

Math 220 Student Survey Results - Summary

This report is a summary of the results of 2 surveys administered online in May 2010, one for students of the Winter 2009 terms, the other for students of the Winter 2008 terms. The surveys contain some common questions, and so both are summarized here. Observations on the results are made following each question. These results and observations are for informational purposes only, as the survey was voluntary and administered after the terms were complete and so may not be representative of the full student population for each term.

The course was taught with 2 different textbooks during this time period. While both texts address basic proof techniques and introductory analysis topics, one has a much greater focus on proof, the other a stronger focus on analysis. The texts are:

Proof Focus: *Mathematical Proofs*, 2nd edition, by G. Chartrand et al.

Analysis Focus: *Analysis with an Introduction to Proof*, 4th edition, by S.R. Lay

The number of respondents from each term are as follows:

Term	Textbook/Focus	Number Enrolled	Number of Respondents	Proportion who responded
2008 WT1 (1 section)	Analysis	57	14	24.60%
2008 WT2 (2 sections)	Proof	107	21	19.60%
2009 WT1 (1 section)	Proof	68	18	26.50%
2009 WT2 (2 sections)	Analysis	145	42	29.00%

Responses to 2008 & 2009 Common Questions (total of 95 respondents):

Q: What proportion of the Math 220 lectures did you attend?

	2008 WT1 (%)	2008 WT2 (%)	2009 WT1 (%)	2009 WT2 (%)	2008 WT1 (#)	2008 WT2 (#)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
90% or more	71.4	81	83.3	78.6	10	17	15	33	75	78.9
80-89%	14.3	4.8	5.6	11.9	2	1	1	5	9	9.5
70-79%	0	4.8	5.6	2.4	0	1	1	1	3	3.2
60-69%	0	0	5.6	2.4	0	0	1	1	2	2.1

50-59%	14.5	0	0	4.8	2	0	0	2	4	4.2
less than 50%	0	9.5	0	0	0	2	0	0	2	2.1

Observations:

- Most respondents claim to attend class regularly.
- No clear differences between terms, possibly “proof” focus terms report slightly better attendance.

Q: In Math 220, when did you typically start the homework?

(for 2009 survey: “when did you typically start the homework?”)

	2008 WT1 (%)	2008 WT2 (%)	2009 WT1 (%)	2009 WT2 (%)	2008 WT1 (#)	2008 WT2 (#)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Immediately after it was assigned	14.3	14.3	17.6	7.3	2	3	3	3	11	11.8
A couple of days after it was assigned	35.7	33.3	41.2	41.5	5	7	7	17	36	38.7
A few days before it was due	21.4	42.9	41.2	39	3	9	7	16	35	37.6
The day before it was due	28.6	9.5	0	12.2	4	2	0	5	11	11.8
The day it was due	0	0	0	0	0	0	0	0	0	0

Observations:

- Most students started the homework a couple of days after it was assigned or a few days before it was due.
- Students from “proof” focus terms report starting their homework somewhat earlier.

Q: After completing Math 220, which of the following skills were you comfortable applying to mathematical problems? (choose all that apply)

(for 2009 survey: “which of the following skills do you feel comfortable applying to mathematical problems?”)

	2008 WT1 (%)	2008 WT2 (%)	2009 WT1 (%)	2009 WT2 (%)	2008 WT1 (#)	2008 WT2 (#)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Using logical connectives and quantifiers	50	81	81.1	81	7	17	11	34	69	72.6
Following the logical structure of a mathematical proof	57.1	61.9	72.2	57.1	8	13	13	24	58	61
Disproving statements by	50	81	83.3	73.8	7	17	15	31	70	73.7

counterexamples										
Using direct proof	50	81	88.9	47.6	7	17	16	20	60	63.2
Proving by induction	57.1	71.4	72.2	88.1	8	15	13	37	73	76.8
Proving by contradiction	64.3	81	94.4	61.9	9	17	17	26	69	72.6
Applying knowledge of basic set operations and relations between sets	28.6	71.4	61.1	64.3	4	15	11	27	57	60
Applying knowledge of functions and their properties	42.9	47.6	55.6	38.1	6	10	10	16	42	44.2
Applying knowledge of number systems and their properties...	35.7	52.4	33.3	26.2	5	11	6	11	33	34.7
Constructing sequences and testing their convergence or divergence	28.6	47.6	33.3	35.7	4	10	6	15	35	36.8
Constructing infinite series and testing their convergence or divergence	21.4	33.3	27.8	35.7	3	7	5	15	30	31.6

Observations:

- Overall, students report most being comfortable with (1) proving by induction, (2) disproving using counterexamples, (3) proof by contradiction and (4) using logical connectives and quantifiers.
- In general, “proof” focus students report a higher frequency of comfort with most skills.
- 2008WT1 students indicated the lowest frequency of comfort with most skills.
- Sequences, series and number systems were infrequently chosen for all terms.

Q: After completing Math 220, which of the following skills did you feel least able to apply to mathematical problems? (choose 3)

(for 2009 survey: “which of the following skills do you feel least able to apply to mathematical problems?”)

	2008 WT1 (%)	2008 WT2 (%)	2009 WT1 (%)	2009 WT2 (%)	2008 WT1 (#)	2008 WT2 (#)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Using logical connectives and quantifiers	7.1	9.5	22.2	9.5	1	2	4	4	11	11.6
Following the logical structure of a mathematical proof	0	4.8	16.7	16.7	0	1	3	7	11	11.6
Disproving statements by counterexamples	21.4	4.8	5.6	7.1	3	1	1	3	8	8.4
Using direct proof	14.3	9.5	0	28.6	2	2	0	12	16	16.8
Proving by induction	21.4	23.8	11.1	11.9	3	5	2	5	15	15.8

Proving by contradiction	7.1	9.5	0	14.3	1	2	0	6	9	9.5
Applying knowledge of basic set operations and relations between sets	28.6	14.3	11.1	16.7	4	3	2	7	16	16.8
Applying knowledge of functions and their properties	35.7	23.8	33.3	33.3	5	5	6	14	30	31.6
Applying knowledge of number systems and their properties...	35.7	28.6	61.1	50	5	6	11	21	43	45.3
Constructing sequences and testing their convergence or divergence	35.7	33.3	61.1	40.5	5	7	11	17	40	42.1
Constructing infinite series and testing their convergence or divergence	35.7	47.6	66.7	45.2	5	10	12	19	46	18.8

Observations:

- Many students report feeling least able to construct sequences and series and test convergence and divergence of these.
- Many also report difficulty with number systems and functions and their properties.
- Proof skills were generally not reported as being “least able to apply.”
- There were no clear differences between the two texts/course focuses.

Q: Do you feel that Math 220 taught you to follow and construct mathematical proofs?

(for 2009 survey: “do you feel this course has taught you to follow and construct mathematical proofs”)

	2008 WT1 (%)	2008 WT2 (%)	2009 WT1 (%)	2009 WT2 (%)	2008 WT1 (#)	2008 WT2 (#)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Yes. It has taught me how to follow and construct mathematical proofs	50	52.4	50	21.4	7	11	9	9	36	37.9
Sort of. I have learned some proof skills, but do not feel that I have learned enough	35.7	19	50	52.4	5	4	9	22	40	42.1
Not really. I feel like I have learned only a few useful proof skills	7.1	23.8	0	23.8	1	5	0	10	16	16.8
No. This course has not taught me how to follow or make proofs at all	7.1	4.8	0	2.4	1	1	0	1	3	3.2

Observations:

- Overall, 80% of students felt the course taught them proofs at least somewhat.
- Responses for 2009WT2 (the most recent term) were much more negative than other terms.
- There are no other clear differences between the different terms. In particular, responses from the “proof” focus terms do not reflect the additional emphasis on proof.

Q: What part of Math 220 did you find most interesting? Why?

(for 2009 survey: “what part of the course did you find most interesting? Why?”)

	2008W T1 (#)	2008W T2 (#)	2009W T1 (#)	2009W T2 (#)	Total (#)
“Proofs (general)”	5	0	1	4	10
“proof by induction”	2	1	2	5	10
“set theory/operations”	1	3	2	2	8
“logic/logical structure of a proof”	0	4	1	2	7
“nothing/not at all interesting or fun”	0	2	0	4	6
“proof by contradiction”	0	4	1	0	5
“series”	1	1	0	2	4
“sequences”	1	1	0	1	3
“everything”	0	2	0	1	3
“cardinality”	0	1	0	2	3
“topology of reals/boundary/neighbourhoods”	0	0	0	3	3

Observations:

- Only topics mentioned at least 3 times were included.
- Many students made comments indicating that they found proofs in general to be the most interesting. Induction was the most commonly mentioned specific proof technique, with proof by contradiction also mentioned many times. Also “logic” and the “logical structure of proofs” were mentioned frequently.
- Students of the “proof” focus terms made comments about specific proof techniques being interesting. Students of the “analysis” focus terms made general comments about proof being interesting (except for induction, which is mentioned specifically).
- Several students also found set theory to be interesting.

Q: What part of Math 220 did you find the most challenging? Why?

(for 2009 survey: “what part of the course did you find the most challenging? Why?”)

	2008W T1	2008W T2	2009W T1	2009W T2	Total (#)

	(#)	(#)	(#)	(#)	
“functions and their properties”	1	3	2	5	11
“series”	2	5	0	2	9
“everything/almost everything”	1	1	0	7	9
“Proofs (general)”	2	0	0	6	8
“sequences”	2	3	0	2	7
“limits”	0	1	1	2	4
“tests too difficult compared to examples”	0	1	2	1	4
“cardinality”	0	1	1	1	3
“topology of reals/neighbourhoods/accumulation pts”	0	0	0	3	3
“sets/mapping of sets”	1	0	0	2	3

Observations:

- Only topics mentioned at least 3 times were included.
- Functions and their properties was found to be challenging in all sections.
- Sequences and series were found challenging for many students.
- Topology concepts like accumulation points, boundary pts, neighbourhoods etc. were frequently mentioned, also limits, sup and inf.
- Students from “analysis” focus terms made many comments about proofs in general being the most challenging – students of “proof” focus terms did not mention this.

Q: How do you think Math 220 could be improved?

(for 2009 survey: “how do you think this course could be improved?”)

	2008W T1 (#)	2008W T2 (#)	2009W T1 (#)	2009W T2 (#)	Total (#)
“remove some content”	0	2	0	6	8
“focus more on proof/how to prove”	0	1	2	4	7
“It's fine the way it is”	3	2	0	1	6
“more examples/practice problems”	0	3	0	2	5
“make the exams easier”	0	1	1	3	5
“make it easier”	0	0	0	3	3
“add some content” (compactness, more logic, limits, derivatives, integration)	1	1	0	1	3
“add compulsory group tutorials”	0	1	1	1	3

Observations:

- Only topics mentioned at least 3 times were included.
- Remove some content, focus on how to prove and more examples/practice problems were the most common suggestions.
- There were several comments suggesting to make assessments/grading easier
- Several respondents said it was fine as is.
- There were no clear differences between terms or text/course focus.

Responses to 2008 Only Questions: (2008WT1 – 14 respondents), (2008WT2 – 21 respondents)

Q: In what courses have you found the skills you learned in Math 220 to be most helpful? (list as many courses as you like)

Course	2008 WT1 (#)	2008 WT2 (#)	Total (#)	Course	2008 WT1 (#)	2008 WT2 (#)	Total (#)
MATH 300	2	3	5	MATH 221	0	2	2
MATH 312	0	5	5	MATH 223	1	1	2
MATH 320	0	5	5	MATH 302	0	2	2
None	1	3	4	MATH 317	1	1	2
MATH 340	0	3	3	MATH 321	0	2	2
MATH 342	2	1	3	MATH 331	0	2	2
MATH 322	1	2	3	most/all courses	2	0	2
CPSC 121	2	1	3				

Observations:

- Only courses mentioned at least twice are included here.
- Math 320, 312 & 300 were most commonly cited. Also MATH 340, 342, 322 & CPSC 121 had many (3) responses.
- Students of 2008WT2 more frequently commented that it was useful for other courses than 2008WT1 students.

Q: If you could go back in time, what would you change about your study methods for Math 220? (choose all that apply)

	2008 WT1 (%)	2008 WT2 (%)	2008 WT1 (#)	2008 WT2 (#)	Total (#)	Total (%)
I wouldn't change anything	0	28.6	0	6	6	17.1

I would attend class more regularly	0	0	0	0	0	0
I would start my assignments earlier	14.3	14.3	2	3	5	14.3
I would spend more time reviewing my assignments and midterms	21.4	28.6	3	6	9	25.7
I would spend less time reviewing my assignments and midterms	0	0	0	0	0	0
I would spend more time reviewing the text and my notes	42.9	4.8	6	1	7	20
I would spend less time reviewing the text and my notes	0	4.8	0	1	1	2.9
I would spend more time working and studying with my classmates	14.3	14.3	2	3	5	14.3
I would spend less time working and studying with my classmates	0	0	0	0	0	0

Others: I would ask for more help from the professor & go to office hour more often, I would study/construct NEW proofs.

Observations:

- Many students in 2008WT2 (proof-focus) said they wouldn't change anything.
- Many students said they would spend more time reviewing assignments and midterms.
- Many students of 2008WT1 (analysis-focus) said they would spend more time reviewing the text and notes. (only 1 in 2008WT2 said this)
- A few in each section said they would work more with classmates or start assignments earlier.

Q: Which of the following skills have you used the most in your mathematics courses since taking Math 220? (choose 3)

	2008 WT1 (%)	2008 WT2 (%)	2008 WT1 (#)	2008 WT2 (#)	Total (#)	Total (%)
Using logical connectives and quantifiers	42.9	38.1	6	8	14	40
Following the logical structure of a mathematical proof	42.9	38.1	6	8	14	40
Disproving statements by counterexamples	42.9	33.3	6	7	13	37.1
Using direct proof	50	47.6	7	10	17	48.6
Proving by induction	35.7	38.1	5	8	13	37.1
Proving by contradiction	35.7	61.9	5	13	18	51.4
Applying knowledge of basic set	35.7	14.3	5	3	8	22.9

operations and relations between sets						
Applying knowledge of functions and their properties	28.6	9.5	4	2	6	17.1
Applying knowledge of number systems and their properties...	14.3	9.5	2	2	4	11.4
Constructing sequences and testing their convergence or divergence	28.6	9.5	4	2	6	17.1
Constructing infinite series and testing their convergence or divergence	21.4	19	3	4	7	20

Observations:

- Overall, proof by contradiction was cited as most commonly used, with direct proof a close second.
- Proof by contradiction was much more commonly rated in 2008WT2 (proof-focus) section.
- Logical connectives and quantifiers, following the logical structure of a proof, disproving by counterexample and proof by induction were frequently chosen.
- Number systems were the least frequently answered.

Responses to 2009 Only Questions: (2009WT1 – 18 respondents), (2009WT2 – 42 respondents)

Q: Which of the following skills do you think you will use the most in your future mathematics courses? (choose 3)

	2009 WT1 (%)	2009 WT2 (%)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Using logical connectives and quantifiers	27.8	35.7	5	15	20	33.3
Following the logical structure of a mathematical proof	33.3	26.2	6	11	17	28.3
Disproving statements by counterexamples	22.2	35.7	4	15	19	31.7
Using direct proof	38.9	31	7	13	20	33.3
Proving by induction	33.3	61.9	6	26	32	53.3
Proving by contradiction	44.4	40.5	8	17	25	41.7
Applying knowledge of basic set operations and relations between sets	5.6	11.9	1	5	6	10
Applying knowledge of functions and their properties	22.2	21.4	4	9	13	21.7
Applying knowledge of number systems	22.2	19	4	8	12	20

and their properties...						
Constructing sequences and testing their convergence or divergence	16.7	14.3	3	6	9	15
Constructing infinite series and testing their convergence or divergence	11.1	11.9	2	5	7	11.7

Observations:

- Overall, proof by induction was thought to be most useful.
- Students from 2009WT2 (analysis-focus) answered proof by induction far more frequently than 2009WT1 (proof-focus) students.
- Proof by contradiction, direct proof and using logical connectives and quantifiers were also highly rated (in both terms).
- Set operations and and relations, infinite series, and sequences were the least frequent answers.

Q: Do you think some of the content and skills introduced in Math 220 should be taught in first year? Why or why not?

	2009 WT1 (#)	2009 WT2 (#)	Total (#)
Yes	3	15	18
Maybe	0	1	1
No	3	15	18
Other	1	3	4

Common reasons given for “Yes”:

1. There is too much material in Math 220 to be taught in one term (4 responses, 2 from each term).
2. Some topics (quantifiers, logical connectives, basic proof ideas and “mathematical way of thinking”) would help for other (earlier) courses (3 responses, 1 from WT1, 2 from WT2).
3. It would help “ease” students into Math 220, because it is a “different way of thinking” (3 responses, all from WT2).

Common reasons given for “No”:

1. No, it's too difficult for first year (8 responses, all from WT2).
2. There is already too much to learn in first year (3 responses, 1 from WT1, 2 from WT2).
3. This is irrelevant for many first year calculus students (2 responses, both from WT1).
4. It is too unrelated to fit into the first-year courses: (2 responses, both from WT2).

Observations:

- There is an even split of opinions for whether some of the content should be taught in first year or not.
- Proponents think quantifiers, logical connectors and seeing some proofs in first year would help reduce the cognitive overload experienced in MATH 220.
- Opponents think first year is already too challenging, and that MATH 220 material is too difficult to try in first year.

Q: What part of the course did you find least interesting? Why?

	2009 WT1 (#)	2009 WT2 (#)	Total (#)
Functions & properties (reasons: don't understand it, struggle to understand)	1	6	7
Cardinality (reasons: little application to real world, didn't understand it)	3	1	4
Sequences/monotone/Cauchy (reasons: don't understand it, boring, hard, hard to visualize)	1	3	4
Memorizing theorems/lemmas (reasons: we don't prove them, too many to remember)	1	2	3
Everything	0	3	3

Observations:

- Only topics mentioned at least 3 times are listed here.
- The most frequently mentioned least-interesting part of the course is functions and their properties, because it is “hard to understand.”
- Cardinality was found uninteresting by several because it was “hard to understand” and has little application to the real world .
- Sequences and their properties were found uninteresting by several because it is “boring”, “hard” and “hard to visualize.”
- WT1 (proof-focus) class was more negative on cardinality, WT2 (analysis-focus) sections were much more negative on functions.

Q: On average, how many hours per week did you spend doing the homework?

	2009 WT1 (%)	2009 WT2 (%)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Less than 1 hour	0	2.4	0	1	1	1.7
1-2 hours	6.3	16.7	1	8	9	15.5

3-4 hours	43.8	40.5	7	17	24	41.4
5-6 hours	37.5	19	6	7	13	22.4
More than 6 hours	12.5	21.4	2	9	11	19

Observations:

- The largest fraction of students (in both sections) reported spending 3-4 hours/week on their homework.
- WT2 (analysis-focus) students gave more varied responses than WT1 (proof-focus) students.

Q: On average, how many hours per week did you spend reading the text and reviewing your notes?

	2009 WT1 (%)	2009 WT2 (%)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Less than 1 hour	5.9	23.8	1	10	11	18.6
1-2 hours	58.8	33.3	10	14	24	40.7
More than 2 hours	35.3	42.9	6	18	24	40.7

Observations:

- Most students in both sections report reviewing the text and notes for at least 1 hour/week.
- Most students of WT1 (proof-focus) section report 1-2 hours/week, students of WT2 (analysis-focus) section were more variable in their responses.

Q: On average, how many hours did you spend studying for each of the midterm exams?

	2009 WT1 (%)	2009 WT2 (%)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Less than 1 hour	0	2.4	0	1	1	1.7
1-3 hours	23.5	7.1	4	3	7	11.9
4-7 hours	41.2	33.3	7	14	21	35.6
8-11 hours	17.6	33.3	3	14	17	28.8
12 hours or more	17.6	23.8	3	10	13	22

Observations:

- Most students reported spending 4-7 hours studying for each midterm.
- WT2 (analysis-focus) students report spending much more time studying for each midterm.

Q: How many hours did you spend studying for the final exam?

	2009 WT1 (%)	2009 WT2 (%)	2009 WT1 (#)	2009 WT2 (#)	Total (#)	Total (%)
Less than 1 hour	5.9	2.4	1	1	2	3.4
1-3 hours	0	0	0	0	0	0
4-7 hours	29.4	16.7	5	7	12	20
8-11 hours	5.9	14.3	1	6	7	11.9
12-15 hours	11.8	14.3	2	6	8	13.6
16 hours or more	47.1	52.4	8	22	30	51

Observations:

- Most students reported spending 16 hours or more studying for the final exam.
- WT2 (analysis-focus) students report spending slightly more time studying for the final than WT1 (proof-focus) students did.