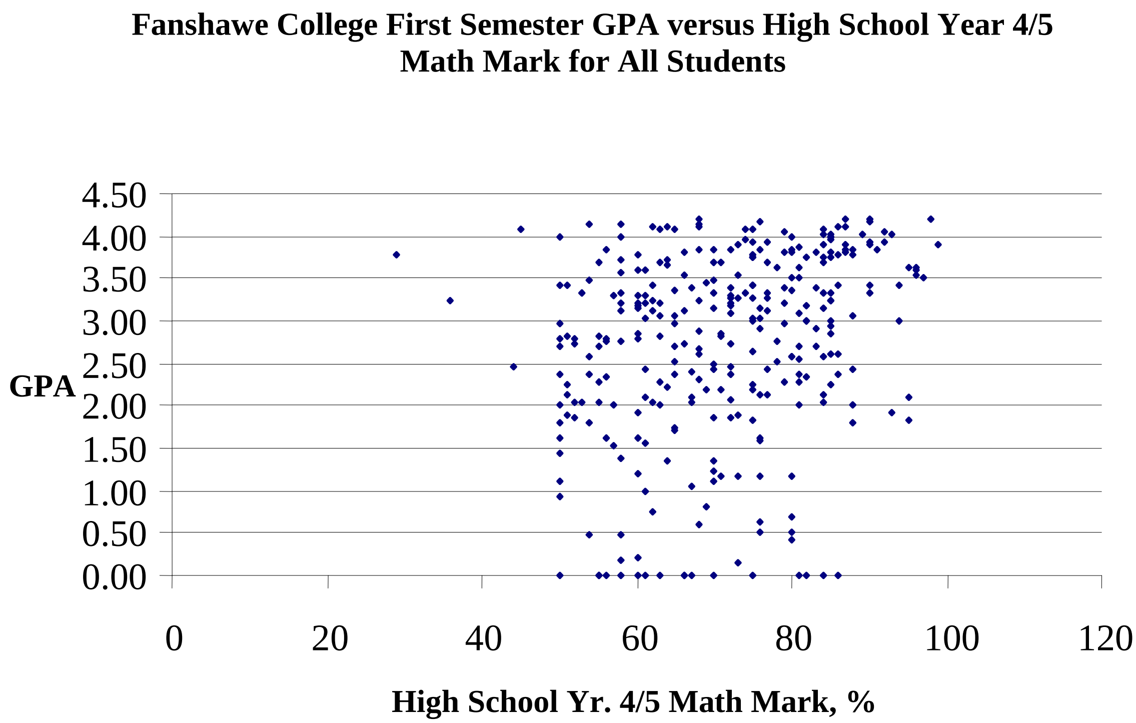
2.3.1 Additional Data

The data provided by Fanshawe College's Institutional Research & Planning Department contained student high school math marks from Grade 9 to Grade 12 under both old and new curriculum and OAC math results for students taking the old curriculum. An analysis of high school math marks versus diagnostic test results, first semester program GPA and math grades was performed. In addition, a study of the success rates of students that entered programs with new curriculum Grade 12 courses, old curriculum Grade 12 and OAC math courses was carried out.

2.3.2 High School Math Marks and First Semester Program GPA

Figure 2.6 is a plot of Program GPA scores against student's year 4/5 high school math marks. This plot exhibits a weak positive correlation (r = 0.253) between the year 4/5 math course taken and first semester program GPA scores.

Fig. 2.6



2.3.3 First Semester Math Course Grades by High School Year 4/5 Math Course

The following set of histograms (fig. 2.7 a – k) represents the grade profile for sets of students emerging from year 4/5 high school math courses. The course titles with matching codes are given in Tables 1.1 and 1.2 (on page 11).

Fig. 2.7a

MCB4U (n = 52)
Grade 12 Calculus (new)

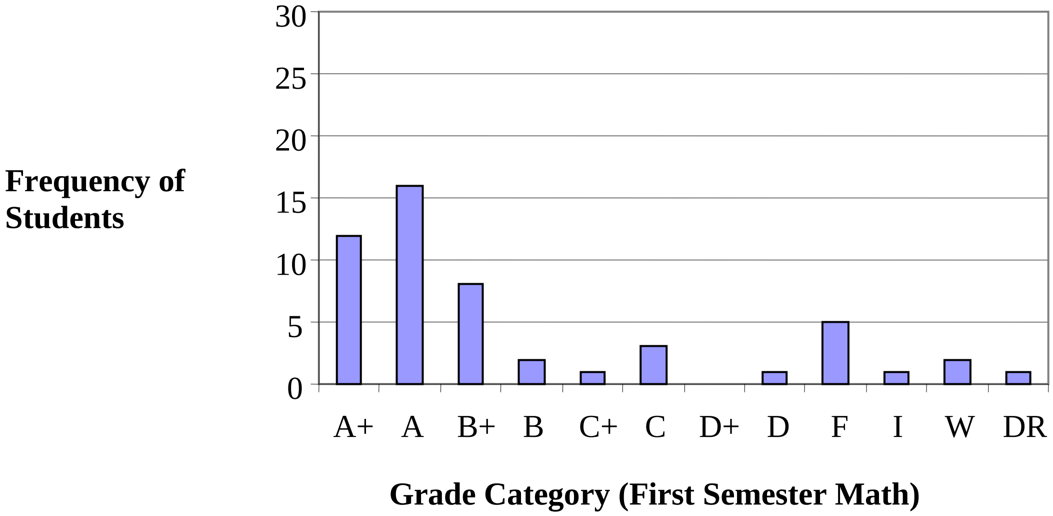


Fig. 2.7b

MGA4U (n = 11)
Grade 12 Geometry and Discrete Math (new)

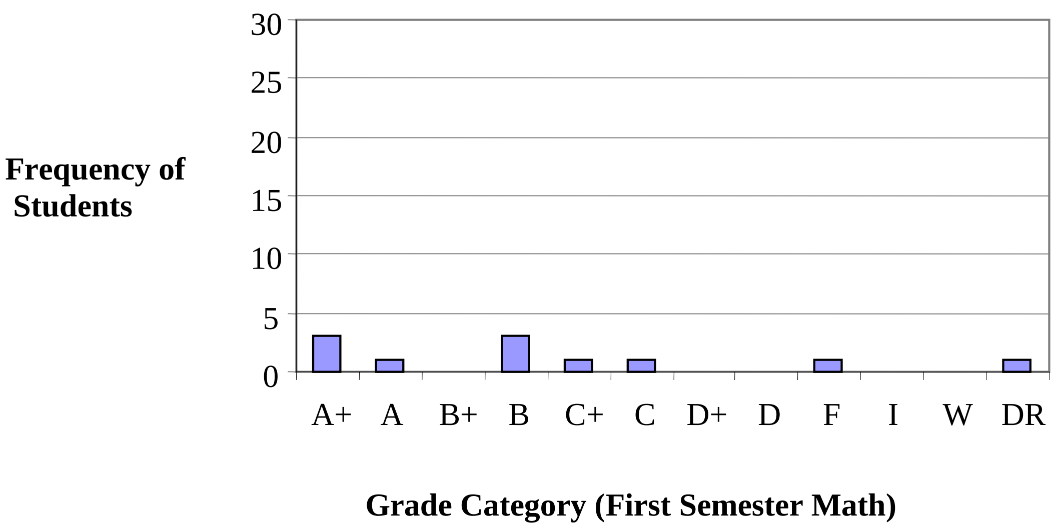


Fig. 2.7c

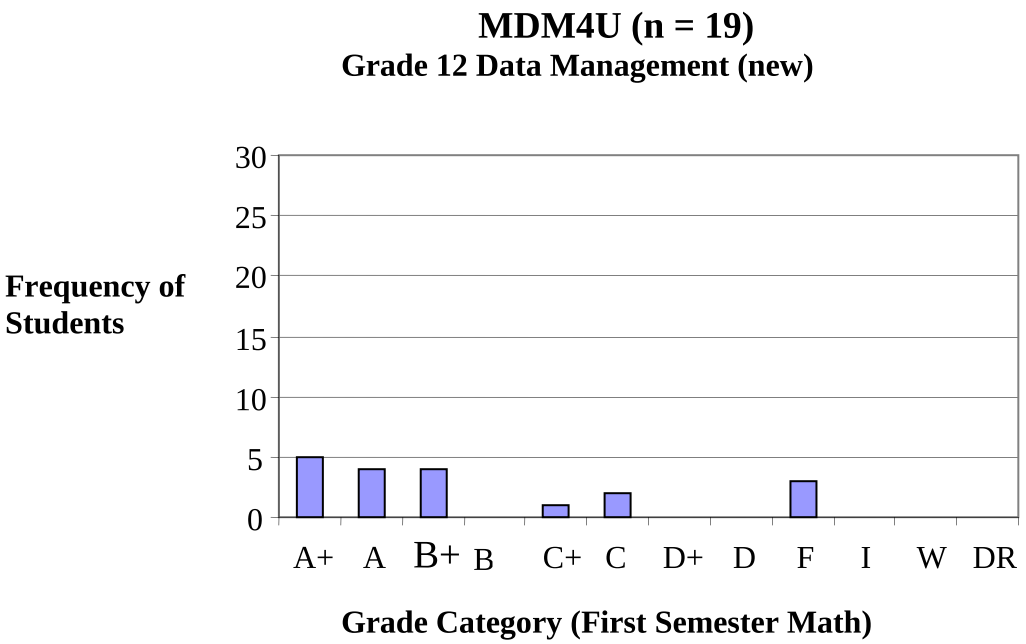


Fig. 2.7d

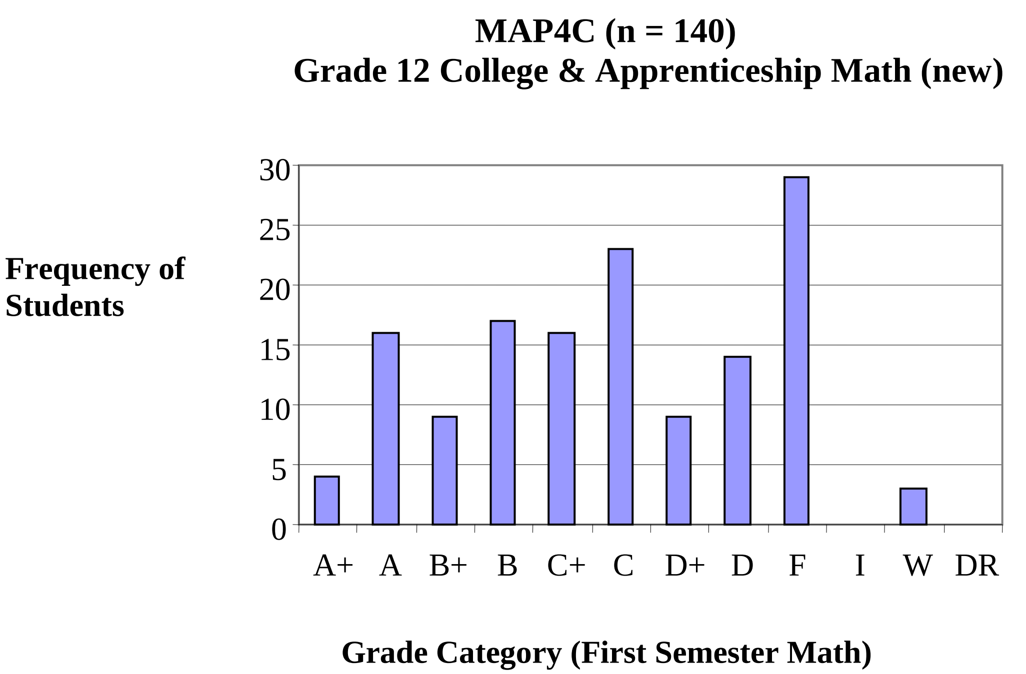


Fig. 2.7e

MCT4C (n = 56)
Grade 12 Math for Technology (new)

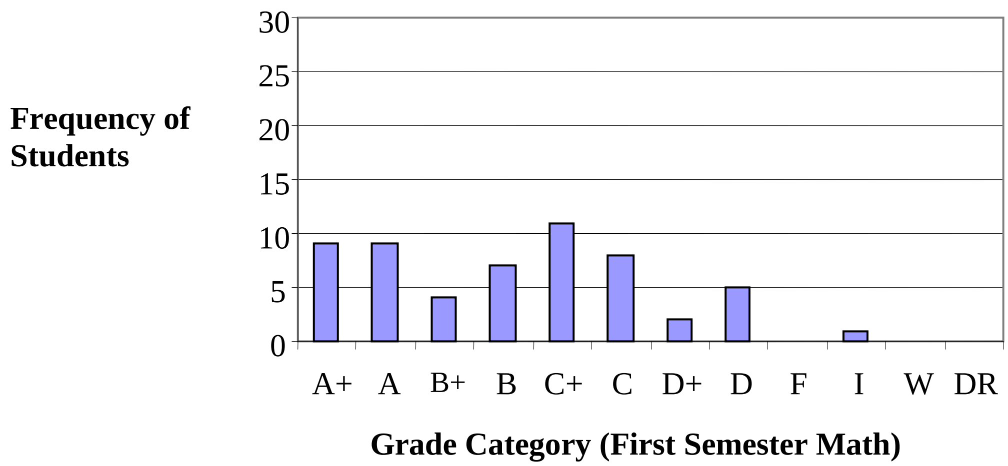


Fig. 2.7f

MAT4A (n = 29)
Grade 12 Advanced Math (old)

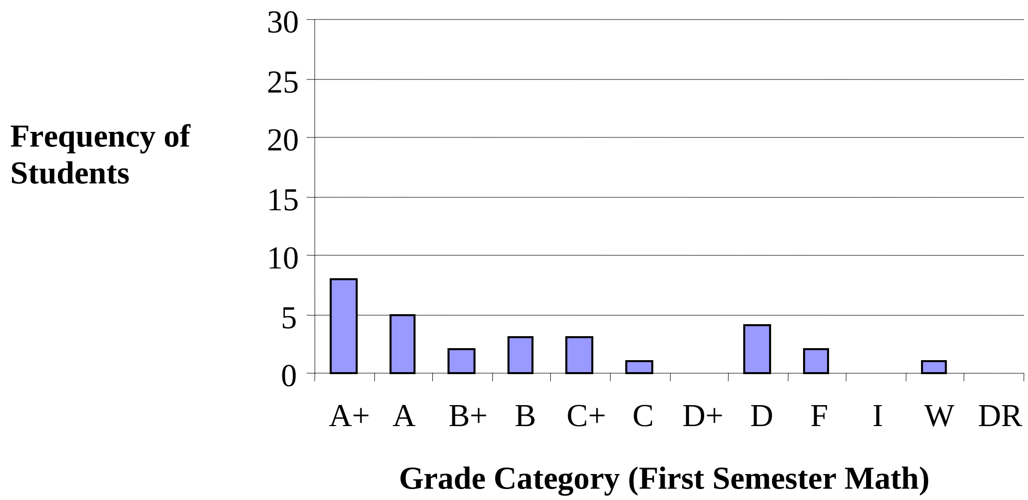


Fig. 2.7g

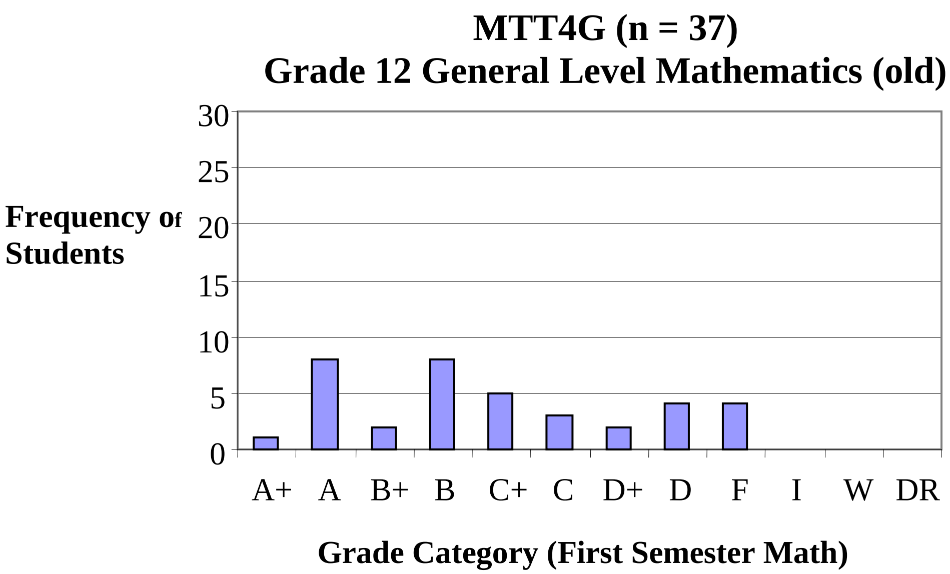


Fig. 2.7h

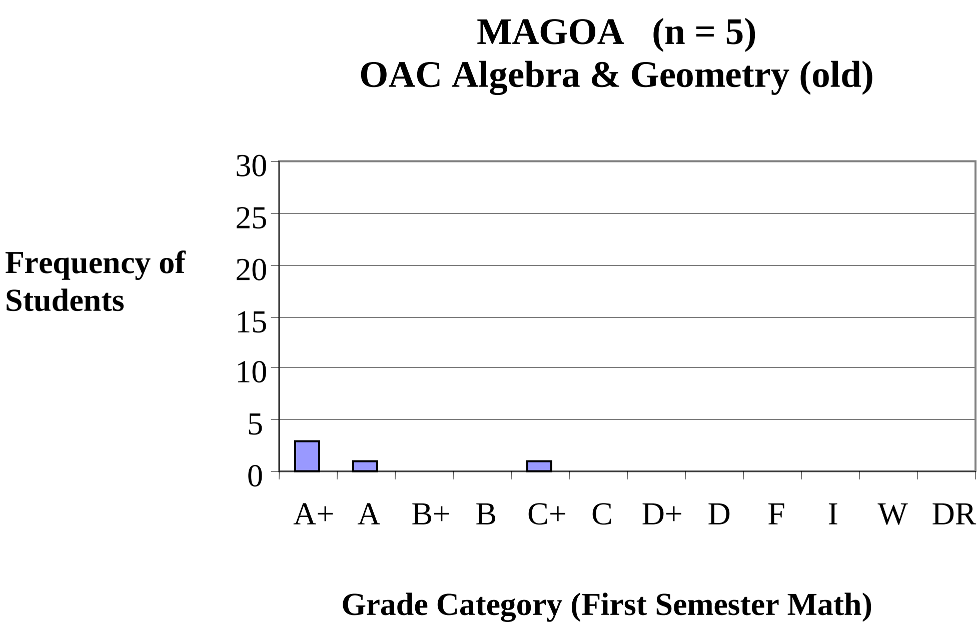


Fig. 2.7i

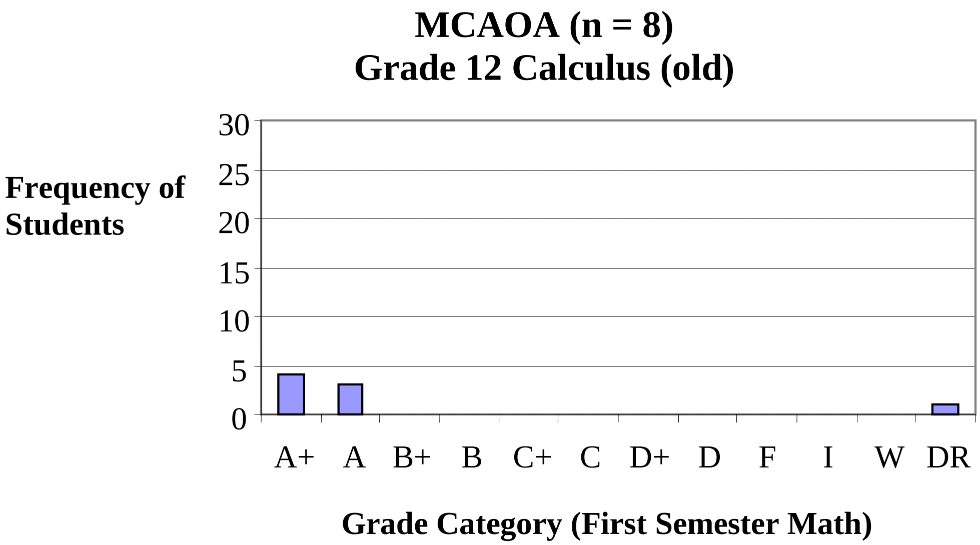


Fig. 2.7j

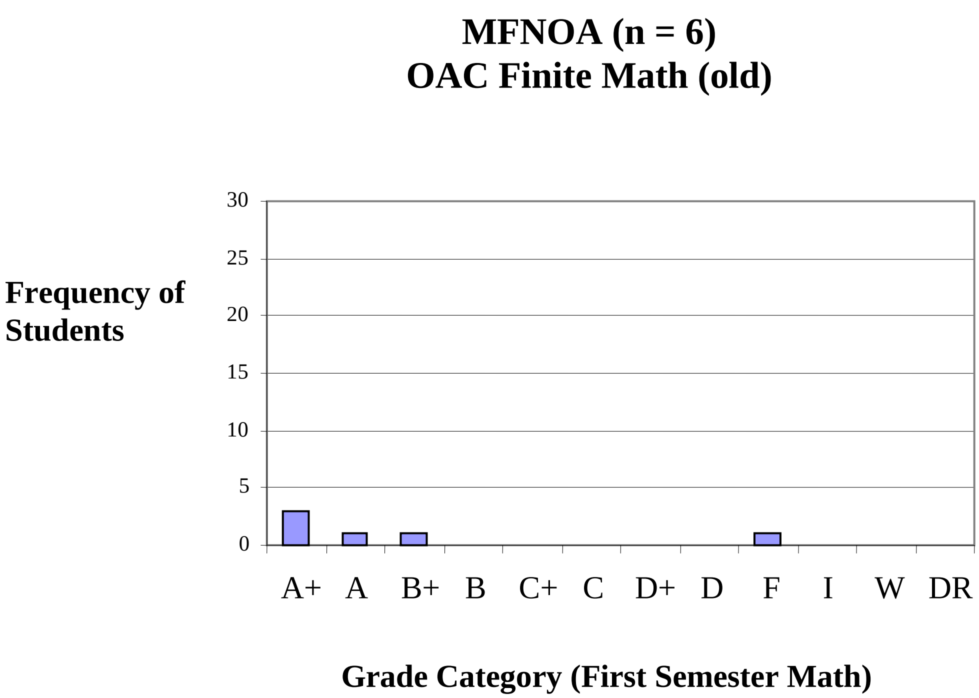
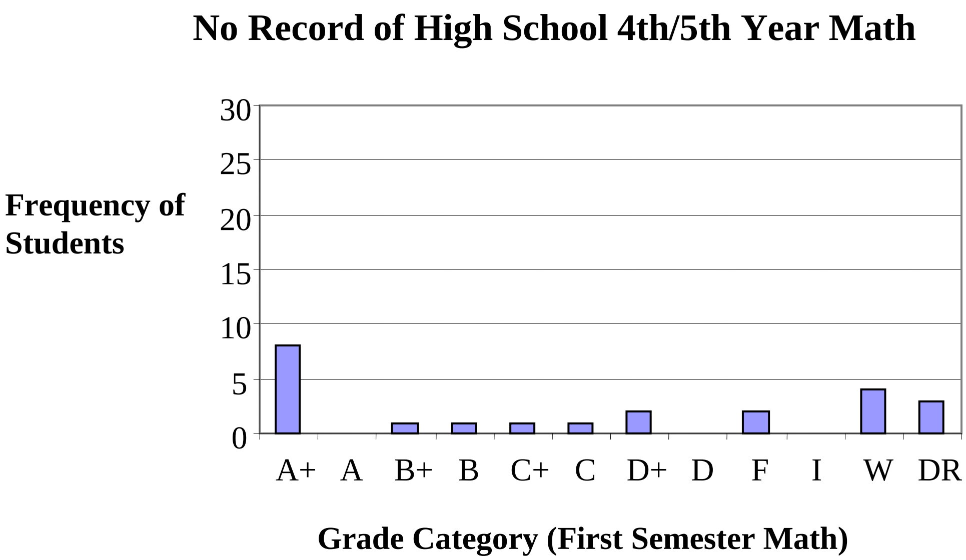


Fig. 2.7k



2.3.4 Failure rates

The first semester college math failure rates of students emerging from various high school year 4/5 math courses is of importance for providing feedback to high school guidance counselors and for college math curriculum design and course delivery. Table 2.3 summarizes the failure rates in college math of the groups of students emerging from the various high school math courses.

Table 2.3 Failure Rates According to High School Math Course

Course Code	Group Frequency	Failure Rate as % of Group Frequency
MCB4U	52	9.6
MGA4U	11	9.1
MDM4U	19	15.8
MAP4C	140	20.7
MCT4C	56	0
MAT4A	29	6.9
MTT4G	37	10.8
MAGOA	5	0
MCAOA	8	0
MFNOA	6	16.7
No Yr. 4/5 Math Course	23	8.7

The overall failure rate for the population (n = 386) is 12.7 %.   The highest failure rate of 20.7 % corresponds to students whose best math mark in year 4/5 was achieved in MAP4C (College and Apprenticeship Math). There are three groups exhibiting a zero failure rate. These are groups that have taken MCT4C (Math for Technology), MAGOA (Algebra and Geometry) and MCAOA (Calculus).

While the group frequencies for the latter two courses are small (5 and 8 respectively), the frequency of the group from MCT4C is the second largest at 56. The clear indication is that students entering Manufacturing Sciences Division postsecondary programs are far more successful when they have taken Math for Technology (MCT4C) in year 4 as opposed to the Math for College and Apprenticeship (MAP4C). There are three university stream math courses under both the old and new high school math curricula. The courses exhibiting the highest failure rates in these groupings are MDM4U (Data Management) and MFNOA (Finite Mathematics).

2.3.5 Analysis of Math Achievement by Stream (Technician and Technology)

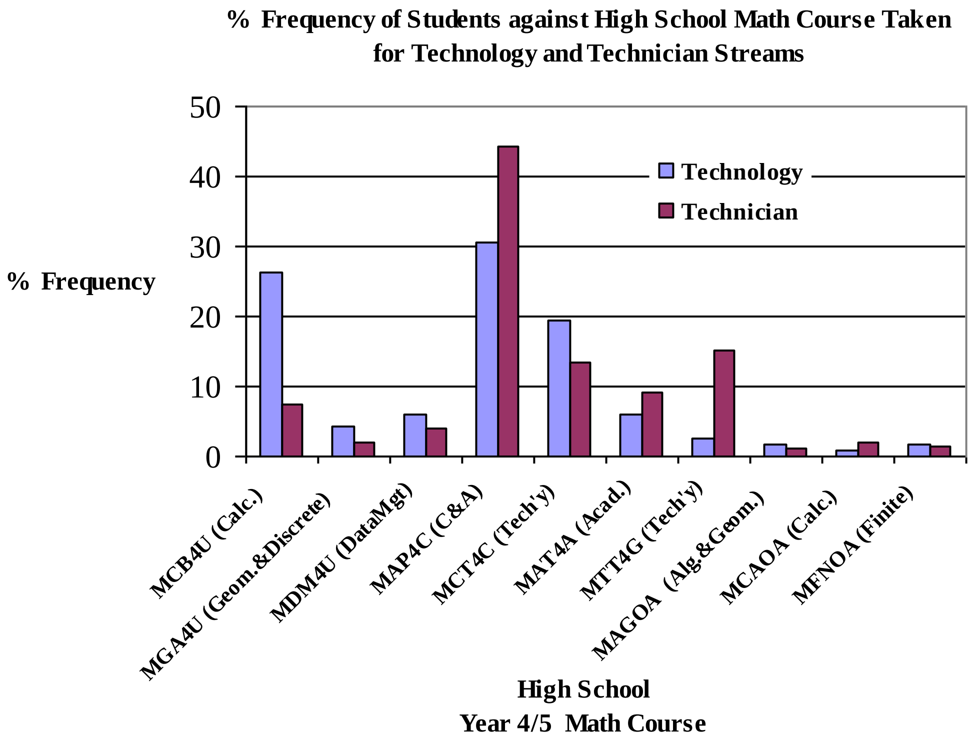
2.3.5.1 Distribution of Students in Technician and Technology Streams by High School Math Course

For all the postsecondary math courses offered by Manufacturing Sciences Division in the Fall term of 2005, it was found that students typically had used one or more of 10 high school math courses as an entrance requirement. A small percentage of students gained access to the college by other pathways such as the ACE or Pre-Technology Programs.   The frequency of first semester Manufacturing Sciences Division (MSD) students (by stream) emerging from various high school math courses (of the 10 identified) is shown in Figure 2.8.

This figure shows the year 4/5 high school math courses that candidates in the technician and technology streams completed prior to entry. In cases where a student took more than one math course at this level, the course in which the student achieved the highest mark is reflected in this distribution.   There were almost twice as many technician students as there were technology students in the Fall 2005 intake. Due to this imbalance in numbers of students in these streams, percentage frequency was used as opposed to actual numbers of students.

Clearly, the College stream math course MAP4C is the most popular math preparation for students entering both streams. A significant number of technology stream students (26 %) opted to take MCB4U (calculus) as a preparation for college as opposed to just over 7 % of technicians.

Fig. 2.8



2.3.5.2 Average Marks of Students in High School Math by Stream

The average mark in each of the 10 identified high school feeder courses is given below in Table 2.4. For most groups (number of students ≥ 3), the average hovers around the 70% range. Interestingly, of these groups, MAP4C students, as a group, exhibited the highest average marks of 72.1% and 78.4 % for technician and technology streams respectively.

Table 2.4 Average High School Math Mark by Course and Stream

Stream	High School Course	MCB4U (Calc.)	MGA4U (Geom.&Discrete)	MDM4U (DataMgt)	MAP4C (C&A)	MCT4C (Tech'y)	MAT4A (Acad.)	MTT4G (Tech'y)	MAGOA (Alg.&Geom.)	MCAOA (Calc.)	MFNOA (Finite)
Technician	**No. of Students**	15	4	8	88	27	18	30	2	4	3
	Average Mark, %	67.7	64.5	70.1	72.1	70.0	64.4	67.8	85.0	62.8	68.3
Technology	**No. of Students**	30	5	7	35	22	7	3	2	1	2
	Average Mark, %	70.6	62.8	72.6	78.4	75.6	74.6	74.0	69.5	29.0	54.0

2.3.5.3 Students Achieving D to C+ Grades in First Semester Math Courses

The analysis of section 2.3.4 dealt specifically with students achieving F grades at the end of first semester in MSD postsecondary program math courses. However, for the purposes of providing better counseling to students entering MSD programs and for remediation opportunities, the grade range of D to C+ is also of special interest. Figures 2.9 (a) and (b) provide an analysis of the backgrounds of students who achieved math grades in this grade range in first semester by stream (technician and technology). As in the case of students who failed a first semester math course, students from the MAP4C course were the most likely to score in the D to C+ range in both the technician and technology streams.

Fig. 2.9a

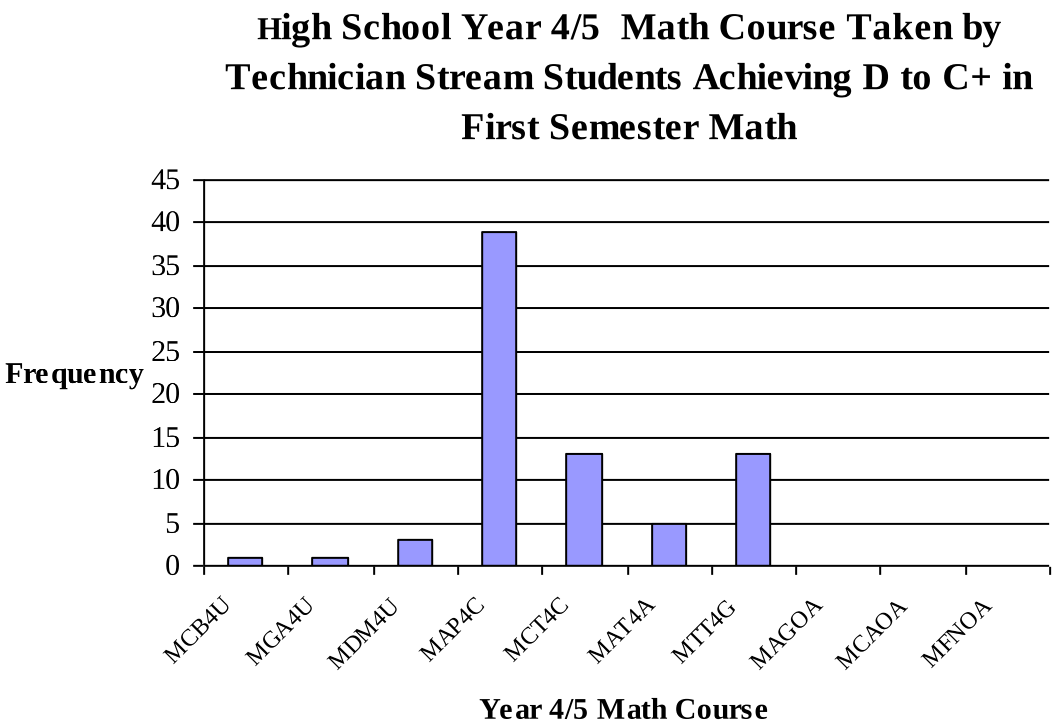
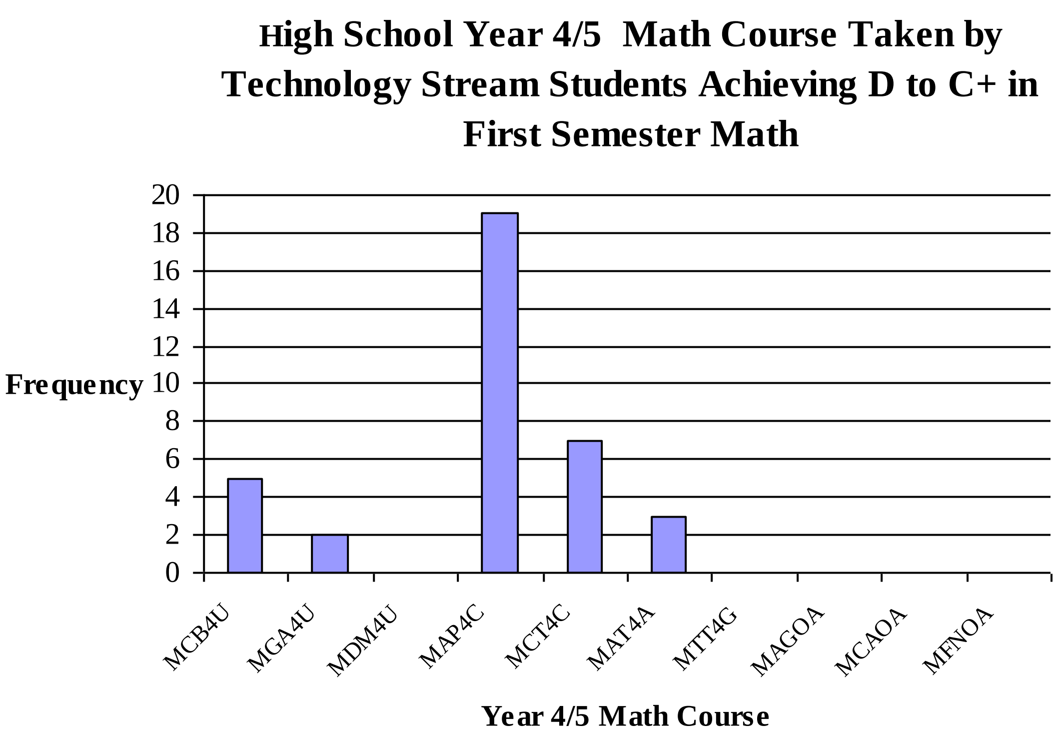


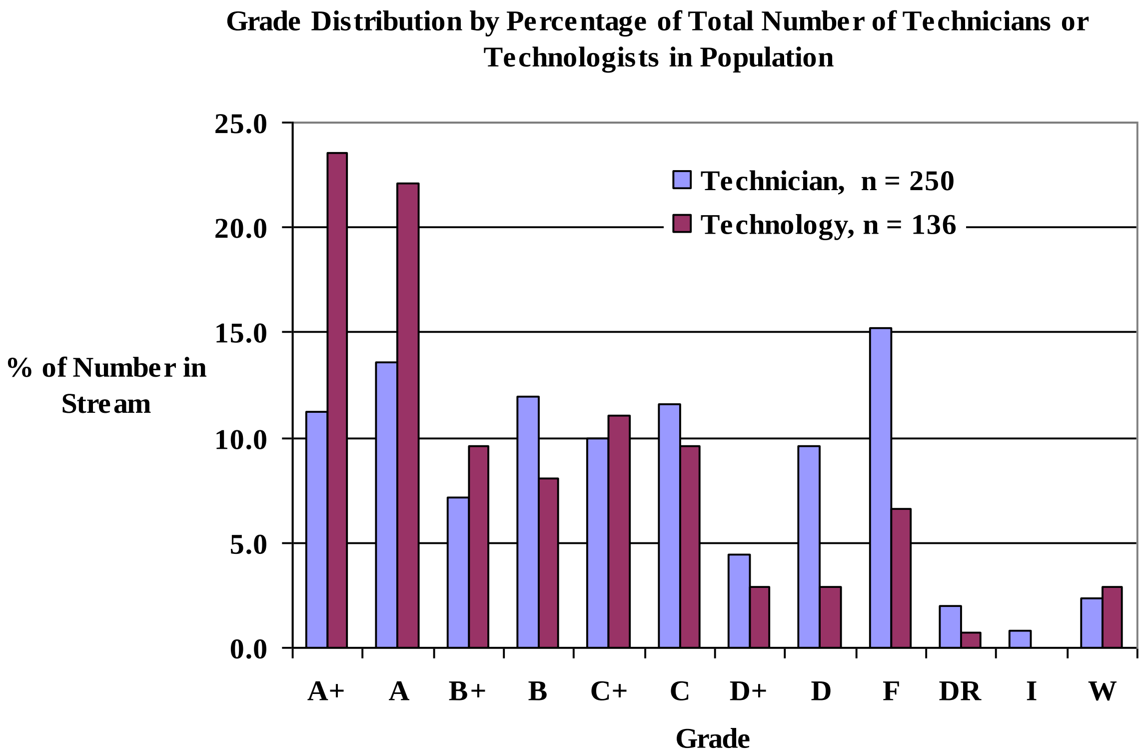
Fig. 2.9b



2.4 First Semester Math Grade Distribution by Stream

The grade achievement in first semester math by the technician and technology streams is given in Fig. 2.10. Since the number of students in the technician stream (250) was nearly double that of the technology stream (136), a percentage frequency of the number of students in a particular stream was used instead of the actual numbers of students falling into each grade category. Both distributions are somewhat trimodal in nature. However, the key distinguishing features include larger percentages of technology students achieving higher grades (A+ and A) and a technician failure rate which is slightly more than double that for technology students.

Fig. 2.10

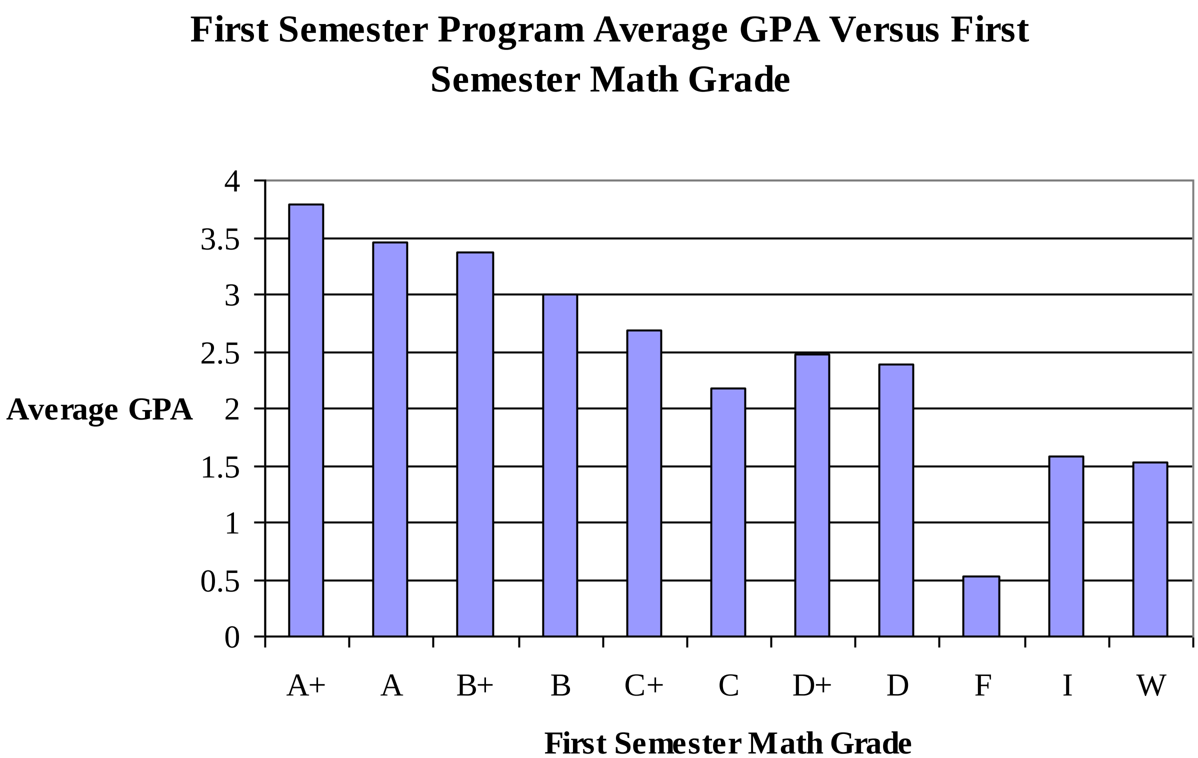


2.5 First Semester Average Program GPA and First Semester Math Grade

As expected, there is a strong positive correlation between average program GPA and math grades in first semester, keeping in mind that math grade point values are one component of the GPA. Fig. 2.11 illustrates the average program GPA against first semester math grade achieved for the entire population studied. Average GPA values decrease linearly from 3.8 for the A+ group down to 2.2 for the C group. A slight rise in GPA for D+ and D math students might indicate that students who were experiencing poor results in math turned their attention towards other subjects although this remains unproven and warrants further study.

The question of how efforts to help students achieve higher math marks affect outcomes in other program courses in first semester also needs to be studied.

Fig. 2.11

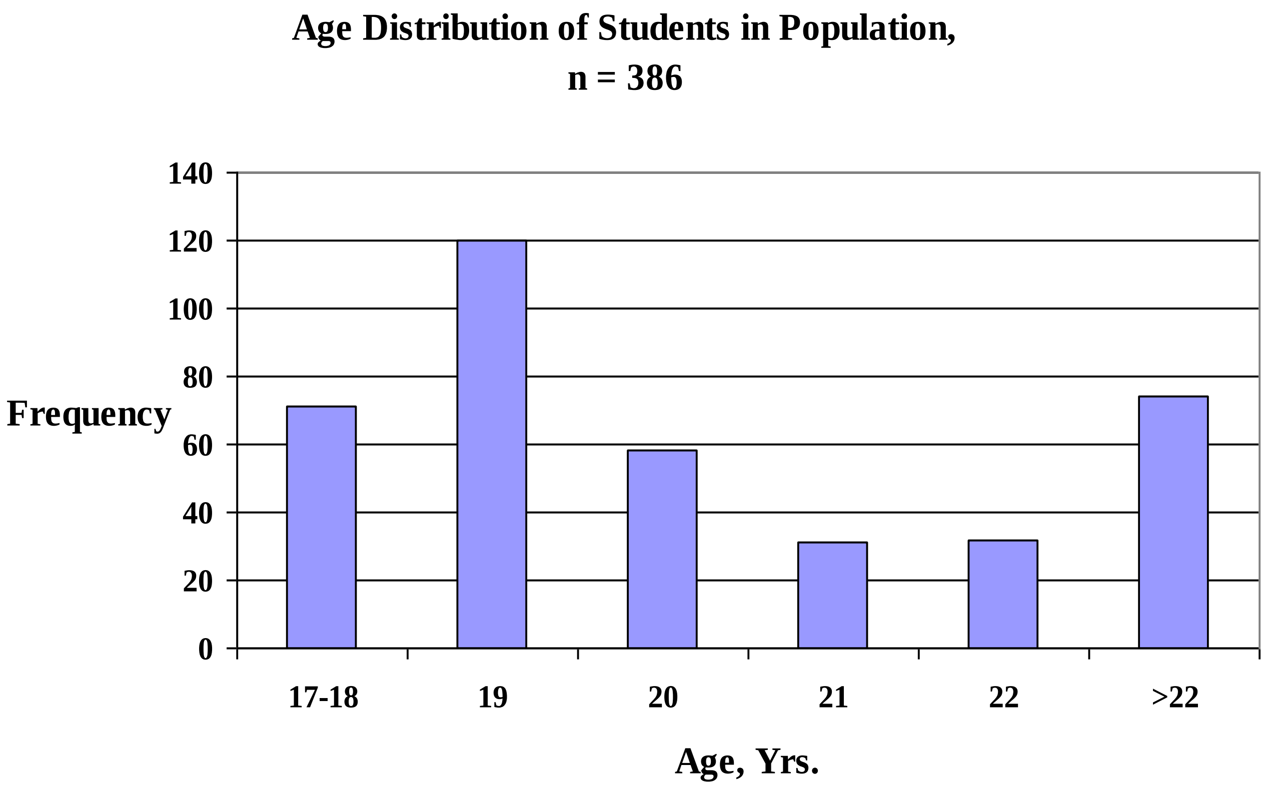


2.6 Age and Gender

2.6.1 Age Distribution

The availability of demographic information concerning age and gender of students entering first semester courses allowed an investigation of first semester math results by age and gender. Fig. 2.12 provides an overall frequency distribution of students entering programs in various age categories. The category of age 17 was combined with the 18-year old category since there was only one student aged 17. A significant number of students (19 %) entering first semester programs are older than 22 years of age. However, there is little variation in the grade distributions of age categories beyond 22 years. Since the sample sizes of these categories decline, the lower limit for the last category was chosen arbitrarily at 23 years, yielding a sample size of 74 students.

Fig. 2.12



2.6.1.1 Math Grade Achievement by Age Category

Figures 2.13a-f provides a breakdown of first semester math grade achievement by age category. The math grades for all entrant age groups shows varying degrees of polymodality. In all groups, three modal peaks can be detected in varying degrees of intensity. Most distributions exhibit modal peaks of uniform frequency although the distributions for the higher age groups show some degree of positive skewing towards the higher grade categories. In particular, the 21 year old and > 22 year old groups showed the highest frequencies of A and A+ grades respectively.

The highest frequency of F grades were found in the 19 and 20 year age categories, both approximately 15 %. The other groups all exhibited failure rates at about the 10% mark.

Fig. 2.13a

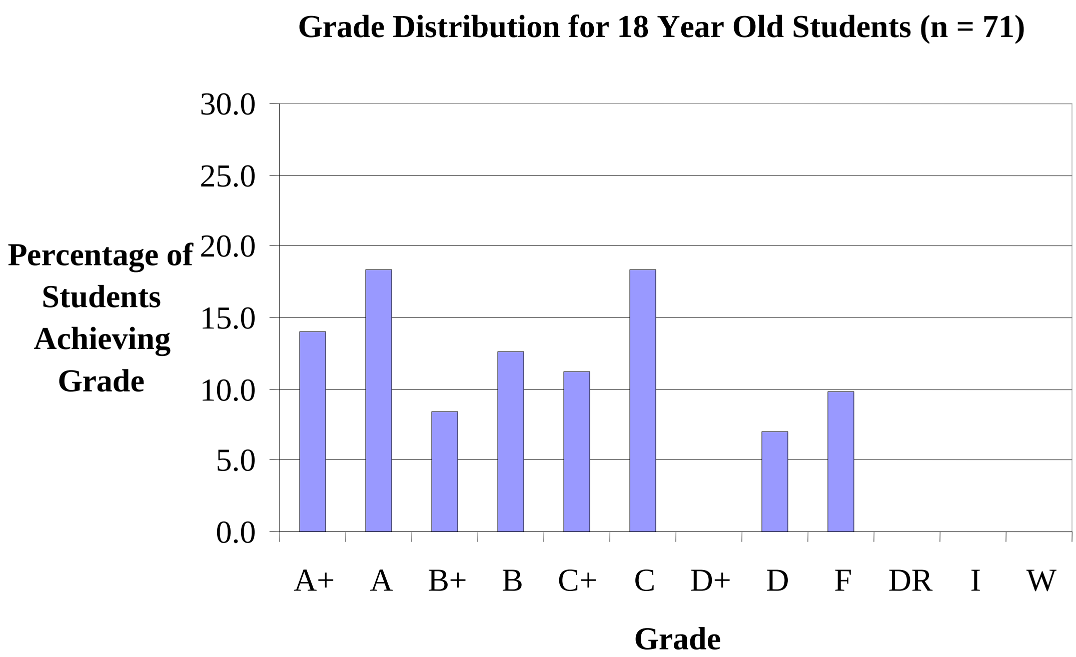


Fig. 2.13b

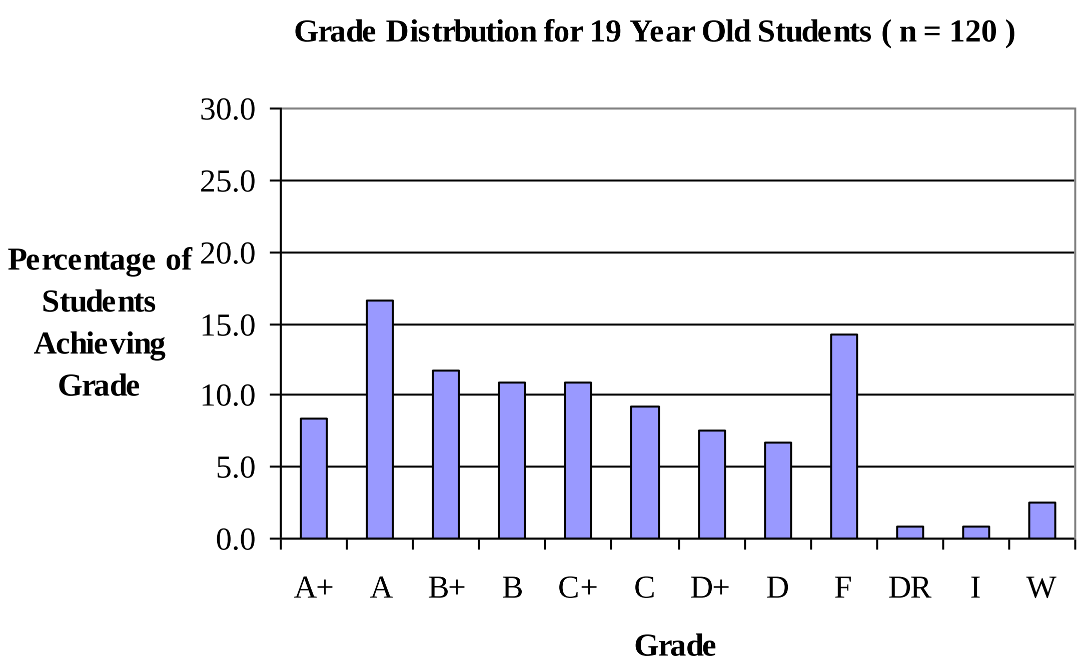


Fig. 2.13c

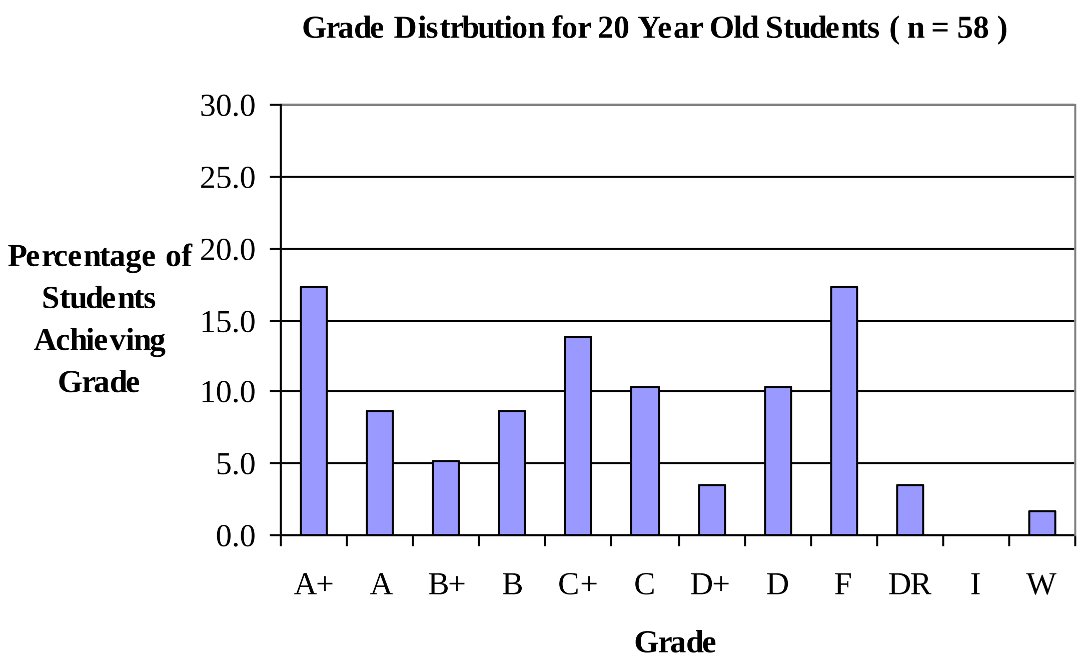


Fig. 2.13d

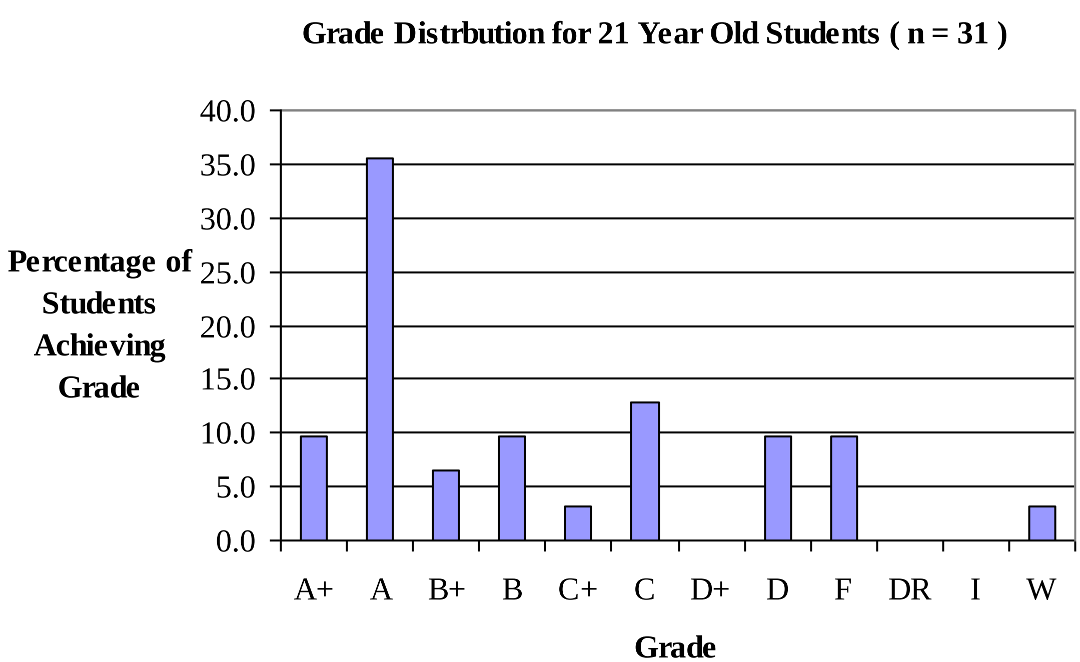


Fig. 2.13e

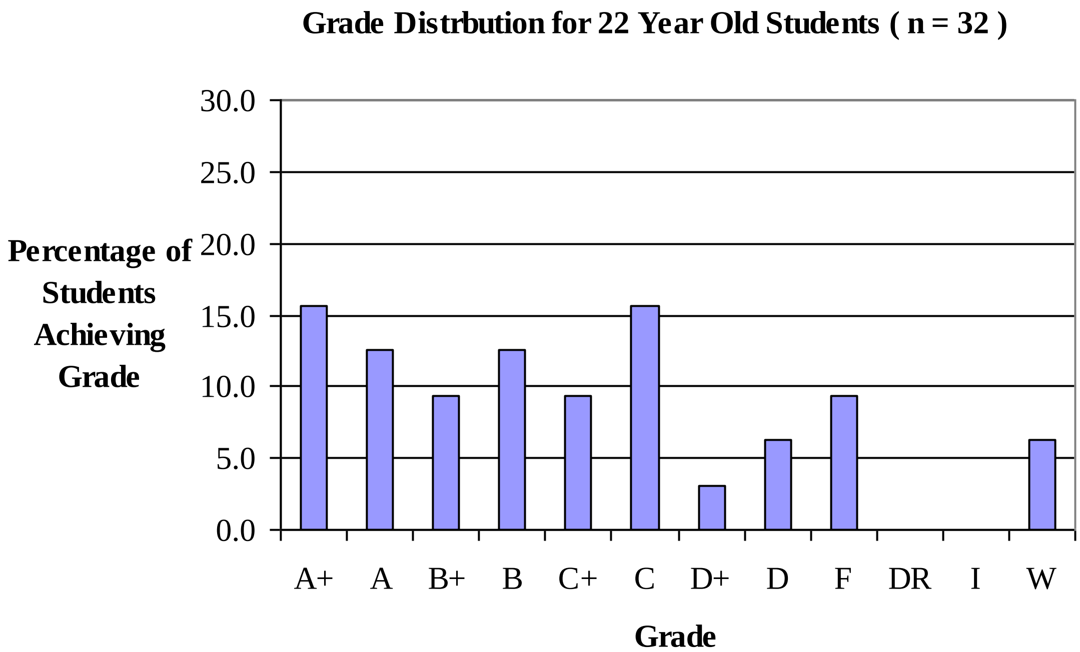
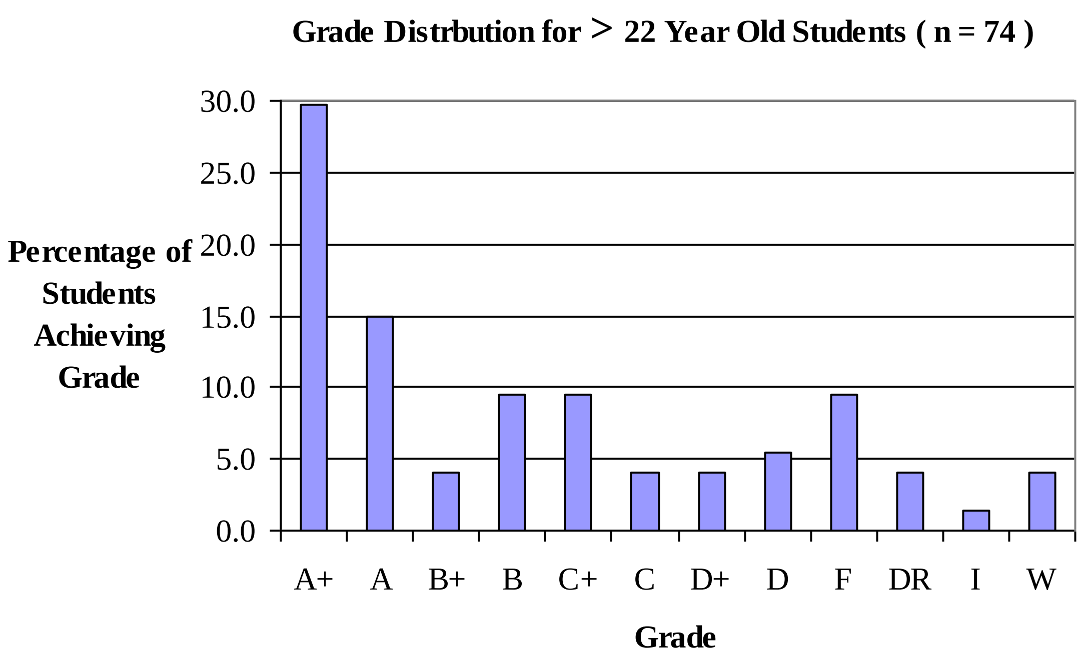


Fig. 2.13f



2.6.2 Gender

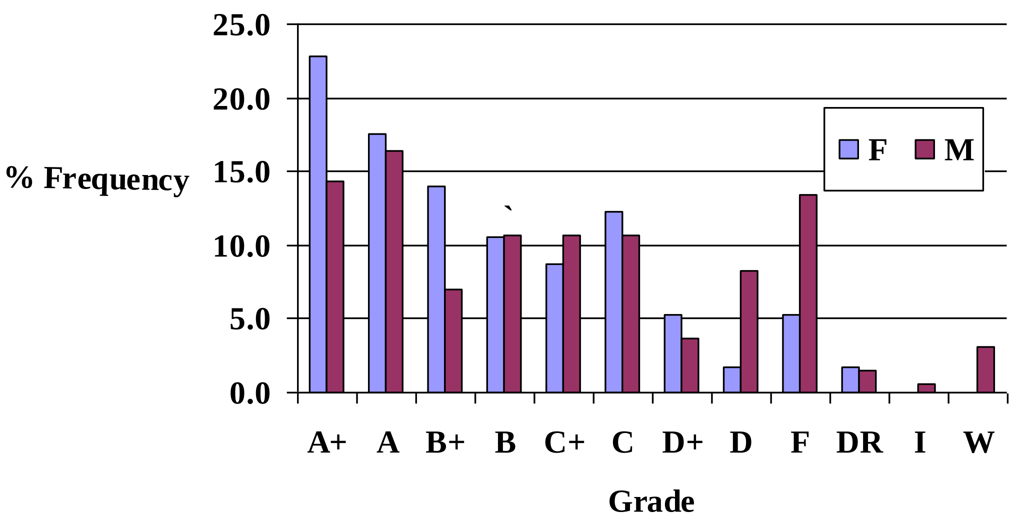
2.6.2.1 First Semester Math Grade Distribution by Gender

Of the total intake of 386 students in first semester Manufacturing Sciences postsecondary programs, 57 were female and 329 male. Figure 2.14 shows the percentage distribution of female and male students over the grade range in first semester math. In the higher grade categories, female students outperformed male students in their first semester math courses relative to their sample sizes.

The midrange grades show mixed results. However, larger percentages of males were likely to achieve D or F grades. The failure rate among males as a group was 13.4 % while the corresponding rate for the female group was 5.3 %, well below the average of the entire group (12.2 %).

Fig. 2.14

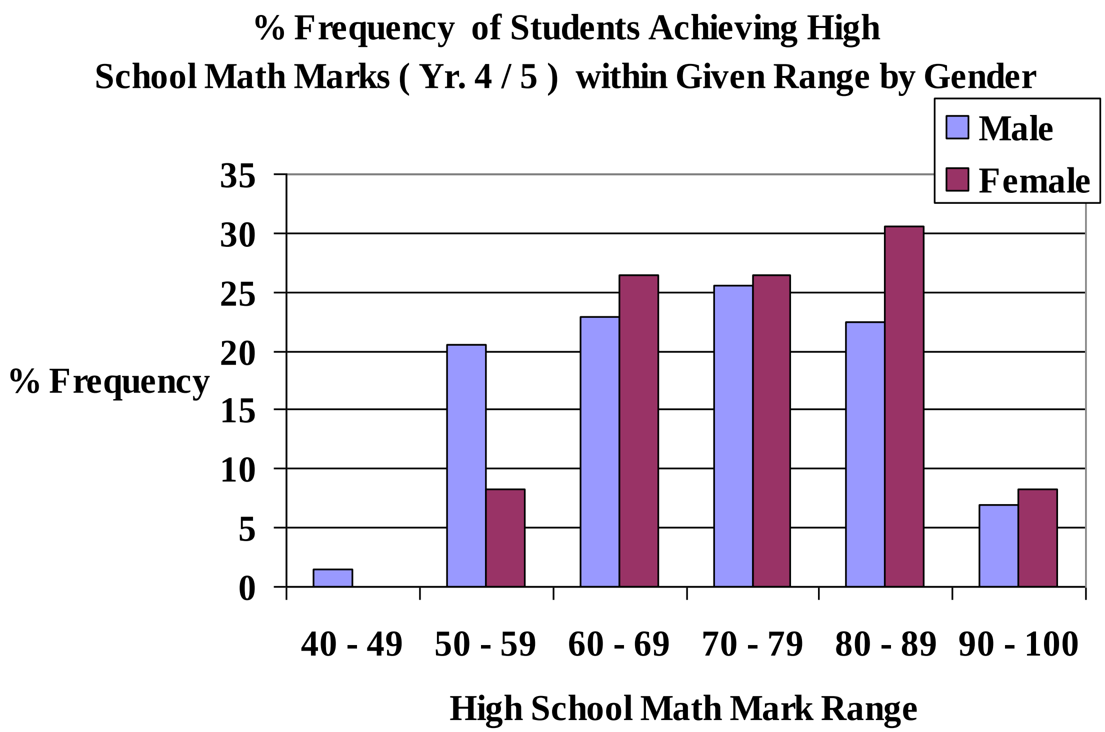
First Semester Math Grade Distribution by Gender as Percentages of Number in each Gender Sample (Female, n = 57; Male, n = 329)



2.6.2.2 High School Year 4/5 Math Course Results by Gender

The trend in first semester College math grades is paralleled by the analysis of high school year 4/5 marks analyzed by gender. Female candidates outscored their male counterparts in all mark categories above 60 %. Fig. 2.15 provides a frequency distribution for the gender groups in class widths of 10 marks between 40 and 100.

Fig. 2.15



3.0 Conclusions

3.1 Diagnostic Test Results

3.1.1 Group Results on the Diagnostic Test

Group results on Part 1 of the diagnostic test illustrated a somewhat normal distribution for frequency of students versus score as expected on such a test. A similar distribution for Part 2 of the test was positively skewed. The reasons for this might include lack of time to complete the second part, lack of will to keep writing through the second hour and inability to reliably answer questions of higher difficulty in algebra.

In studying the test results by section, the weakness as a group in providing correct answers on some of the more difficult topics is evident. In particular, manipulation of algebraic fractions and solving word problems involving writing equations from a worded statement exhibited quite low average scores. The end of Part 2 dealt with topics in trigonometry and geometry. Scores on these sections exhibited a slight improvement over the previous sections dealing with more complicated algebraic operations.

3.1.2 Diagnostic Test Results and Success in First Semester

Mean diagnostic test marks for the group were computed for each grade category. These average marks show the expected trend of a positive correlation of test marks with math grades. Dispersion statistics of range and standard deviation were also computed for each category. The range and standard deviation are large for each category indicating that success of individual students is not predictable using diagnostic testing in this format.

For the purpose of comparing diagnostic test marks with first semester math achievement, the overall body of marks from both parts of the diagnostic test was transformed as a percentile ranking. This ranking was subdivided as decile groupings.

Within each decile grouping, frequencies of letter grades were tabulated and presented as histograms. The highest four decile groupings exhibit a strong trend of first semester math grades towards the upper end of the grade scale. The remaining (lower) deciles show mixed results with significant numbers of students still achieving high first semester math grades.

However, the lowest four decile groupings show a significantly larger proportion of students performing in the D and F range in first semester college math. In this case, the diagnostic test results provide a useful indicator of potential "at risk" behaviour for a significant sample of students in first semester.

This information, provided early in the term, would provide useful feedback to both the student and teacher.

The correlation between diagnostic test scores and first semester program success as measured by GPA is moderately weak and thus the test is not a reliable predictor of individual success. However, as a group, the diagnostic test mark was a better indicator of first semester math success than the students' best high school year 4/5 math marks.

3.2 High School Math Preparation and Success in First Semester

The majority (77%) of first semester candidates entered Manufacturing Sciences Division postsecondary programs with one or more "new" curriculum (grade 12) math courses. Students emerging from university stream courses (MCB4U, MGA4U, and MDM4U) and Math for Technology (MCT4C) were best prepared for success in first semester college math.

In the Manufacturing Sciences Division fall 2005 intake, 140 students had emerged from the grade 12 course Math for College and Apprenticeship (MAP4C). Of all 10 possible prerequisite high school grade 12/OAC math course groups, this was the largest. This group exhibited both the highest group average (74%) in MAP4C compared to all other admissible high school grade 12/OAC math course groupings but also the highest failure rate (20.7%) in first semester College math. The average first semester College math failure rate for all other groups was 7.3%.

In addition, the students who took MAP4C make up a large proportion of the group who achieved first semester math grades in the lower portion of the grade range (D to C+).

The group of students (n = 56) that took Math for Technology (MCT4C) exhibited the lowest failure rate (0%) of any group with a significant sample size.

The correlation of grade 12/OAC marks with first semester program GPA is also weak.

Based on these weak links, high school math marks are not a reliable indicator of success in first semester math or overall program grade outcomes. The Grade 12 high school math course MAP4C was not an effective preparation for entry into first semester College math in Manufacturing Sciences Division postsecondary programs in 2005.

3.3 Technician and Technology Streams

There were 250 students registered in technician stream programs versus 136 students in technology stream programs. As a proportion of their group, a higher percentage of Technology stream students attained math grades in the upper levels of the grade range (A+,A,B+) than the technician group. Conversely, the rate of failure of technician stream students is proportionately more than double the rate for first semester technology stream students. In general, the students who consider themselves capable of tackling a technology program have an easier transition between high school math and College math.

For example, the technology students who have taken MAP4C (College and Apprenticeship Math) have a group average in that course 6.3 % higher than the corresponding group of technician students. The disparity in failure rates also indicates that the high school candidates for technician programs might not be aware of the level of challenge of first semester math and the degree to which mathematics runs through other first semester program courses.

3.4 First Semester GPA and First Semester Math Grade

There is a strong positive correlation between first semester program GPA and success in student’s first semester math course. This is expected since math grade points are included in the overall GPA. The measurement of math grade points and a grade point average based on remaining courses was not performed.

3.5 Age and Gender

3.5.1 Age

The highest proportion (~30%) of A+ math grades for first-year students occurs in the highest age category (> 22 years). This is likely due to an increased maturity of older first year students and greater commitment to their program of choice. However, it must be added that the math backgrounds of these students were not specifically checked. For example, some of these students might have entered post-secondary programs via Fanshawe College's ACE or Pre-Tech programs.

The failure rate for the groups of 19 and 20-year old students from the data tends to be higher (~ 15% versus ~10% for all other age categories).

3.5.2 Gender

Female students, as a group, proportionately achieved higher math grades (A+, A, B+) than the male group. In the middle of the grade range (B,C+,C,D+) there seems to be little difference in the performances in first semester math between these groups. Males outnumbered females proportionately in the D and F grade ranges. In particular, males failed math at more than twice the rate of the female group and seemed to show a higher tendency to withdraw from first semester math.

Female candidates were better prepared as a group using their high school grade 12/OAC marks as a standard. The female group scored, on average, 5.3% higher than the male group in these upper level high school math courses.

4.0 Recommendations

4.1 Diagnostic Testing

The results of diagnostic testing cannot predict individual student success (or “at risk” behaviour) according to this study. However, the decile rankings of students scores on the diagnostic test indicates that the test is of some value to communicate potential "at risk" behaviour to both student and teachers.

This study found that the groups of students falling into the bottom four deciles of the diagnostic test rankings were most likely to either fail first semester math or exhibit “at risk” behaviour. Further diagnostic testing would examine the reliability of this conclusion. This early warning with respect to potential difficulties in math allows both student and teacher the opportunity to engage additional resources to ensure success in college math.

4.2 Preparation for Technology Programs

The best preparation for first semester technology math, according to the data gathered, is a high school math course in the University stream or the Math for College Technology course (MCT4C) in the College stream. The Math for College and Apprenticeship (MAP4C) is a poor preparation for technology math and students emerging from this pathway in high school suffer approximately three times the failure rate as students graduating from all other prerequisite courses. Students applying to Manufacturing Sciences Division postsecondary programs should be made aware of the need to take a minimum of the Math for College Technology course (MCT4C). It would benefit the college system as a whole if :

- high school math teachers (and guidance counselors) are made aware of this data immediately;
- the Heads of Technology agreed that all technology programs across the province change technology program requirements for MCT4C from “recommended” to “required” within a period of two years.

4.3 Further Investigation

4.3.1 Tracking

Continuous tracking of student results in first-year technology math needs to be conducted. Tracking would provide insight into the effectiveness of high school math preparation in light of a changing high school curriculum. These changes will continue to have effects over several more years. In addition, continuous tracking of student progress would allow validation of the conclusions made above and also flag changing trends.

4.3.2 Further Questions

Further questions which have arisen from this report include the following:

1. Why did some students who performed poorly on the diagnostic test have significant success in first semester math? Conversely, why did some students who performed well on the diagnostic test achieve low math grades in first semester?

2. Why are male students far more likely to fail math or withdraw from their course/program than female students during first semester?

3. Why the failure rate in first semester math is for students enrolled in technician programs proportionately double the rate for students in technology programs?

4. Why did the group of students who withdrew from programs during first semester have the highest average diagnostic test score?

5. Would the results of this study hold true for the other College School of Technology Divisions/programs?

There are several areas of investigation beyond the scope of this report which warrant further study. These include:

- an assessment of the effectiveness of current teaching methods in College mathematics;
- an analysis of student work habits connected with independent study and completion of homework assignments and their effect on math grades;
- the effectiveness of learning support services in remediation of the effects of "under preparation" for College math;
- the impact of preparation in other foundational high school courses such as English;
- and Communications as factors in the degree of success achieved in first semester math;
- an analysis of high school student perception of the level of math required in various program streams;
- an analysis of the effectiveness of College preparatory programs in preparing students for postsecondary technology programs.