Westfield State University – Discovering the Art of Mathematics
Results from Class Surveys, 1997 – 2011

Overview

The survey described here was developed by Prof. Julian Fleron to capture students' reactions to their experiences in MA110 - Mathematical Explorations, one of two Mathematics for Liberal Arts courses which helps satisfy a core requirement at Westfield State University.

The survey was an optional, anonymous, paper survey. The pre-term survey was giving at the beginning of the first class meeting. The post-term survey was given during the last class., except on two occasions (F03 and F04) when it was distributed during the last class and students were to turn it in with their final work. This resulted in greatly reduced response rates and this practice was discontinued.

The survey consisted of fifteen questions, to which the respondents were asked to indicate the extent to which their answer was "yes" or "no". The questions were as follows:

1. Do you dislike mathematics?
2. Is your only reason for taking this course that it satisfies the core requirement in mathematics and analytical sciences?
3. Do you think that mathematics can be beautiful?
4. Is there something in mathematics that you think is beautiful that you could describe?
5. Are "word problems" difficult for you?
6. Do you have a positive attitude about mathematics?
7. Do you think that you have below average mathematical ability?
8. Are you worried about the grade you might receive in this course? (Pre) / Are you scared of this course? (Post)
9. Do you think you will enjoy this course? (Pre) / Did you enjoy this course? (Post)
10. Do you think you will get anything out of this course? (Pre) / Did you get anything out of this course? (Post)
11. Do you think it is appropriate that mathematics is part of the liberal arts core at WSU?
12. Did you enjoy the last mathematics class you took before coming to WSU?
13. Do you feel comfortable reading and interpreting quantitative information?
14. Do you know what mathematics is?
15. Do you think you will remember this course 10 years from now?

From the spring of 1997 to the fall of 2011, this survey was given to students all of Prof. Fleron's sections of MA110. There were two sections in each semester except F98 when there was only one (honors) section. The survey was also given at the beginning of three other semesters, but as it was not also given at the end of the semester, these were not included in the analysis. The semesters and number of students who participated in the survey in each semester are shown on the table below. In this table, the letter "N" represents the number of individuals who responded to the given survey in each semester, so the row for "N Pre" shows the number of respondents to the pre-survey. The semesters are given in shorthand such that "S97" refers to the spring of 1997, "F98" to the fall of 1998, etc.

Semester	S97	S98	F98	F02	S03	F03	S04	F04	F08	S10	F10	S11	F11
N Pre	64	58	12	65	68	64	63	57	75	63	59	69	51
N Post	51	62	12	52	53	38	38	50	70	57	61	61	46

Other than F03 and S04, unequal numbers of respondents are due to student absences when the survey was implemented and the optional nature of the survey.

This report provides an analysis of the key findings from these surveys as examined in aggregate across all semesters. Although the data are not presented here, the patterns of change from pre- to post-surveys were fairly similar from one semester to the next.

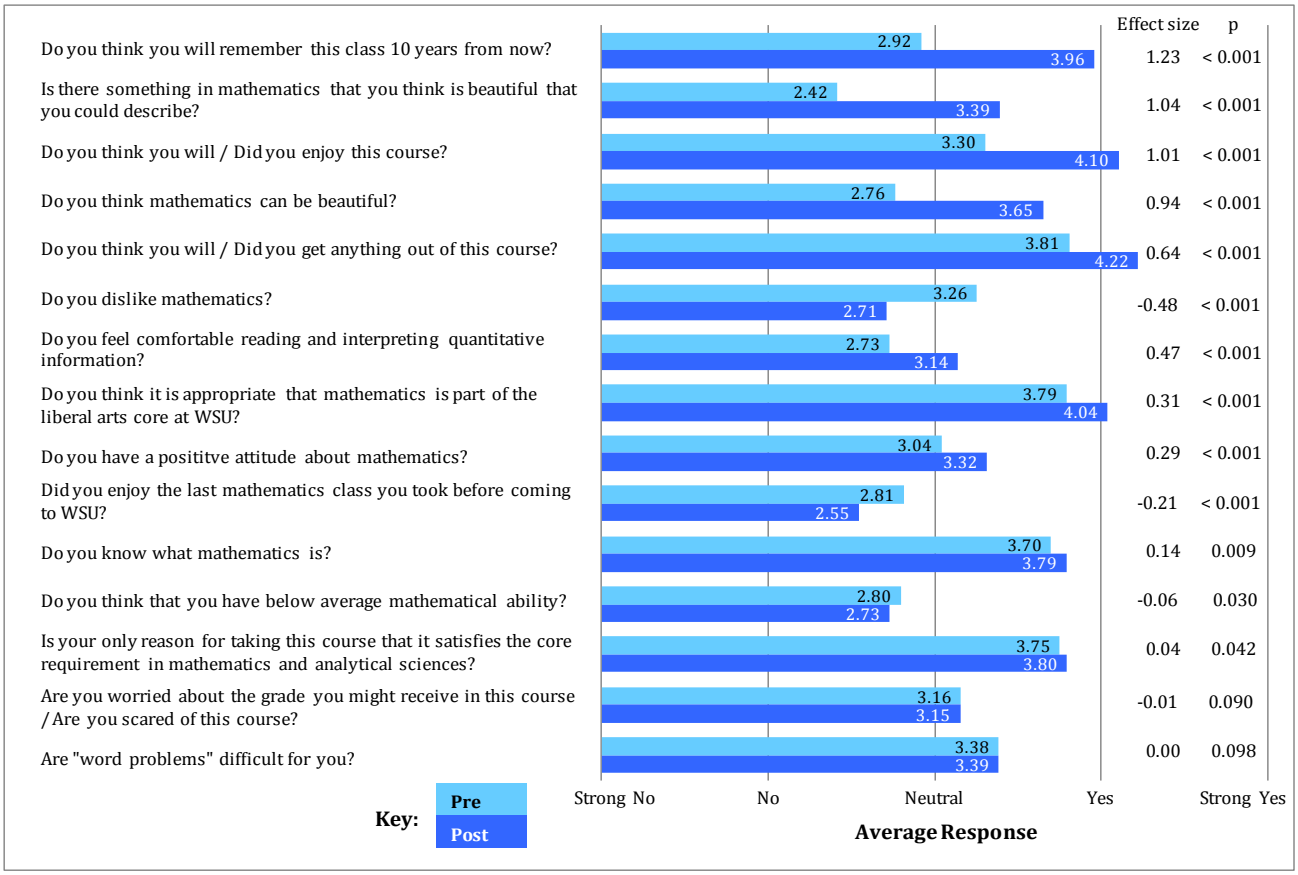
Findings

An analysis of the survey responses showed that there were substantial differences between the responses on the pre-survey and those on the post-survey for some questions but not for others. To examine these statistically, we used two basic metrics, p scores and effect sizes.

P scores refer to the probability that the difference between two means occurred due to random variation. Generally, a p score of less than 0.05 (i.e. a difference that had less than a 5% likelihood of occurring due to random variation) is considered statistically significant. In the case of this report, the p values were produced by running independent-sample t-tests for the second between the pre- and post-survey results[1].

Effect sizes are standardized measures of the difference between two means. They are calculated by dividing the difference between the means by the pooled standard deviation of the group, which is an average of the standard deviations of the two groups. This measure is independent of the scale of the measure, so the effect size of a question worth one point can be compared to the effect size of the test score as a whole without any modification. In general, an effect size of 0.2 is considered small, one of 0.5 is considered moderate, and 0.8 or greater is considered large. It has been estimated that the average teacher can demonstrate an effect size increase of around 0.4 between a pre- and a post-test in the absence of any useful intervention.

[1] Technically, it would have been more appropriate to use a paired-sample t-test that matched the survey results for each individual on the pre- and post-surveys, but since the surveys were anonymous matching was not possible and thus an independent-samples test was in order.



The graph above shows the average responses on the pre- and post-surveys, scaled such that a "strong yes" was a 5 and a "strong no" a 0, and the effect sizes and p-scores of each difference. The responses are sorted by the magnitude[2] of the effect size.

This graph displays a number of things. First off, most of the questions showed a statistically significant change—only the last two did not. What this means is that for most questions, the differences that were seen between the two sets of scores were unlikely to have occurred by chance and probably reflect real differences between the two survey-taking periods. On the other hand, some of these differences were very small—the change in their response to "Do you think that you have below average mathematical ability?" for example—while others are very large, such as the change in the responses to "Do you think you will remember this class 10 years from now?". The table below shows the extent of the changes associated with each question.

Question	Extent of change
Do you think you will remember this class 10 years from now?	Large increase in "yes"
Is there something in mathematics that you think is beautiful that you could describe?	Large increase in "yes"
Do you think you will/Did you enjoy this course?	Large increase in "yes"

[2] It will be noted that some effect sizes are negative while others are positive. Negative numbers just mean that the post-survey score was lower than the pre-survey score. The magnitude of the difference still follows the same rules for the size of the effect, so an effect of -0.48, as in the case of the question "Do you dislike mathematics?", is still considered medium-sized.

Do you think that mathematics can be beautiful?	Large increase in "yes"
Do you think you will/Did you get anything out of this course?	Medium increase in "yes"
Do you dislike mathematics?	Medium increase in "no"
Do you feel comfortable reading and interpreting quantitative information?	Medium increase in "yes"
Do you think it is appropriate that mathematics is part of the liberal arts core at WSU?	Small increase in "yes"
Do you have a positive attitude about mathematics?	Small increase in "yes"
Did you enjoy the last mathematics class you took before coming to WSU?	Small increase in "no"
Do you know what mathematics is?	No meaningful change
Do you think that you have below average mathematical ability?	No meaningful change
Is your only reason for taking this course that it satisfies the core requirement in mathematics and analytic sciences?	No meaningful change
Are you worried about the grade you might receive in this course?/Are you scared of this course?	No statistically significant change
Are "word problems" difficult for you?	No statistically significant change

Thus it is clear that the largest changes were in the students' enjoyment of the course—they enjoyed it much more than they thought they would at the beginning of the course—and their sense that there was something beautiful about mathematics. To a lesser extent, they were more likely to say they had gotten something out of participation in the course than they had predicted they would, they were less likely to dislike mathematics, and they were more comfortable with quantitative information. To a small extent, they were more likely to have a generally positive attitude toward mathematics and to think it was an appropriate part of the WSU curriculum. Interestingly, they were also less likely to say they had enjoyed their most recent pre-WSU math course, probably because it looked less enjoyable in comparison to this class. There were a number of responses that the course did not change appreciably, however. These had to do with their general understanding of what mathematics was, their estimation of their own mathematical ability, their sense of how difficult "word problems" were, their worry about their grades, and their reasons for taking the course.

What these responses indicate is that students enjoyed the course, felt that they had learned from it, and gained a new understanding of mathematics and of themselves in relation to it, particularly the idea that mathematics can be "beautiful." On the other hand, the course did not change their worry about grades, which is perhaps to be expected, or their perceptions of themselves as being above average mathematicians—this latter finding may indicate that they felt that they were more able to do math but that this was not because of some inherent ability but rather that anyone could do what they did in the same circumstances. Overall, the survey shows the course to have been tremendously impactful and well-appreciated by the students.

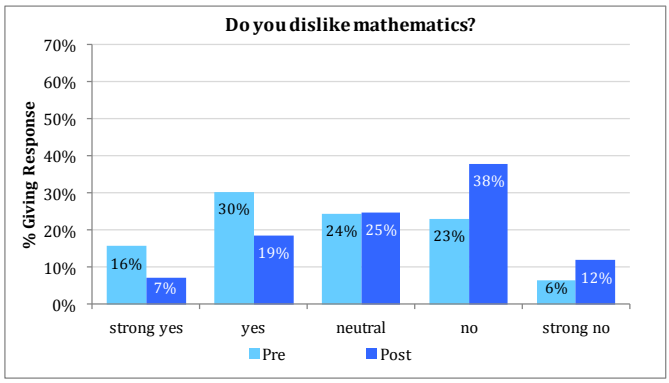
Responses by Question

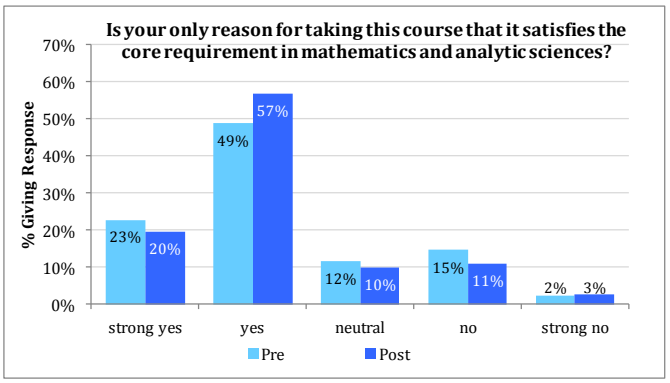
The following table shows the complete distribution of responses for all of the survey questions, including the number of given responses for the answer (top number) and the percentage of total responses (bottom percentage). In addition, the total number of usable responses is given (N), along with the average response (Avg), using a scale where "strong yes" was coded as a 5.0 and "strong no" as a 1.0, and the standard deviation of those responses. It should be noted that there were often cases where individuals did not answer particular survey questions, said that they had no opinion, or provided unusable responses. These were not included in the data, which is why the totals are not equal from question to question.

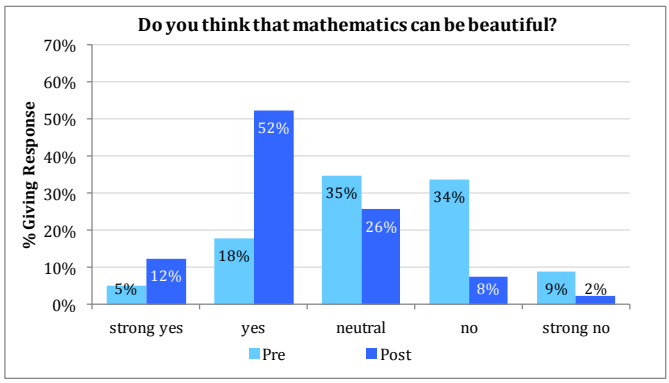
	PRE								POST							
	strong yes	yes	neutral	no	strong no	N	Avg	SD	strong yes	yes	neutral	no	strong no	N	Avg	SD
Do you dislike mathematics?	113 16%	220 30%	177 24%	167 23%	47 7%	724	3.26	1.16	45 7%	116 19%	154 25%	237 38%	74 12%	626	2.71	1.12
Is your only reason for taking this course that it satisfies the core requirement in mathematics and analytic sciences?	173 23%	370 49%	88 12%	111 15%	17 2%	759	3.75	1.03	124 20%	361 57%	63 10%	70 11%	17 3%	635	3.80	0.97
Do you think that mathematics can be beautiful?	36 5%	128 18%	250 35%	243 34%	65 9%	722	2.76	1.01	78 12%	330 52%	162 26%	48 8%	14 2%	632	3.65	0.87
Is there something in mathematics that you think is beautiful that you could describe?	16 2%	95 13%	130 18%	402 56%	71 10%	714	2.42	0.92	49 8%	296 47%	145 23%	125 20%	12 2%	627	3.39	0.95
Are "word problems" difficult for you?	137 18%	219 29%	226 30%	160 21%	20 3%	762	3.38	1.08	107 17%	202 32%	176 28%	129 20%	21 3%	635	3.39	1.09
Do you have a positive attitude about mathematics?	27 4%	244 32%	271 36%	173 23%	47 6%	762	3.04	0.97	33 5%	281 44%	206 32%	109 17%	17 3%	646	3.32	0.90
Do you think that you have below average mathematical ability?	62 8%	180 24%	139 18%	306 40%	77 10%	764	2.80	1.15	56 9%	144 22%	103 16%	258 40%	86 13%	647	2.73	1.20

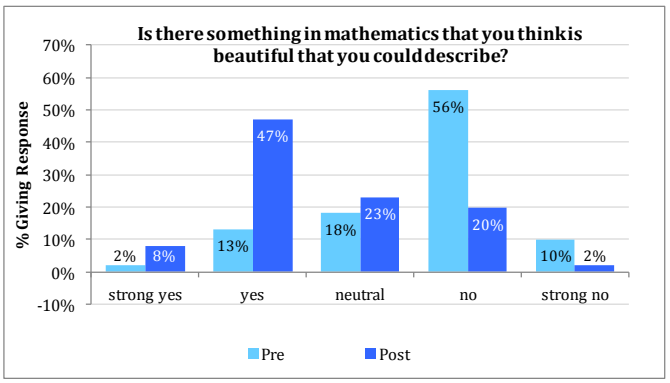
	PRE								POST							
	strong yes	yes	neutral	no	strong no	N	Avg	SD	strong yes	yes	neutral	no	strong no	N	Avg	SD
Are you worried about the grade you might receive in this course?/Are you scared of this course?	104 14%	214 28%	180 24%	225 30%	38 5%	761	3.16	1.14	88 14%	196 30%	140 22%	174 27%	50 8%	648	3.15	1.18
Do you think you will/Did you enjoy this course?	28 4%	281 38%	337 46%	72 10%	20 3%	738	3.30	0.80	195 30%	345 54%	78 12%	18 3%	5 1%	641	4.10	0.77
Do you think you will/Did you get anything out of this course?	53 7%	532 71%	135 18%	21 3%	7 1%	748	3.81	0.64	207 33%	379 60%	38 6%	6 1%	5 1%	635	4.22	0.67
Do you think it is appropriate that mathematics is part of the liberal arts core at WSC?	83 11%	487 66%	117 16%	34 5%	17 2%	738	3.79	0.79	161 25%	371 59%	77 12%	12 2%	12 2%	633	4.04	0.79
Did you enjoy the last mathematics class you took before coming to WSC?	57 8%	213 29%	133 18%	219 29%	123 17%	745	2.81	1.23	50 8%	130 21%	95 15%	198 31%	159 25%	632	2.55	1.28
Do you feel comfortable reading and interpreting quantitative information?	7 1%	156 21%	282 38%	236 32%	68 9%	749	2.73	0.92	16 3%	194 31%	312 49%	92 14%	22 3%	636	3.14	0.82
Do you know what mathematics is?	35 5%	497 66%	178 24%	38 5%	2 0%	750	3.70	0.65	45 7%	431 68%	135 21%	20 3%	1 0%	632	3.79	0.62
Do you think you will remember this class 10 years from now?	11 2%	186 26%	303 42%	178 25%	44 6%	722	2.92	0.90	151 24%	336 53%	119 19%	20 3%	6 1%	632	3.96	0.80

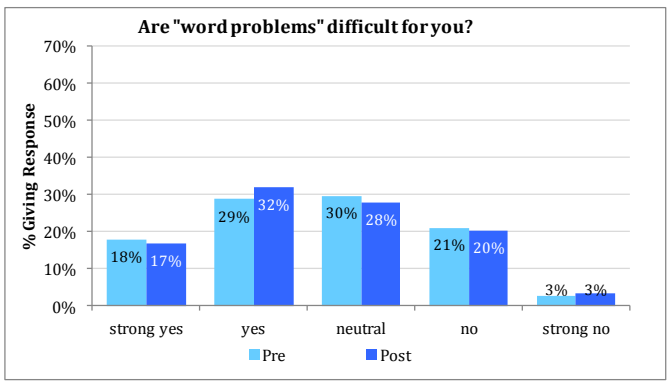
The table does not do justice to the true size of some of the effects, so the distributions are shown again on the following graphs, with one provided for each question.

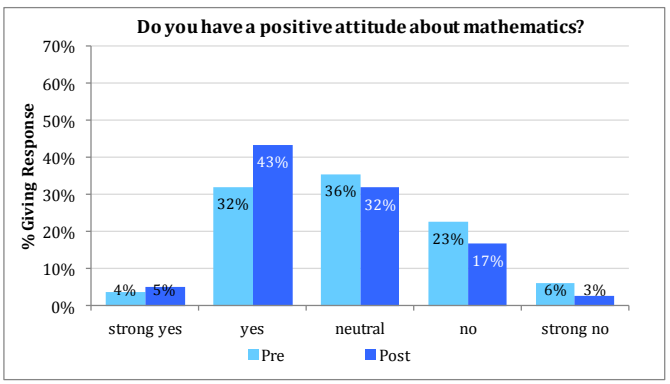


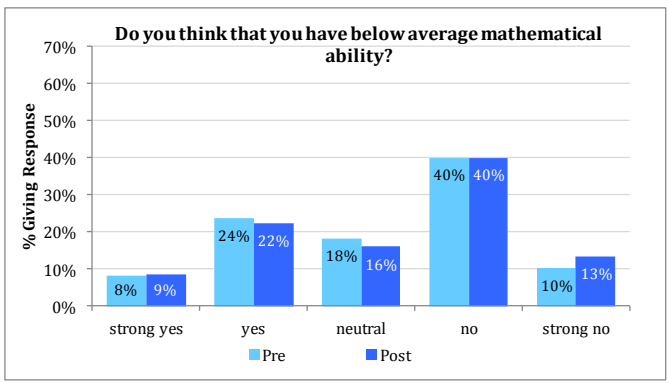


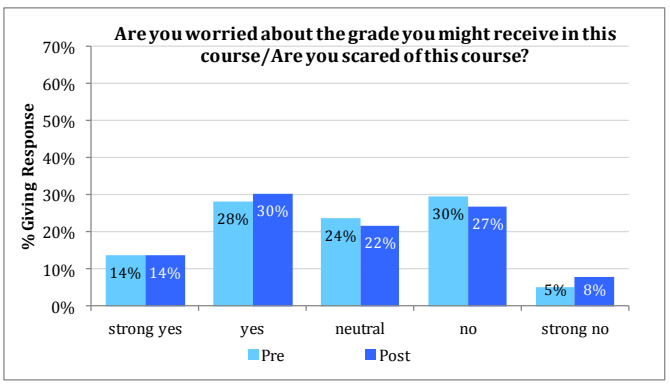


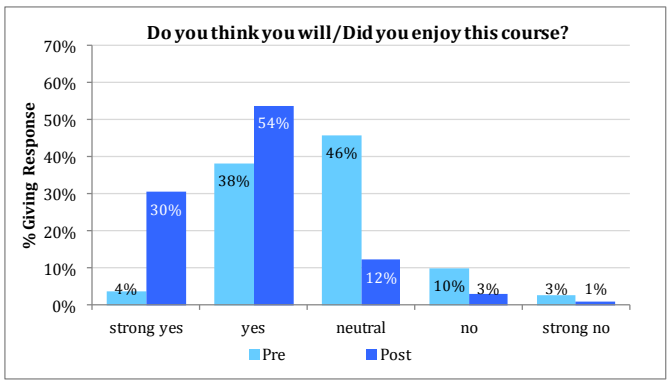


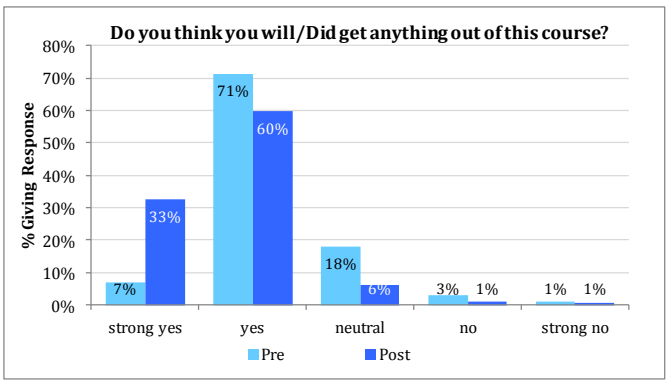


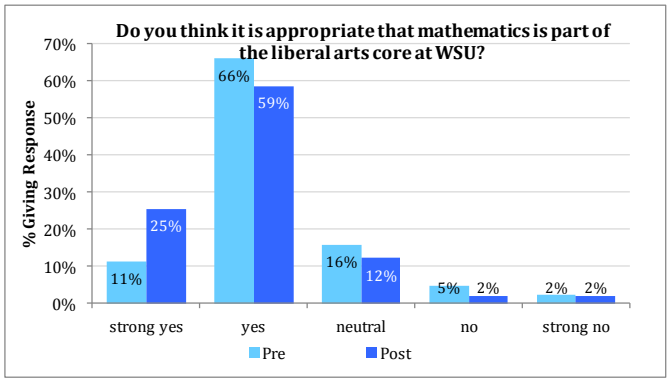


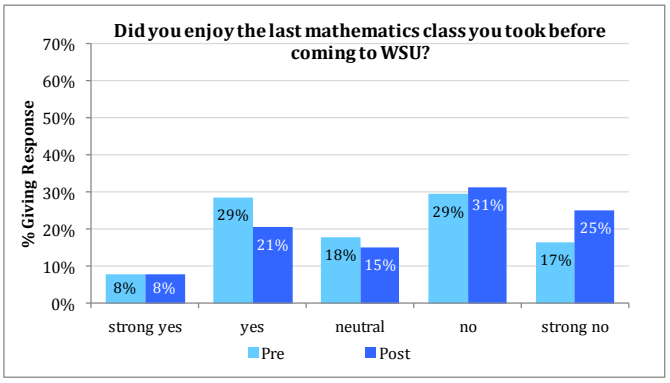





Do you think you will/Did you enjoy this course?
% Giving Response
70%
60%
50%
40%
30%
20%
10%
0%
4%
30%
38%
54%
46%
12%
10%
3%
3%
1%
strong yes
yes
neutral
no
strong no
Pre
Post


Do you think you will/Did get anything out of this course?
% Giving Response
80%
70%
60%
50%
40%
30%
20%
10%
0%
7%
33%
71%
60%
18%
6%
3%
1%
1%
1%
strong yes
yes
neutral
no
strong no
Pre
Post


Do you think it is appropriate that mathematics is part of the liberal arts core at WSU?
% Giving Response
70%
60%
50%
40%
30%
20%
10%
0%
11%
25%
66%
59%
16%
12%
5%
2%
2%
2%
strong yes
yes
neutral
no
strong no
Pre
Post


Did you enjoy the last mathematics class you took before coming to WSU?
% Giving Response
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strong yes
yes
neutral
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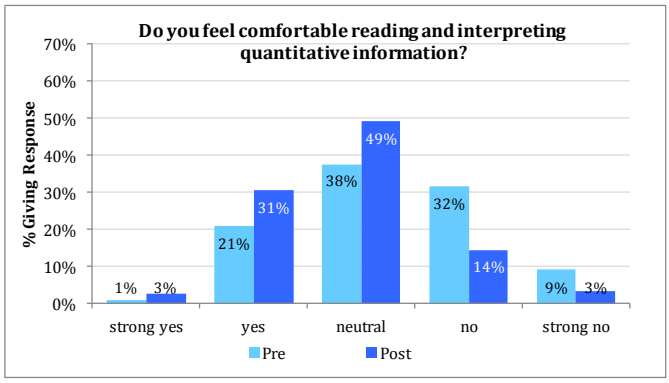
Do you feel comfortable reading and interpreting quantitative information?
% Giving Response
70%
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50%
40%
30%
20%
10%
0%
1%
3%
21%
31%
38%
49%
32%
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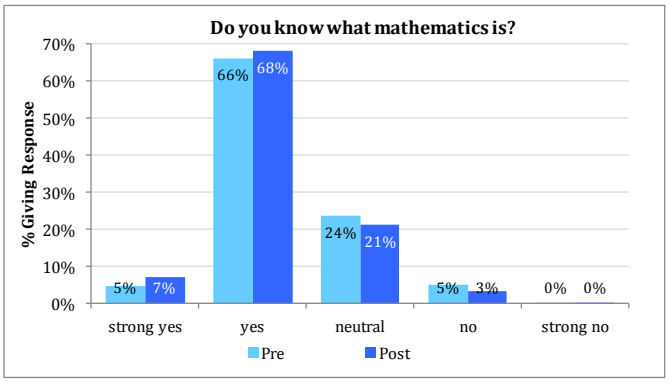
9%
3%
strong yes
yes
neutral
no
strong no
Pre
Post


Do you know what mathematics is?
% Giving Response
70%
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strong yes
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strong no
Pre
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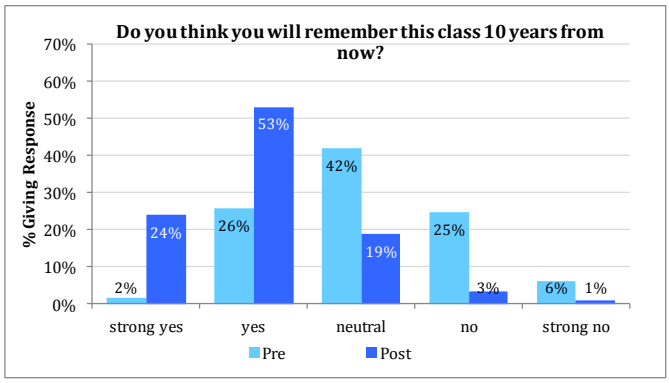
Do you think you will remember this class 10 years from now?
% Giving Response
70%
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Pre
Post