Wisconsin Department of Public Instruction & University of Wisconsin System
WISCONSIN CURRICULUM ARTICULATION PROJECT
WORKING GROUP FINAL REPORT
10 April 2001
CESA #7/8 Mathematics Subgroup

I. Working Group Name and Participants The working group name is the CESA #7/8 Mathematics Subgroup. Contact information for the subgroup members is in Appendix 1.

A. Lead Teacher
Gregory Davis

B. Working Group Members

1. UW System Faculty

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|---|---|
| Gregory Davis | UW-Green Bay |
| Tian-You Hu | UW-Green Bay |
| Nikitas Petrakopoulos | UW-Green Bay |
| Marty Schuh | UW-Manitowoc |

N. Petrakopoulos left the project in May 2000 after retiring from UW-Green Bay.

2. High School Faculty

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|---|---|
| Cheri Conover | West De Pere High School |
| Scott Kirst | Oconto Falls High School |
| Dennis Kostac | West De Pere High School |
| Ray Lucas | West De Pere High School |

D. Kostac left the project in April 2000 citing insufficient time to participate.

lI. Working Group Proceedings

A. Focus

The CESA #7/8 Mathematics Subgroup focused on

- Interface between High School and University mathematics courses a the following levels:
  - Intermediate Algebra
  - Algebra and Trigonometry
  - Calculus I
- Speed at which material is covered at the High School and the University for the same class
- Use of technology in the classroom
- Assessment of student experiences

B. Process

1. Meeting dates

After the initial meeting on 3 February in Wisconsin Dells, the CESA #7/8 Mathematics Subgroup met for two three hour meetings on the UW-Green Bay campus (25 March 2000 and 20 May 2000). Members corresponded extensively using e-mail to complete work associated with the project.

2. Sources of information

The CESA #7/8 Mathematics Subgroup carefully studied the Wisconsin's Model academic Standards for Mathematics and a draft copy of the Wisconsin high School Graduation Test. Course descriptions provided by high school faculty members of the committee were compared to course descriptions provided by UW system faculty for courses at the intermediate algebra, algebra and trigonometry, and calculus I mathematics levels.

3. Data collected

A questionnaire was created to help determine how well high school mathematics curriculum is aligned with university curriculum. The questionnaire was administered to students at UW-Green Bay in a section of each of Intermediate Algebra, Algebra and Trigonometry, Calculus I, Calculus II, and Introductory Statistics. The questionnaire was also administered to a section of Calculus I at UW-Manitowoc. A copy of the questionnaire can be found in Appendix 2.

4. Other activities

Discussion amongst committee members further addressed issues related to the speed at which material is covered at their own institutions as well as what is viewed as appropriate use of technology.

C. Findings and Results

1. Observations

It seemed that overall, the High School instructors in the group were much more aware of what was in the Wisconsin Model Standards than the University instructors. It was noted that it is difficult to 'unwrap' the standards; one of the problems is that the standards cover more than one year of mathematics. Importantly the group viewed the standards as a minimum.

Much time was spent trying to get a feel for the current instructional levels and expectations for our students and each other (instructors). A summary of the comments and concerns are as follows:

How students view the subject is important; do they have a passion for mathematics or are they interested in just obtaining the knowledge to pass the class? Certainly mastery of the subject is of prime importance - they need to learn what they learn very well. Mastery of the subject matter is key. Students must be confident in their abilities. They also must have sufficient breath in the subject to be mathematically literate. It seemed that at all levels that instructors

were concerned about the questionable algebra skills in their students. There was concern about the mathematical level needed for certification of K-8 teachers, many of who teach beginning algebra but may not have taken much mathematics themselves.

Instructors have their own set of problems. There are many useful and interesting mathematical concepts, techniques, and applications that can be presented to students; however, un-policed curriculum will not get done. The current curriculum is crowded; instructors will often only do what they need to get done. Accountability of instructors is important; instructors at each level must be able to assume that they will have students that have been properly trained at the previous level. Variation of instruction occurs at all levels and can be due to many factors. Instructor's interest and focus within the course may influence student outcomes. Too much of a gradation of ability within a class can make class management very difficult. Alternate learning styles - individual vs. group learning, collaborative learning, etc. - puts additional pressure on the amount of material that can be covered in a course. There is often pressure from students, parents, others to keep the amount of homework down. It was also noted that there is quite a bit of competition for getting students into advanced classes both at the high school and college level - the same students are often prized in several disciplines.

The interface between high school and college mathematics can occur at many levels. Group discussions focused primarily at three levels: the intermediate algebra level, the algebra and trigonometry level (pre-calculus level), and the first semester calculus level. Proper placement of students as well as student knowledge is important for a successful transition between institutions. Placement may be improved via input from their high school instructors and/or by taking the early placement mathematics test offered to junior level high school students. Time between the taking of high school and college mathematics courses should be considered in placement decisions. Copies of textbooks currently used at local high schools could be useful for college instructors to aid in placement and awareness of student knowledge. College instructors need to be aware that there are a number of capable high school students that don't take advanced mathematics in high school in order to be assured of keeping their GPA up. Specific expectations for starting college level, first semester calculus were discussed. It was desired that incoming students have the basics of logic and proof; that is, the ability to prove mathematical statements via logical arguments. In the past, much of this material had been covered in a mathematical analysis course after taking algebra and trigonometry in high school. This course has been removed in many high schools - most students now go directly from algebra and trigonometry to calculus.

Syllabi from a number of courses, both from the high schools and the universities were circulated. There was no concern about material that was covered both at the high school and the university. In fact those present feet that a bit of overlap is desired. On the other hand, gaps; i.e., missing material is not good. It is desirable that the high schools would teach the basics to a high degree so students are ready for college mathematics. The background does not need to include calculus. Gaps in proof writing skills, induction, combinatorics, and of course, algebra need to be minimized. Similarly high school instructors need to have students entering from the middle schools with appropriate mathematics background. This requires that middle school instructors need to have a strong enough mathematical background to teach algebra effectively.

In discussion related to the ability to move from concept to abstraction (symbolism) it was noted that there could be age dependence. Students may need to older before they fully understand

what they are doing. Students need to have strong communication and problem solving skills; they need to be able to explain what they are doing when they solve a problem. These skills need to be further developed once students enter college.

Finally it was noted that summer review programs for incoming freshman could help students make the transition between high school and university mathematics courses easier.

2. Summary of Data

The student questionnaire has been administered to five classes at UW-Green Bay (intermediate algebra, algebra and trigonometry, calculus 1, calculus II, and introductory statistics) and one class at UWC-Manitowoc (calculus I). Summaries of the UW-Green Bay results are in Appendix 3 and summaries of the UW-Manitowoc results are in Appendix 4.

Observations included that most of the incoming students took their first college mathematics class at the highest level that they had in high school or at the next higher level. The exception to this occurs at the intermediate algebra level. Here many of the students had taken high school classes that were at a higher level than intermediate algebra. These students would have been placed in intermediate algebra based on their WMPT score (or because they failed to take the WMPT and were placed in intermediate algebra by default). Conjectures for why there is an apparent 'misalignment' at this level include that some of the students had a lengthy time between high school and college mathematics, some students hadn't planned on taking mathematics at the college level, and some of the students may be math-phobic.

It was noted that essentially all of the surveyed students had taken a geometry course in high school. It was also noted that essentially all students had taken homework home on a regular basis during their time in high school.

It was difficult to assess the results related to the amount of writing, reading, and individual and group project involvement. The survey questions were written to vaguely and many student interpreted writing to include taking notes, doing word problems, etc. Some students felt that regular homework was an individual project and that working in groups on homework constituted a group project.

Based on the survey results a significant proportion of high school students have experience with graphing calculator technology; however, the proportion is not high enough that college instructors can assume students know graphing calculator as they enter college.

Survey results indicated that most of the students had taken high school mathematics courses in which their instructors lectured or led the class most of the time (80% or more of the time).

The vast majority of the students surveyed felt that their high school mathematics courses had prepared them adequately for their college level mathematics courses. There were a few interesting student comments related to their preparedness for college mathematics. One indicated that the student would have liked to have been encouraged to take more mathematics in high school. Another indicated that there was a great difference in teaching style between high school and college mathematics courses.

Members of the committee discussed the possibility of teaching classes in a fashion that would make transitions between high school and college teaching styles easier for the students. This may be accomplished by having more independence on the role of high school students near the end of high school classes and more dependence on the role of the college instructor near the beginning of college classes. Such teaching strategies may elevate the perception that if you do poorly in high school it's (always) the teacher's fault and more toward the perception that it's (often) your own fault.

3. Findings from other activities

Members of the subgroup feel that when used appropriately, calculators can be powerful tools. The use of calculators can aid in higher-level thinking. Calculators have the potential to allow students to explore more (numerically) complicated problems then they would be able to without them. Many new textbooks at the High School level require graphing calculators. UW-Green Bay faculty members expect students to know how to use graphing calculators when they come into the University.

Members of the subgroup feet that students need to have an appropriate balance between theory and application. Students need to know how to prove their results when asked; i.e., use technology to the max - but know how to verify the result. Students need to know and understand the process from which their solution follows. It was noted that students relying on calculator on WMPT don't typically do as well as those that are more comfortable with hand and mind calculations. The exact mix of theory and application is unclear. There are different needs for students depending on whether they go on to attend college or if they are initially employed by a business. Some people coming back to visit high school after graduation and being employed wish they had more mathematics, some wish they had less. People often don't see the value of mathematics

It was also noted that a significant proportion of High School students do not have number sense. This, in part, may be due to limited number sense in elementary education instructors. Teachers should be able to do problems without calculators - this is not always the case. It was questioned as to whether elementary teachers should be trained differently - should there be more mathematics required in their education? Should there be a mathematics resource person in each school; i.e., an instructor who has specialized in mathematics?

High school students are aware that the pace material is covered in universities and colleges is higher than that in the high school. Previous students often come back to the high school and report this fact. They also point out that universities and colleges are filled with stronger students.

The format in which material is presented may differ greatly between high school and the university. In high school students are involved in more group work. In the university there are more classes that follow a standard lecture format. Furthermore, a large number of high school students are able to finish their homework while in the classroom. This is not the case in the university. Typically students entering the universities will need to modify their study habits.

It is understood that we need to be able to take students from where they are, in terms of their mathematical skills, to where we want them to be. The better preparation students receive at each level - elementary through college - the easier it is to achieve this goal. Effective communication between instructors at each educational level is necessary. The communication lines between high school and college need to include people in the mathematics discipline - not just the education program. It is important that high school instructors are aware of what university instructors expect.

D. Actions/Revisions

Because of the general alignment of coursework between the high-school and university we do not see that there is a need for major revision in course content, any assessment instruments, pedagogy, etc. However, since we have learned more about teaching strategies and techniques at our different institutions, there most likely will be attempts to try one or more of the strategies and techniques that we have now been introduced to.

E. Reflections and Recommendations

One of the most gratifying outcomes of this articulation project has been the initiation of dialog between high-school faculty and university disciplinary faculty. While there has been ongoing interaction between high-school faculty and university education faculty, there has historically been little or no interaction between experts in the discipline at the high school and university levels. It would be wonderful if these interactions could be maintained and/or expanded. We also feel that it is important to foster similar interactions with middle school instructors.

We feel that a major obstacle in the continuing education of students in mathematics is the problem of retention of material presented at all levels. As students move through our educational system more material needs to be re-taught than we are satisfied with. Why this is so and how to combat this problem is a worthy line of study. Optimization of the learning process is a difficult and universal problem - perhaps a direction that can be pursued by another system wide project such as this one.

APPENDIX 1 CESA #7/8 Mathematics Subgroup member contact information

*Name:* Cheri Conover
***Institution:*** West De Peer High School
*Address:* 665 Grant Street
De Peer, WI 54115
*Phone:* 920-338-5262
*Fax:* 920-338-5310
*Email:* cheri@uncubed.com
***Preferred Contact TimelMethod:*** e-mail
*Subject(s) Taught:* All HS levels except trigonometry.

*Name:* Gregory Davis
***Institution:*** UW-Green Bay
*Address:* 2420 Nicolet Drive
Green Bay, WI 54311
*Phone:* 920-465-2249
*Fax:* 920-465-2376
*Email.* davisg@uwgb.edu
***Preferred Contact TimelMethod:*** e-mail
***Subject(s) Taught:*** Intermediate algebra through advanced mathematics courses.

*Name:* Tian-you Hu
***Institution:*** UW-Green Bay
*Address:* 2420 Nicolet Drive
Green Bay, WI 54311
*Phone:* 920-465-2173
*Fax:* 920-465-23 76
*Email.* but@uwgb.edu
***Preferred Contact TimelMethod:*** e-mail
*Subject(s) Taught:* Algebra, trigonometry, calculus sequence, analysis sequence, and linear algebra sequence.

*Name:* Scott Kirst
***Institution:*** Oconto Falls High School
*Address:* P.O. Box 988
Oconto Falls, WI 54154
*Phone:* 920-846-4467
*Fax:* 920-846-4444
*Email.* sctkirst@aol.com
***Preferred Contact TimelMethod:*** e-mail
*Subject(s) Taught:* AP physics, astronomy, science, algebra, geometry, trigonometry, pre-calculus.

*Name:* Dennis Kostac
***Institution:*** West De Pere High School
*Address:* 665 Grant Street
De Pere, WI 54115
***Phone:*** 920-338-5286
*Fax:* 920-338-5310
*Email:* sta22c@aol.com
***Preferred Contact TimelMethod:*** e-mail
*Subject(s) Taught:* Pre-calculus and calculus.

*Name:* Ray Lucas
***Institution:*** West De Pere High School
*Address:* 665 Grant Street
De Pere, WI 54115
***Phone:*** 920-338-5256(W) 920-449-0172(H)
*Fax:* 920-338-5310
*Email.* lucas@netnet.net
***Preferred Contact TimelMethod:***
***Subject(s) Taught:*** Physics, advance algebra.

*Name:* Nikitas Petrakopoulos
***Institution:*** UW-Green Bay
*Address:* 2420 Nicolet Drive
Green Bay, WI 54311
*Phone:*
*Fax:*
*Email:*
***Preferred Contact TimelMethod:*** *? retired* to Florida.
***Subject(s) Taught:*** Primarily the calculus sequence and differential equations. Member of the UW System Mathematics Placement Test Committee.

*Name:* Marty Schuh
***Institution:*** UW-Manitowoc
*Address:* 1118 Fairmont Lane
Manitowoc, WI 54220
***Phone:*** 920-683-4736(W) 920-682-2332(H)
*Fax:* 920-683-4776
*Email:* mschuh@uwc.edu
***Preferred Contact TimelMethod:*** 10:00-10:50 (phone), evenings, e-mail
***Subject(s) Taught:*** All freshman-sophomore course of the UW including quantitative reasoning, elementary algebra through differential equations and content courses for elementary teachers.

APPENDIX 2 Student Questionnaire

This questionnaire has been designed to help determine how well high school mathematics curriculum is aligned with university mathematics curriculum. Information from this survey will be used as part of a report generated by the UW-system wide Curriculum Articulation Project. The major goal of the project is to create a 'seamless' transition between high school and university coursework. If you would like more information about this project please feel to contact Dr. Gregory Davis in ES323. Thank you for your input.

1. What was the highest level of mathematics that you completed in High School?
2. Did you complete a course in geometry in High School?
3. How much statistics did you have in your high school mathematics courses?
4. Other than algebra, geometry, and advanced algebra, what mathematics courses were offered in high school?
5. How often was homework assigned in your High School mathematics classes?
6. How often were you required to complete mathematics assignments outside of normal class time?
7. How often were you involved in individual projects in your High School mathematics classes?
8. How often were you involved in group projects in your High School mathematics classes?
9. How much reading did you have to do in your High School mathematics courses?
10. How much writing did you have to do in your High School mathematics courses?
11. Did you use a graphing calculator for your High School mathematics classes? If yes, was it required and what type was it?
12. Other than calculators, what technology did you use in your High School mathematics courses?
13. In your High School mathematics classes, what percentage of the time was the teacher teaching students and what percent of the time were students teaching students?
14. How well did your High School mathematics courses prepare you for your University mathematics courses?
15. What was the first University mathematics course you enrolled in and what mathematics course(s) are you currently enrolled in?

APPENDIX 3 UW-Green Bay Student Questionnaire Results

Students in five different courses at UW-Green Bay completed the survey. The courses included a section of each of the following: 600-101 Intermediate Algebra, 600-104 Algebra and Trigonometry, 600-202 Calculus 1, 600-203 Calculus II, and 600-260 Introductory Statistics.

1. What was the highest level of mathematics that you completed in High School?

| | Intermediate Algebra | Algebra and Trigonometry | Calculus I | Calculus II | Introductory Statistics | Total |
|---|---|---|---|---|---|---|
| General Math | 1 ( 3%) | 0 ( 0%) | 0 ( 0%) | 0 ( 0%) | 0 ( 0%) | 1 ( 1 %) |
| Geometry | 6 (18%) | 1 ( 5%) | 0 ( 0%) | 1 ( 5%) | 2 ( 7%) | 10 ( 8%) |
| Algebra | 7 (21 %) | 6 (27%) | 4 (19%) | 2 (11 %) | 8 (30%) | 27 (22%) |
| Trigonometry | 1 ( 3%) | 4 (18%) | 1 ( 5%) | 0 ( 0%) | 2 ( 7%) | 8 ( 7%) |
| Pre-calculus | 15 (45%) | 5 (23%) | 13 (62%) | 5 (26%) | 9 (33%) | 47 (39%) |
| Analysis | 2 ( 6%) | 1 ( 5%) | 0 ( 0%) | 0 ( 0%) | 0 ( 0%) | 3 ( 2%) |
| Calculus | 0 ( 0%) | 3 (14%) | 3 (14%) | 11 (58%) | 6 (22%%) | 23 (19%) |
| Other | 1 ( 3%) | 2 ( 9%) | 0 ( 0%) | 0 ( 0%) | 0 ( 0%) | 3 ( 25) |

2. Did you complete a course in geometry in High School?

| | Intermediate Algebra | Algebra and Trigonometry | Calculus I | Calculus II | Introductory Statistics | Total |
|---|---|---|---|---|---|---|
| Yes | 31 (94%) | 22 (100%) | 21 (100%) | 19 (100%) | 27 (100%) | 120 (98%) |
| ~No | 2 ( 6%) | 0 ( 0%) | 0 ( 0%) | 0 ( 0%) | 0 ( 0%) | 2 ( 2%) |

3. How much statistics did you have in your high school mathematics courses?

| | Intermediate Algebra | Algebra and Trigonometry | Calculus I | Calculus II | Introductory Statistics | Total |
|---|---|---|---|---|---|---|
| None | 14 (42%) | 9 (43%) | 13 (62%) | 9 (47%) | 16 (59%) | 61 (50%) |
| Some | 13 (39%) | 7 (33%) | 5 (24%) | 7 (37%) | 8 (30%) | 40 (33%) |
| Full Course | 5 (15%) | 1 ( 5%) | 2 (10%) | 3 (16%) | 3 (11%) | 14 (12%) |
| Other | 1 ( 3%) | 4 (19%) | 1 ( 5%) | 0 ( 0%) | 0 ( 0%) | 6 ( 5%) |

4. Other than algebra, geometry, and advanced algebra, what mathematics courses were offered in high school?

Responses from Intermediate Algebra students:

Statistics, trigonometry; calculus; calculus; honors geometry, trigonometry, pre-calculus, calculus; don't remember; trigonometry, discrete, calculus, statistics; calculus; calculus; calculus; calculus AB, calculus

BC, trigonometry; calculus 1, trigonometry, and mathematical analysis; pre-calculus with trigonometry, calculus; don't know; calculus; FST, pre-calculus; pre-calculus, calculus, statistics; calculus (one semester); analysis and calculus; trigonometry, algebra and trigonometry, pre-calculus, calculus; trigonometry; precalculus and calculus; I did not participate; pre-calculus, calculus, applied mathematics; trigonometry; analysis, calculus, advanced calculus, statistics; calculus; calculus; introduction to college mathematics, statistics, advanced statistics, trigonometry; trigonometry; advanced mathematical concepts, calculus, precalculus, trigonometry; trigonometry, calculus, problem solving I and II; calculus; none.

Responses from Algebra and Trigonometry students:

AP calculus; calculus, AP calculus, advanced calculus, advanced trigonometry; calculus, trigonometry; calculus; advanced mathematics, calculus, and cord classes; trigonometry; statistics; calculus; that was all; calculus, analysis; pre-calculus, calculus; statistics, calculus 1, II, pre-algebra, basic mathematics; I am not really sure; advanced calculus, statistics; probability and statistics, calculus, trigonometry; calculus, statistics; calculus, mathematical analysis, statistics; I'm not sure because I followed the algebra, geometry, algebra and trig plan; IB pre-calculus, IB calculus, IB math methods (higher calculus I believe), IB math studies 1 and 2; trigonometry and pre-calculus, but I did not take them; calculus.

Responses from Calculus I students:

Algebra 1, II, trigonometry and calculus, geometry; pre-calculus, calculus, statistics I and II; math IV, calculus; pre-calculus, calculus, college algebra, trigonometry; pre-calculus, calculus; trigonometry, precalculus, calculus; calculus; statistics, calculus, analysis; algebra, trigonometry, pre-calculus, A.P. calculus; calculus; calculus; Don't know; pre-calculus and calculus; probability and statistics, advanced algebra (trigonometry); pre-calculus; calculus; a lot; pre-calculus, calculus, statistics; statistics, calculus, precalculus; trigonometry and analytic geometry, statistics, pre-calculus, calculus.

Responses from Calculus 11 students:

Analysis and differential equations, mechanics, sets and logic; Calculus; don't know; statistics, calculus, math connections; calculus, analytic geometry; math analysis - between algebra II and trigonometry and calculus, calculus; trigonometry, calculus; pre-calculus; calculus, statistics; advanced mathematical concepts as of my senior year and the following year they started calculus; calculus, statistics; pre-calculus, discrete mathematics, calculus; calculus I; probability and statistics, trigonometry, analytic geometry, elementary functions; logic, trigonometry, mechanics, statistics; calculus I, II; AP calculus, pre-calculus, some other lower level classes; statistics, applied mathematics, mathematical connections, calculus; statistics, calculus, pre-calculus, trigonometry.

Responses from Introductory Statistics students:

Trigonometry and calculus; calculus, pre-calculus, college algebra and trigonometry; trigonometry and calculus; trigonometry and calculus; general mathematics, analysis; trigonometry, statistics, calculus; trigonometry, calculus; mathematical analysis, advanced topics in mathematics, AP calculus; trigonometry and calculus; calculus; calculus and statistics; pre-calculus and calculus; trigonometry and calculus; trigonometry and calculus; advanced mathematics, pre-calculus, International Baccalaureate (IB): IB Math Studies 1,11, IB calculus; none.

5. How often was homework assigned in your High School mathematics classes?

| | Intermediate Algebra and Algebra | | Trigonometry | Calculus I | Calculus II | Introductory Statistics | | Total |
|---|---|---|---|---|---|---|---|---|
| Every Day | 23 | (70%) | 18 (82%) | 16 (76%) | 16 (84%) | 17 | (63%) | 90 (74 |
| 3 + Days a Week | 4 | (12%) | 2 ( 9%) | 2 (10%) | 2 (11%) | 8 | (30%) | 18 (15 |
| Weekly | 3 | ( 9%) | 0 ( 0%) | 1 ( 5%) | 0 ( 0%) | 1 | ( 4%) | 5 ( 4 |
| Never | 0 | ( 0%) | 1 ( 5%) | 2 (10%) | 0 ( 0%) | 0 | ( 0%) | 3 ( 2 |
| Other | 3 | ( 9%) | 1 ( 5%) | 0 ( 0%) | 1 ( 5%) | 1 | ( 4%) | 6 ( 5 |

6. How often were you required to complete mathematics assignments outside of normal class time?

| | Intermediate Algebra and Algebra | | Trigonometry | Calculus I | Calculus II | Introductory Statistics | | Total |
|---|---|---|---|---|---|---|---|---|
| Every Day | 12 | (36%) | 11 (50%) | 14 (67%) | 13 (68%) | 15 | (56%) | 65 (53 |
| 3 + Days a Week | 13 | (39%) | 9 (41%) | 2 (10%) | 4 (21%) | 9 | (33%) | 37 (30 |
| Weekly | 4 | (12%) | 1 ( 5%) | 3 (14%) | 1 ( 5%) | 2 | ( 7%) | 11 ( 9 |
| Never | 1 | ( 3%) | 0 ( 0%) | 2 (10%) | 0 ( 0%) | 0 | ( 0%) | 3 ( 2 |
| Other | 3 | ( 9%) | 1 ( 5%) | 0 ( 0%) | 1 ( 5%) | 1 | ( 4%) | 6 ( 5 |

7. How often were you involved in individual projects in your High School mathematics classes?

| | Intermediate Algebra and Algebra | Trigonometry | Calculus I | Calculus II | Introductory Statistics | Total |
|---|---|---|---|---|---|---|
| Never | 17 (52%) | 12 (55%) | 11 (52%) | 8 (42%) | 11 (41%) | 59 (48%) |
| Rarely | 12 (36%) | 7 (32%) | 5 (24%) | 8 (42%) | 13 (48%) | 45 (37%) |
| Often | 3 ( 9%) | 2 ( 9%) | 2 (10%) | 2 (11 %) | 2 ( 7%) | 11 ( 9%) |
| Other | 1 ( 3%) | 1 ( 5%) | 3 (14%)- | 1 ( 5%) | 1 ( 4%) | ~7 (.6%) |

8. How often were you involved in group projects in your High School mathematics classes?

| | Intermediate Algebra and Algebra | | Trigonometr | | Calculus I | Calculus II | Introductory Statistics | | Total |
|---|---|---|---|---|---|---|---|---|---|
| Never | 15 | (45%) | 12 | (55%) | 10 (48%) | 7 (37%) | 6 | (22%) | 50 (41%) |
| Rarely | 13 | (39%) | 7 | (32%) | 7 (33%) | 7 (37%) | 16 | (59%) | 50 (41%) |
| Often | 3 | ( 9%) | 2 | ( 9%) | 3 (14%) | 5 (26%) | 5 | (19%) | 18 (15%) |
| Other | 2 | ( 5%) | 1 | ( 5%) | 1 ( 5%) | 0 ( 0%) | 0 | ( 0%) | 4 ( 3%) |

9. How much reading did you have to do in your High School mathematics courses?

| | Intermediate Algebra | | Algebra and Trigonometr | | Calculus I | Calculus II | Introductory Statistics | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| None | 12 | ( 36%) | 4 | (18%) | 5 (24%) | 3 (16%) | 2 | ( 7%) | 26 (21%) | |
| A Little | 16 | (48%) | 16 | (73%) | 12 (57%) | 16 (84%) | 24 | (89%) | 84 (69%) | |
| A lot | 1 | ( 3%) | 1 | ( 5%) | 1 ( 5%) | 0 ( 0%) | 1 | ( 4%) | 4 ( 3%) | |
| Other | 4 | (12%) | 1 | ( 5%)l | 3 (14%) | 0 ( 0%) | 0 | ( 0%) ~ | 8 ( 7%) | 1 |

10. How much writing did you have to do in your High School mathematics courses?

| | Intermediate Algebra | | Algebra and Trigonometry | | Calculus I | Calculus II | Introductory Statistics | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| None | 16 | (48%) | 14 | (64%) | 11 (52%) | 9 (47%) - | | 9 (33%) | 59 (48%) | |
| A Little | 9 | (27%) | 6 | (27%) | 8 (38%) | 8 (42%) | 17 | (63%) | 48 (39%) | |
| A lot | 2 | ( 6%) | 1 | ( 5%) | 1 ( 5%) | 2 (11%) | | 1 ( 4%) | 7 ( 6%) | |
| Other | 6 | (18%) | 1 | ( 5%) | 1 (5%) | 0 ( 0%) | | 0 ( 0%) I | 8 ( 7%) | |

11. Did you use a graphing calculator for your High School mathematics classes? If yes, was it required and what type was it?

With the exception of two persons mentioning Casio calculators, all responses named Texas Instrument products. TI-81, TI-82, TI-83, TI-85, and TI-86 were all used. In some cases the school supplied the calculators.

| | Intermediate Algebra | | Algebra and Trigonometry | | Calculus I | Calculus II | Introductory Statistics | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| Yes | 20 | (61%) | 13 | (59%) | 16 (76%) | 13 (68%) | 17 | (63%) | 79 (65%) | |
| No | 13 | (39%0 | 9 | (41%) | 5 (24%) | 6 (32%) | 10 | (37%) | 43 (35%) | |
| Required | 12 | (36%) | 6 | (27%) | 13 (62%) | 8 (42%) | 11 | (41%) | 50 (41%) | |
| Required Given Yes | | 60% | | 46% | 81% | 62% | | 65% | 63% | |

12. Other than calculators, what technology did you use in your High School mathematics courses?

| | Intermediate Algebra | | Algebra and Trigonometry | | Calculus I | Calculus II | Introductory Statistics | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| None | 25 | (76%) | 18 | (82%) | 12 (57%) | 15 (79%) | 17 | (63%) | 87 (71%) | |
| Computer | 8 | (24%) | 4 | (18%) | 8 (38%) | 4 (21%) | 10 | (37%) | 34 (28%) | |
| Other | 0 | ( 0%) | 0 | ( 0%) | 1 ( 5%) | 0 ( 0%) | 0 | ( 0%) j | 1 | ( 1%) |

Chalkboard, compasses, protractors, slide rules, logarithm tables, math videos, pencil, paper, eraser, overhead projector, and our brains were listed as other types of technology used in the classroom.

13. In your High School mathematics classes, what percentage of the time was the teacher teaching students and what percent of the time were students teaching students?

| | Intermediate Algebra | | Algebra and Trigonometry | Calculus I | Calculus II | Introductory Statistics | | Total |
|---|---|---|---|---|---|---|---|---|
| 100% | 12 | (36%) | 7 (32%) | 8 (38%) | 8 (42%) | 11 | (41%) | 46 (38%) |
| 95% | 6 | (18%) | 2 ( 9%) | 0 ( 0%) | 0 ( 0%) | 5 | (19%) | 13 (11%) |
| 90% | 6 | (18%) | 3 (14%) | 3 (14%) | 6 (32%) | 8 | (30%) | 26 (21%) |
| 80% | 2 | ( 6%) | 3 (14%) | 2 (10%) | 0 ( 0%) | 0 | ( 0%) | 7 ( 6%) |
| 75% | 3 | ( 9%) | 4 (18%) | 3 (14%) | 1 ( 5%) | 1 | ( 4%) | 12 (10%) |
| 70% | 1 | ( 3%) | 0 ( 0%) | 2 (10%) | 1 ( 5%) | 0 | ( 0%) | 4 ( 3%) |
| 65% | 0 | ( 0%) | 0 ( 0%) | 0 ( 0%) | 0 ( 0%) | 1 | ( 4%) | 1 ( 1%) |
| 50% | 1 | ( 3%) | 2 ( 9%) | 1 ( 5%) | 1 ( 5%) | 0 | ( 0%) | 5 ( 4%) |
| 25% | 0 | ( 0%) | 0 ( 0%) | 1 ( 5%) | 0 ( 0%) | 0 | ( 0%%) | 1 ( 1%) |
| Other | 2 | ( 6%) | 1 ( 5%) | 1 ( 5%) | 2 (10%) | 1 | ( 4%) | 7 ( 6%)~ |

14. How well did your High School mathematics courses prepare you for your University mathematics courses?

| | Intermediate Algebra | Algebra and Trigonometry | Calculus I | Calculus II | Introductory Statistics | Total |
|---|---|---|---|---|---|---|
| Very Well | 19 (58%) | 17 (77%) | 19 (90%) | 16 (84%) | 20 (74%) | 91 (75% |
| Not Well | 8 (24%) | 3 (14%) | 1 ( 5%) | 3 (16%) | 4 (15%) | 19 (16%) |
| Other | 6 (18%) | 2 ( 9%) | 1 ( 5%) | 0 ( 0%) | 3 (11%) | 12 (10%) |

Additional comments from Intermediate Algebra students:

It was over 10 years ago, I don't remember; I felt this class was easy for me; I took math in high school and then waited a year and a half to take it in college, so I relearned almost everything; fairly well - I just should of continued with more mathematics. I took trigonometry my sophomore year and then stats and that was it; poorly - we got to use notes on all tests and quizzes - did not prepare me for this class; I think they should have spent more time helping us so we were more prepared when coming to the university; its been 10 years, I forgot a lot, it's hard to say; what I did helped; excellent - except for I don't know why I was placed in a lower mathematics class in college - it's too easy; a lot - the upper level courses did; very well, intermediate is a basic review from overall in high school; it didn't help very much.

Additional comments from Algebra and Trigonometry Students:

Algebra I and II and geometry prepared me well, but pre-calculus was taught in a very confusing way so it was like learning it from the start in college; It did not help - I had to go start back with elementary algebra in college; They taught the basics so the college material built on that; Very well - I am in pre-calculus right now and it is all completely a review; Overall I felt prepared; Good, but I forgot over the summer; Graduated HS in 93, did not take higher math, not needed for physical therapy major at that time. Just reentered college and changed major to compute science; It helped a little in certain areas.

Additional comments from Calculus I students:

Alright - did not prepare me for UW-Madison; Very well - covered as much in high school as calculus in college; Great - I needed that knowledge for college; Very well, in fact my scores on the entrance examination were just a bit to low and I had to take algebra and trigonometry which was all review; I wish I would have taken calculus, no one encouraged me to do so.

Additional comments from Calculus II students:

Not very well because I didn't have math in the calculus level; Good, I understood the concepts from day one; I had good instruction of the basics so I was pretty well prepared.

Additional comments from Introductory Statistics students:

OK - not very good in math though; High school was probably adequate, however, I have been out of high school for nine years, so a lot of my high school math has left me; It gave me the basics to move on; Not very much. College professors are completely different in most aspects than high school teachers - grading, tests, etc.; Too long ago to consider as prep for college; I think extremely well

15. What was the first University mathematics course you enrolled in and what mathematics course(s) are you currently enrolled in?

| | First University Mathematics Course | | | | | |
|---|---|---|---|---|---|---|
| | Elementary Algebra | Intermediate Algebra | Algebra and Trigonometry | Calculus I | Calculus II | Introductory Statistics |
| Current Intermediate Course Algebra | 12 | 19 | | | | |
| Algebra and Trigonometry | 3 | 13 | 5 | | | 1 |
| Calculus 1 | 1 | 5 | 10 | 4 | | 1 |
| Calculus 11 | | 3 | 5 | 8 | 3 | |
| Introductory Statistics | 9 | 7 | 3 | 5 | | 3 |

APPENDIX 4 UW-Manitowoc Student Questionnaire Results

Students at UWC-Manitowoc completed the survey. The course was a section Calculus 1.

1. What was the highest level of mathematics that you completed in High School?

| | Calculus I | Calculus I |
|---|---|---|
| General Math | 1 | 6% |
| Geometry | 1 | 6% |
| Algebra | 2 | 13% |
| Trigonometry | 1 | 6% |
| Pre-calculus | 10 | 63% |
| Calculus | 1 | 6% |

2. Did you complete a course in geometry in High School?

| | Calculus I | Calculus I |
|---|---|---|
| Yes | 16 | 100% |
| No | 0 | 0% |

3. How much statistics did you have in your high school mathematics courses?

| | Calculus I | Calculus I |
|---|---|---|
| None | 8 | 50% |
| Some | 5 | 31% |
| Full Course | 1 | 6% |
| Other | 2 | 13% |

4. Other than algebra, geometry, and advanced algebra, what mathematics courses were offered in high school?

Responses from Calculus I students:

Calculus; none; I wasn't aware of any other courses offered; pre-calculus, calculus, statistics; pre-calculus, calculus, trigonometry, computer mathematics; trigonometry, calculus, pre-calculus; trigonometry, precalculus, calculus; up to calculus; trigonometry, pre-calculus, calculus; statistics, pre-calculus, calculus; precalculus, AP calculus, probability and statistics, trigonometry; none; pre-calculus, calculus, probability and

statistics, and some computer mathematics; pre-calculus, calculus, trigonometry, introduction to college mathematics; calculus, trigonometry, pre-calculus, introduction to college mathematics; pre-calculus.

5. How often was homework assigned in your High School mathematics classes?

| | Calculus I | Calculus I |
|---|---|---|
| Every Day | 15 | 94% |
| 3 + Days a Week | 1 | 6% |

6. How often were you required to complete mathematics assignments outside of normal class time?

| | Calculus I | Calculus I |
|---|---|---|
| Every Day | 7 | 44% |
| 3 + Days a Week | 6 | 38% |
| Weekly | 0 | 0% |
| Never | 2 | 13 |
| Other | 1 | 6% |

7. How often were you involved in individual projects in your High School mathematics classes?

| | Calculus I | Calculus I |
|---|---|---|
| Never | 8 | 50% |
| Rarely | 5 | 31 |
| Often | 3 | 19% |

8. How often were you involved in group projects in your High School mathematics classes?

| | Calculus I | Calculus I |
|---|---|---|
| Never | 5 | 31 |
| Rarely | 6 | 38% |
| Often | 5 | 31 |

9. How much reading did you have to do in your High School mathematics courses?

| | Calculus I | Calculus I |
|---|---|---|
| None | 7 | 44% |
| A Little | 5 | 31 |
| A lot | 4 | 25% |

10. How much writing did you have to do in your High School mathematics courses?

| | Calculus I | Calculus I |
|---|---|---|
| None | 6 | 38% |
| A Little | 5 | 31 |
| A lot | 5 | 31 |

11. Did you use a graphing calculator for your High School mathematics classes? If yes, was it required and what type was it?

All responses named Texas Instrument products. TI-81, TI-82, TI-83, TI-85, and TI-89 were all used. In some cases the school supplied the calculators.

| | Calculus I | Calculus I |
|---|---|---|
| Yes | 12 | 75 |
| No | 4 | 25% |
| Required | 9 | 56% |
| Required given yes | | 75% |

12. Other than calculators, what technology did you use in your High School mathematics courses?

| | Calculus I | Calculus I |
|---|---|---|
| None | 9 | 56% |
| Computer | 5 | 31 |
| Other | 2 | 13 |

TI - mini-labs, overheads, pencil, paper, projector and movies, chalk and chalkboard, definitions, protractors, and special protractors were listed as other types of technology used in the classroom.

13. In your High School mathematics classes, what percentage of the time was the teacher teaching students and what percent of the time were students teaching students?

| | Calculus I | Calculus I |
|---|---|---|
| 100% | 1 | 6% |
| 95% | 2 | 13 |
| 90% | 2 | % |
| 85% | 2 | 13 |
| 75% | 1 | % |
| 70% | 1 | 13 |
| 60% | 5 | % |
| 50% | | 6% |
| Oth | | 6% |

14. How well did your High School mathematics courses prepare you for your University mathematics courses?

| | Calculus I | Calculus I |
|---|---|---|
| Very Well | 14 | 88% |
| Not Well | 2 | 12% |

Additional comments from Calculus I students:

Extremely well, I don't think I could've been more prepared; greatly, but I understand and comprehend all of it, whereas others did not; somewhat, a lot of information seemed to be dropped and new stuff learned, but, I still know basically what to expect.

15. What was the first University mathematics course you enrolled in and what mathematics course(s) are you currently enrolled in?

| | First University Mathematics Course | | |
|---|---|---|---|
| | Algebra Pre-calculus | Calculus I | Statistics |
| Current Mathematics Course | Calculus 1 6 8 | 1 | 1 |